DESIGN AND DEVELOPMENT OF WHEEL FORCE TRANSDUCER TO OBTAIN ROAD LOAD DATA FROM MULTIPURPOSE AGRIGULTURAL TRUCK

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ABSTRACT

A new safe multipurpose agricultural truck popularly known as "Thai Pattana" or "E-TAN" was developed by MTEC, NSTDA for the first and second generations. For the further development and to meet the higher safety standard for the farmer on the farm of Thailand, more analysis and study on this vehicle is essential. Road load data is one of the preliminary data which needs to be obtained for its development at present state.

Road load data, which plays a vital role in design process for automotive dynamic condition before testing and analysis at different terrains: city, highway, and off-road, can be obtained by wheel force transducer (WFT). Design and development of an appropriate wheel force transducer that determines road load data for multipurpose agricultural truck is the kernel of this thesis.

Wheel force transducer need to be achieved at minimum capital with robust and user-friendly design. The road load data obtained by wheel force transducer is passed through different signal transmission devices, analogue to digital system further to the data acquisition. The specified wheel force transducer has four beams architecture with inner annular & outer annular rings with four webs on the loadcell. These webs on outer annular rings are designed to transmit force at 180 degree in phase of beam from the point of application. A unique unibody structure for loadcell has enhanced rigidity of structure. Meanwhile, rim adapter and hub adapter have been designed to assemble loadcell in between wheel rim. These adaptors has 2 mm circular offset to

maintain the axis of rotation at high speed and to provide easy assembly.

Loadcell on wheel force transducer has been designed based on shear stress principle. Symmetric design of loadcell has been done for equal distribution of load and manufacturing view point. Analysis of different thin walled: circular, square, octagonal and hexagonal beam with circular hollow having equal cross-section area and volume was performed to determine stress pattern. Though shear stress on circular beam was found to be maximum, square hollow beam with 26% less shear stress than circular beam has been selected for its manufacturing-oriented design and sensor placement.

While wireless adapter and power supply unit has been designed to be on centre of rotation for appropriate balance as per the vehicle requirement to maintain original conditions. Eventually finite element analysis has been done to predict its strength with improved stress concentration area. At the same time different materials (SUS 630, SUS 304, SUS 400, Aluminium 2014-T6, 2024-T4, 2024-T81, 6061-T6 and 7075) and structures has been analysed resulting into light weight system.

Moreover, half bridge strain gauge FCT-2-350-C4-11 sensor has been employed at the maximum shear stress with minimum moment points arranged in Wheatstone full bridge configuration using NI 9144 adaptors identically on each four radially extended beams. Wheel force signal has been transferred through NI strain gauge module 9237 in combination with wireless chassis cDAQ module 9191. To strengthen the signal and deal with Doppler Effect during the dynamic test a simple router has been used to communicate with a fast processing notebook for data acquisition.

Finally, designed and developed wheel force transducer prototype has been tested at different phases. It has been calibrated and during the test it is able to find measure force with errors below 7%. Designed WFT maximum operating temperature is of 60 ^{0}C and it has been integrated with 15″ wheel rim.

Keywords: wheel force transducer, road load data, geometric modelling and analysis, wireless data acquisition.

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CHAPTER 1
INTRODUCTION

1.1. BACKGROUND

Thailand has been making rapid progress and has been recognised as a newly industrialized country in Southeast Asia. Since 1960s development in agriculture has supported Thailand to have transition to an industrial economy and still Thai government focus on agriculture sector [1]. Till 2006, agriculture, forestry and fishing contributes less than 10% of GDP but employed 39% of work force in contradictory 44.9% of GDP but employed only 23% of work force. Most recently Thailand has been centre of automobile manufacturing for the Association of Southeast Asian Nations (ASEAN) [2]. Taking consideration of these two sectors some enthusiastic researcher from National Metal and Materials Technology Center (MTEC), National Science and Technology Development Agency (NSTDA) performed research for the design and develop multipurpose agricultural truck. This research gave a remarkable result of first generation multipurpose agricultural truck in 2007 by second hand automobile parts.

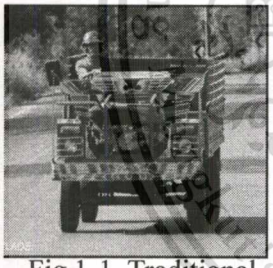


Fig 1-1. Traditional Thai Agricultural Truck

Fig 1-2. First Generation Multipurpose Agricultural Truck

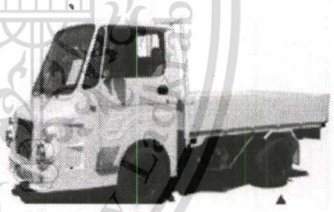


Fig 1-3. Second Generation Multipurpose Agricultural Truck

Second generation multipurpose truck has been developed till 2012. Till this date MTEC, NSTDA has collaborated with Thai industries to make truck with genuine parts. The truck has been made with limited considerations and parameters available. Now it has been more important to improve this vehicle meeting more safety standards for farmers on field. Thus, more vigorous research on each part is necessary to get those particular data in the real time condition. To meet this need, efficient tools are required to measure data serving as basis for simulations and for design of vehicle bodies, chassis and drive trains.

Wheel force transducer (WFT) is one of these essential tools to acquire data. Road load data (RLD) is one of the preliminary data which needs to be obtained for its development at present stage. Once road load data generated; this data supports whole vehicle development process ensuring the design, simulation, validation. This data will be representative of intended market to ensure a high quality and reliable product. Road load data saves the time and cost for research during modeling and analysis before new product or prototype.

Advantage for use of wheel force transducers is to instrument vehicle components to measure the forces directly in each component. An advantage of this method is potential for minimal modifications to the vehicle components, and mass-elastic properties of the vehicle can nominally be maintained.

Other alternative to obtain road load data would be installing strain gauges on the suspension components. Disadvantage of installing strain gauges on components to obtain stress and strain, desired components may require additional machining to physically have clearance for gauges and wiring, and may require additional machining to minimize material in areas to achieve a minimally desired stress and strain levels. These modifications can affect weights and stiffness of suspension components such that they no longer represent standard vehicle components. Thus, at same time labour, disassembly and reassembly, and component modification where we want to find stress and strain can make traditional component instrumentation undesirable.

Another negative aspect of classical component instrumentation is that components inherently will have high errors due to fact that structural design of these components is not optimized as a transducer. Classical component instrumentation can be very time consuming and costly, and often resulting data can be subject to high errors in linearity, hysteresis, etc. as well as calibrated accuracy errors [3].

Wheel force transducer avoids lots of disadvantages as it is close to load interface of vehicle which is tire contact patch. It replaces the wheel disc by a loadcell, which is designed not as a vehicle component but as a sensor. Accuracy is much better then and all requirements of a measuring system can be met without restrictions [4].

1.2. PROBLEM STATEMENT

As design and development of multipurpose truck was a low budget project to buy a commercial wheel force transducer was not feasible but was very important. Other was wheel force transducer available in market was not designed for Thai agricultural truck thus it was an essential factor for its design and development. Next commercial wheel force transducer had a tedious data acquisition thus a new technology with Wi-Fi data acquisition system has been introduced and tested. These are some of the problems that made design and development of wheel force transducer to be essential.

1.3. OBJECTIVES

The objective of this thesis is design and development of wheel force transducer locally to obtain road load data to develop multipurpose agricultural truck to increase the safety standard for its use on the farm of Thailand. Meanwhile, concept for signal processing with wireless technology for data acquisition system minimising than with slip ring technology has been done. Structure design affects the signal transmission. Thus, simple and compact design of wheel force transducer with manufacturing oriented design is other challenge of the project.
Challenge In short the objective and scope of work are:

1.4. SCOPE OF THE WORK

- ✓ Design and development of loadcell and other components of wheel force transducer required for it to fix on the wheel.
- ✓ Analysis of components using finite element method to predict design parameters of the components.
- ✓ Design and development of data acquisition system for the wheel force transducer.

CHAPTER 2
LITERATURE REVIEW

Beginning with steam engine and evolving to complex consumer need to luxury automobile, engineers has been designing for hundreds of years. They have been developing first self-power engine as a steam engine 1769 to today's luxury hybrid vehicle. To meet customer need, improvement on design and development of more sophisticated vehicle designers need real time data. Road load data is one of those data which is essential for vehicle development at preliminary stage [5].

Road load data is essential on design and development process for automotive dynamic condition before testing and analysis at different terrains for example; city, highway, and off-road. It is equally important for durability and endurance estimation for the existing product. Road load data acquisition saves time and cost for research during the modelling and analysis before new product or prototype [4], [6], [7]. This road load data directly depends upon the road profile, driving condition and environment.

Certain types of on-road and in-lab testing of wheeled vehicles requires transducers that can sense tri-axial forces (fore/aft, vertical, lateral) and moments (torque, camber, and steer) introduced into the spindle of a vehicle's suspension. Common transducer designs for this purpose incorporate load sensing elements within a wheel or more specifically, in space between tire and wheel hub. This type of six-channel multi-axial transducer is commonly referred to as a wheel force transducer (WFT).

It is of great significance to measure wheel force in multi-axis in real time, for researching and estimating the dynamic performance of the vehicle, such as braking, accelerating, suspension, tire abrasion and road profile collecting.

In using a wheel force transducer, generally a modified or substituted rim and transducer assembly is assembled to the vehicle spindle. Loading of tire and rim is measured at transducer and output from spinning tire can be gathered by data acquisition via a contacting slip ring, telemetry or other signal transfer device.

2.1. WHEEL FORCE TRANSDUCER SYSTEMS

Wheel force transducer systems are generally expensive, and complex. Many automotive industries had their own standards; till 1993 some car company build their

own WFT because available systems on market did not meet their needs. Many of them build were dedicated to one vehicle and not easily adaptable to other machines. Walter Weiblen and Thomas Hofmann in 1997 investigated different wheel force transducer system all over the world available on that period. They found seven types of wheel force transducer during their investigation. These two researchers had involved nine supplier companies selling WFT for actual and detail information. They also include information and other feedbacks of the supplier companies [8]. Moreover, second paper was published by Walter Weiblen, Hans Kockelmann and Hans Burkard with additional information. While Japanese wheel force transducer system was not available overseas and kept secret. Therefore, Japanese wheel force transducer systems was not included into their evaluation. Thus an overview on the commercial wheel force transducer status by middle of 1998 was achieved.

According to the research there were seven types of WFT namely D, I , K , R, V, G, M system while the Japanese system was given the name T system after Tokyo Sokki Kenkuyo, a WFT manufacturing company(more details following sections). Among these D, I , K , R and V system were the leading systems which were optimized and show innovation. G system was on full development phase, which had reached the end of the product cycle. This system had been replaced by M system as a newly introduced system. Meanwhile, D, K and M are sold and serviced with a global sales organisation. I and V are sold and serviced directly from Germany and Europe is the main application of these systems. R-system was predominantly used and found in the USA.

These WFT-systems basically classified into three design categories:

2.1.1. STRAIN GAUGED BEAM AND SPOKE

Strain gauged beam and spoke are widely used type of wheel force transducer system. Most of the WFT belong to this category namely D, G, M, R, and T. Strain gauges as a sensor is directly applied to a structure consisting of beam and spoke elements. Sensor are important elements for WFT, some of the sensors provided by different companies are mentioned. In the area of high precision six component WFT the GSE/ RS-Technology provide sensor for G- system, the DATRON supply for D-system, Tokio Sokki provide for T.

Wheatstone full bridge configurations are used for the strain gages to one bridge per load component. This configuration helps using symmetry effects temperature compensation to a high degree without additional means. Rim stiffness doesn't affect measured signals. Crosstalk compensation is essential as manufacturing tolerances such as positioning of strain gauges can be reduced but not avoided at all. Measurement of static and dynamic loads and moments is possible with a high accuracy (better than 2% of FS). Weight, mass, stiffness and inertia equal to a standard wheel are achievable in nearly all cases. The cost of this type of design is comparatively high as lots of strain gauges have to be put very accurately to the surface of a complex structure including all of the wiring.

D-System

D-systems have been upgraded to use a D/D slide-in card into the MEGADAC data acquisition systems. This WFT was developed and use in late 70's. It has been available on market since 1996. An absolute angle encoder senses the wheel position. Within the rotating wheel electronics the bridges are supplied and the bridge signals are amplified to a level of 5.

G-System

G-system was developed by GSE at its full stage and reached to end of production cycle. This wheel force transducer consists of a quenched and tempered low alloy steel structure. This system used 24 strain gages as sensor to sense shear stresses. Power supply and signal transmission is either achieved by slip rings analogue wise, or digitally, using a PCM transducer. Coordinate conversion is done on-board analogue wise or digitally.

M-System

After some years of selling WFT systems based on the G-system a new lightweight wheel force transducer was introduced which has been engineered by MTS Systems Corporation. This system, called SWIFT (Spinning Wheel Integrated Force Transducer) was presented by the end of 1997 and shown at the SAE exhibition in spring 1998. The slip-ring assembly is attached to the strut carrying also the angle encoder.

R-System

This system is basically similar to G-system; yet it is optimized to reduce the mass and the temperature drift. The new transducer elements are one-piece especially heat treated high strength aluminium alloy. It is available with a slip ring assembly as a fully analogue system. It includes an angle encoder and an additional temperature channel to sense for the temperature of the electronics.

2.1.2. INDIVIDUAL LOADCELLS

Wheel force transducer in this category consists of three axis force sensing loadcells. These loadcells are arranged symmetrically on a circle on the wheel as a sensor. IGeL I-system and KISTLER K-system follow this basic design.

I-System

This system was developed in the early 90's for AUDI. Carbon fiber composite material was used for the development of I-system WFT. It carries hall-sensors to sense the wheel position as an incremental angle encoder and wheel rotational direction. This hall sensor used 60 magnets while it was increased to 180 magnets later to increase its resolution. I-system also uses a PCM telemetric system. Signal amplification is done in wheel electronics, coordinate conversion in the on-board electronics.

K-System

K-system sensor is quite similar to I-system using 3 axis piezo-loadcells instead of strain gauge loadcells. The angular position of the wheel is determined by an electromagnetic angle encoder in the RWD, and a built-in analogue calculator then transforms the rotating coordinate system of the RWD into a stationary coordinate system relative to the car body, using the output from the angle encoder.

2.1.3. MECHANICALLY SEPARATED LOAD COMPONENTS

Wheel force transducer following this design features two sets of measuring elements of strain gauged bolt or spoke design. Six temperature and velocity compensated

strain gage bridges (in total 56 strain gauges) sense each of the six load components. WFT-system using this principle is VELOS V-system.

2.2. SIGNAL TRANSMISSION

Complete vehicle data acquisition systems are generally expensive, and complex. Many are dedicated to one vehicle and not easily adaptable to other machines. The challenge is in transmitting signals from revolving wheel to the stationary on-board data logging system. Different electronics and angle detector helps wheel force transducer to detect tractive force and moments of the wheel on a vehicle. It is difficult to measure vertical and horizontal forces acting on a wheel in motion and there is no easily accessible interface between revolving wheel and vehicle chassis. Thus measurements of wheel force have received considerable attention in tractive performance studies.

Different researchers have done research for most of the systems for measuring vehicle performance. Ground speed has been measured from rotational velocity of a non-drive wheel [9], radar and sonic units [10]. The axle or drive-wheel speeds were measured using magnetic sensors [11], direct-current tachometers, rotary encoders or indirect measurements from the engine speed [9], [13]. The drawbar pull has been measured from strain gauges mounted in tractor drawbars [10], strain gauged three-point links and three-point hitch dynamometers [11].

A wheel torque meter with conventional strain gauge techniques was developed by Anderson et al (1974) to measure applied wheel torques. The common method for wheel force measurements is strain gauges with a slip ring mounted at the outer end of the axle to stationary recording equipment [11], [12], and [13].

The other method of telemetry is that of actually transmitting the strain gauge signal through the use of radio-frequency transmitters mounted on shaft and picking up the signal by means of a receiver placed nearby .Musunda et al. (1983) used a set of strain gauges and a commercially available FM (Frequency Modulated) telemetry system on the drive shaft of a four-wheel drive (4WD) tractor for torque measurement. The FM telemetry eliminated the use of slip rings. One data acquisition package had a radio telemetry system (Freeland et al., 1988) that protected microprocessor from a harsh environment [14].

2.3. BENCHMARKING AND TECHNOLOGY SURVEY

W. Weiblen and T. Hofmann 1997 and 1998 did research for seven types of wheel force transducer around the globe with the same methodology. They did analysis based upon the data and information provided by the suppliers. As wheel force transducer is very expensive device and similar methodology has been followed. Technology survey was done based on the literature found on the online web.

Currently, wheel force transducer use two different types of sensor. These sensors are typically selected during the selection of loadcell:

1. Electric strain gauges
2. Piezoelectric materials

2.3.1. ELECTRIC STRAIN GAUGES TRANSDUCER

Transducers with strain gauge principle are sometimes known as passive transducer. With passive transducer systems the force to be determined is measured indirectly via the deformation of the elastic measuring element. The loadcell element must be selected for appropriate elasticity so as to ensure adequate sensitivity. The advantage of this measuring technique is that there is no lower cut-off frequency, thereby allowing a purely static measurement to be made.

2.3.2. PIEZOELECTRIC MATERIAL TRANSDUCER

Transducer with piezoelectric material has same material as measuring element and the sensor element. Therefore it is not necessary to measure deformation and correlate. Advantage of this measuring technique is loadcell elements can be kept smaller by several orders of magnitude. In this technique sensors are characterized by extremely high rigidity, combined with a correspondingly high natural frequency. Given an appropriate design, rigidity and sensitivity are independent parameters. While for the piezoelectric measuring technique, the lower cut-off frequency largely depends on the time constant or drift of the charge amplifier, in which case we speak of a quasi-static measurement.

Some of the details of Kristler; a leading wheel force transducer company, RoaDyn P103/106 were studied. The mechanical designs of both single-component and multi-component rotating wheel dynamometers are basically similar. As shown in Fig3-1,

eight shear sensors are incorporated between the bases and cover plates in the single component wheel dynamometer. The components are linked under a high mechanical preload via the preload bolts and nuts, so that there is sufficiently high frictional force for transfer of the shear forces perpendicular to the preload bolts. The orientation of the sensors is selected in such a way that the sensitive axis of the pair of quartz plates in the sensor is tangential to the circumferential direction about the wheel axis of rotation, in order to determine the applied drive or braking torque via simple geometric relationship [15].

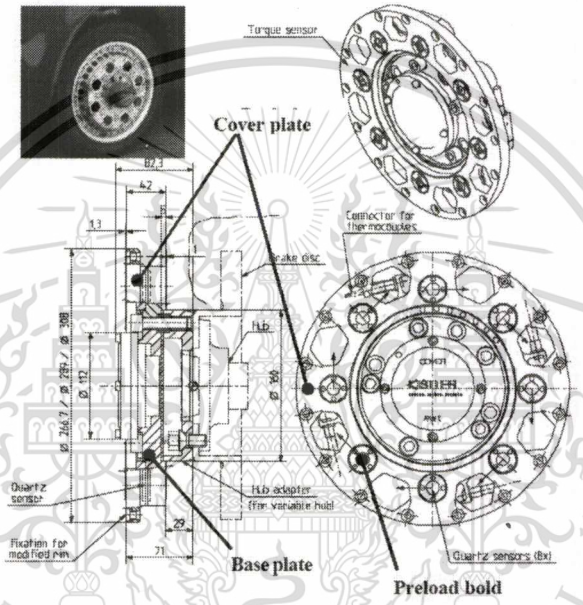
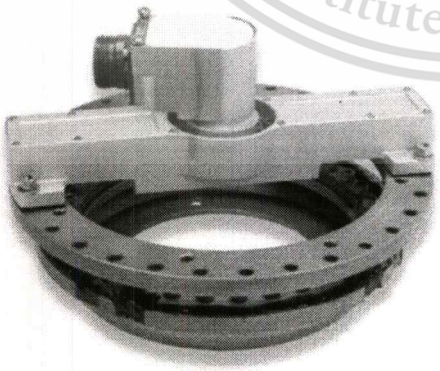


Fig 2-1. Design of the RoaDyn P103



Model: LW9.5 and LW9.5T

Fig 2-2. Michigan Scientific Corporation Wheel Force Transducer

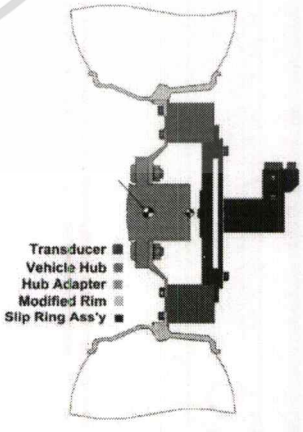


Fig 2-3.RS Technology Wheel Force Transducer

2.4. FINITE ELEMENT ANALYSIS

Customer demands for new products with high quality and effective cost puts much pressure on scientists and research engineers. Being equipped with cutting-edge technology tools fulfils customer demand effectively. In general, engineering problems are mathematical models of physical situations. These mathematical models are differential equations with a set of corresponding boundary and initial conditions. These differential equations are derived by applying fundamental laws and principles of nature or science or a control volume. These governing equations represent balance of mass, force or energy.

In an engineering problem, there are two sets of parameters that influences the way in which a system behaves. First, there are those parameters that provide information regarding natural behaviour of a system. In other word the physical parameters or the properties such as modulus of elasticity, thermal conductivity or viscosity etc. These can also be known as homogenous part of analytical solutions. Next, there are those parameters that produce disturbances in real life or in a system. These parameters include external forces, moments, moment of inertia, temperature differences across a medium and pressure difference in a fluid flow, voltage difference etc. These can also be known as particular part of analytical solutions. It is important to understand the role of these parameters during simulation, particularly finite element modelling (FEM) and finite element analysis (FEA).

Analyse and test of system before a large investment has become an urge for entrepreneurs, popularly known as simulation. Simulation is the art and science of creating a representation of a process or system for the purpose of experimentation and evaluation. Meanwhile, prediction of system performance, evaluation of a certain feature in the system, comparison between several alternatives and gaining knowledge of the system at different phases, problem detection, and presentation of predicted results are very essential.

For effective design, analysis and optimization of system over time simulation is one of widely accepted and reliable tool. In 1971 ANSYS was released for the first time. For the finite element analysis some of the parameter we need to define are force, element size and constrains collectively known as boundary conditions. FEA has been utilized using ANSYS for obtaining stress-strain histories of materials to design components.

CHAPTER 3
DESIGN OF WHEEL FORCE TRANSDUCER

Wheel force transducer design is a complex undertaking process, requiring many skills. Extensive relationships need to be subdivided into a series of simple tasks. The complexity of the subject requires a sequence in which ideas are introduced and iterated. Need of good design for efficient manufacturing at the design stage of the product was essential at the period.

Designed wheel force transducer design decisions sometimes had to be made with too little information, occasionally with just the right amount of information, or with an excess of partially contradictory information. Decisions were sometimes made tentatively, with the right reserved to adjust as more becomes known. Design has been made by communication-intensive activity in which both words and pictures are used, and written and oral forms. Also lots of brainstorming has been done to develop the wheel force transducer including the manufacturing expert.

A designer's personal resources of creativeness, communicative ability, and problem solving skill are intertwined with knowledge of technology and principles. Engineering tools are combined to design wheel force transducer, that is functional, safe, usable, manufacturable, regardless of who builds it or who uses it.

3.1. WHEEL LOAD TRANSDUCER OVERVIEW

An overview of the wheel force transducer has been overdrawn after study of different scientific literatures and company literatures for the product. Moreover, in this thesis electric strain gauge transducer has been introduced for low cost and robust design for multipurpose agricultural truck. After research on wheel force transducer, I have decided to differentiate the process and corresponding parts into two sections highlighted below:

1. Mechanical Process and Components
2. Signal Transmission Process and Components

3.1.1. MECHANICAL PROCESS AND COMPONENTS:

Mechanical process measures Road Load from ground to wheel through loadcell. During strain gauge based transducer design, mechanical component and selection of its materials plays a vital role for the determination of actuating response from the source to sensor. Wheel force transducer's mechanical component principally consists of three components as shown in fig 3-1 which are listed below:

1. Rim adaptor
2. Hub Adaptor &
3. Loadcell

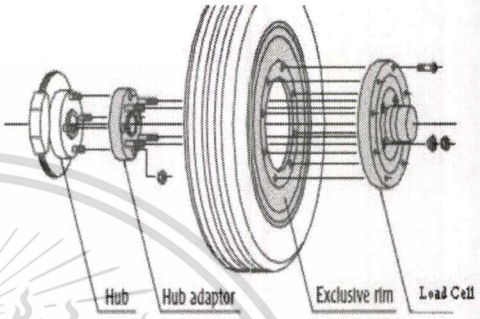


Fig 3-1. Mechanical Components

Mechanical component on wheel force transducer helps for the transmission of road load data from ground via sensing circuit and sensors employed on loadcell. This loadcell is mounted in between the spindle and wheel rim. Rim of the vehicle need to be modified during this process to adjust loadcell components. Rim adaptor is welded on the modified rim while hub adaptor is fixed on the hub of vehicle axle. Then the loadcell is fixed by the help of wheel hub adaptor and rim adaptor as indicated in the fig 3-2 below.

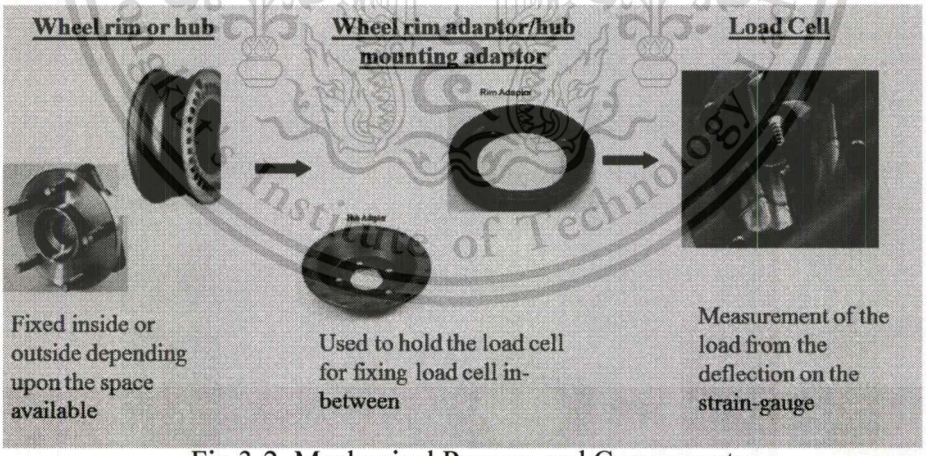


Fig 3-2. Mechanical Process and Components

Signal obtained from strain gauge sensing circuit is converted from analogue to digital signal through various signals processing unit to obtain the road load data. Mentioned wheel force transducer loadcell consists of outer and inner annular disc with radially extended beams. Outer and inner annular disc are designed to fix it with rim adaptor and hub ring respectively. Radially extended beams are designed in between either of the annular beams. These beams are so designed to attach sensors and their number

can be varied as per the need within 360 degree. Meanwhile, loadcell on this kind of wheel force transducer must be unibody component as shown in fig 3-3.

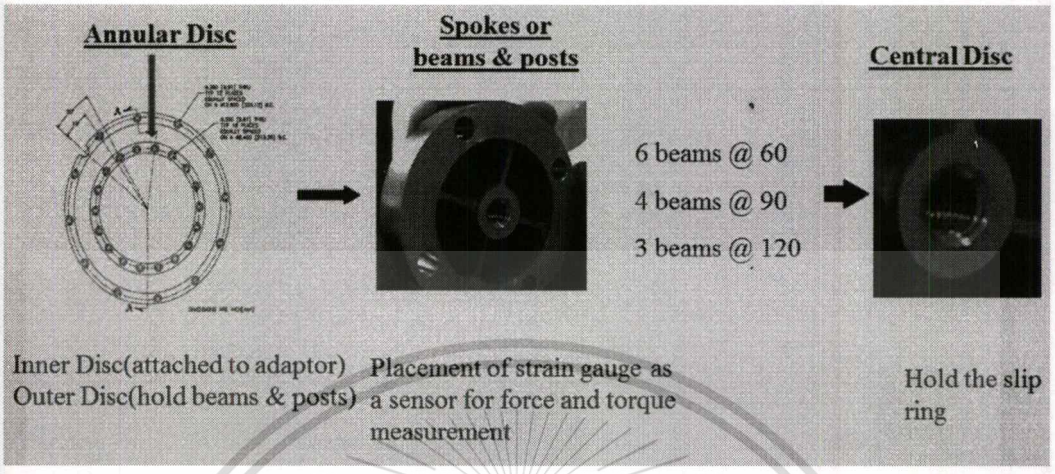


Fig 3-3. Loadcell Components

3.1.2. SIGNAL TRANSMISSION COMPONENTS

Signal Transmission components indicate those components which are used for data acquisition on wheel force transducer from sensing circuit employed on loadcell along with digital or analogue computer via different modes. Obviously, data acquisition system has been considered as a vital system for any of the transducer. Data acquisition method can be categorised on the basis of ways of transmission as highlighted below.

1. Slip Ring Data Acquisition System
2. Wireless Data Acquisition System

Slip Ring Data Acquisition System:

In this system, slip ring would be used to transmit data from the sensing circuit to analog or digital computer as shown in fig 3-4. All of the signals obtained from the loadcell would be passed through cables without twist during rotation of the wheel. Slip-ring telemetry has been used to solve the problem of twisting of cables during the high speed rotation of vehicle on dynamic test. Mostly, this kind of arrangement includes amplifying circuits before slip ring. By amplifying output signals, problems associated with noise introduced by slip ring are reduced. In this configuration, mounting plate is required to mounts slip ring assembly to central hub.

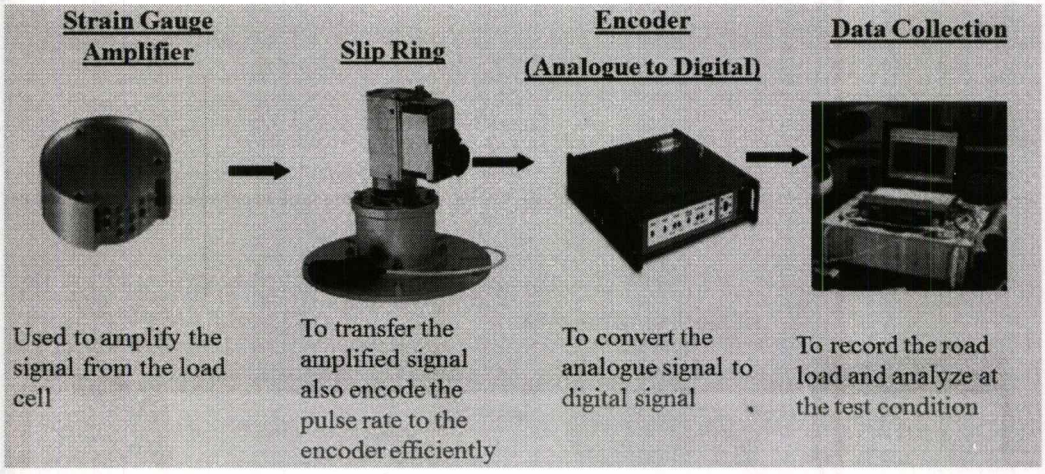


Fig 3-4. Slip Ring Data Acquisition Process and Components

Wireless Data Acquisition System

In this system wireless data acquisition device would be used to transmit data from the sensing circuit to analog or digital computer directly via electromagnetic wave or it would be stored on memory chips/card. This wireless data acquisition device would be fixed on wheel of the vehicle. An external router would be used to communicate with the cDAQ device providing the ad-hoc network overcoming the dropler and hopper effect and making signal transmission stronger (more detail on Section 3.5).

3.2. DESIGN CRITERIA

To design wheel force transducer information about the vehicle was the first step. This multipurpose agricultural truck had a maximum load of 5 Tonne. An assumption was made for the load distribution of 40% on front axle and 60% on rear axle. 20kN force on the front axle and 30kN at the rear axle was supposed to be distributed on the multipurpose agricultural truck. Although the rear load would be divided equally on two wheels; 30kN load was kept for analysis as it has to be tested on harsh condition.

Design and development of wheel force transducer's loadcell is the most sensitive part which needs to be designed with greater effort. This loadcell need to be designed to sense force in two dimensions (x-axis and z-axis force). It is not only the most essential part of wheel force transducer, but also the most vulnerable to be designed within limited space available.

Meanwhile, different adaptors for loadcell have been designed as per the attachment for loadcell. These adaptors not only help to hold the loadcell at its designed axis, also helps to maintain the original condition during the tests.

Wireless adaptor with three legs has been designed carefully not only to hold data acquisition hardware perfectly on the rotating wheel but also to should have an easy inter-changeability and its functional monitoring compatibility.

3.3. DESIGN METHODOLOGY

A flowchart has been developed for the planning and efficient design of wheel force transducer. This flowchart describes the mechanical components design of transducer keeping in mind sensor placement and arrangement of data acquisition components. This design methodology has been developed for robust design at low cost with manufacture oriented design at limited space in between the modified rim and spindle of multipurpose agricultural truck.

Designer must first understand the function of a device before designing its architecture. Knowledge of a concept gives an idea that is necessary to evaluate the physical principle that governs its behaviour. Confirming that the concept will function as expected with feasible development is a primary goal in in WFT design.

Following flowchart shows the step in decision making either to go for the manufacturing of the designed structure as per the manufacturer or modify the design for further improvement with compromise on the design parameters.

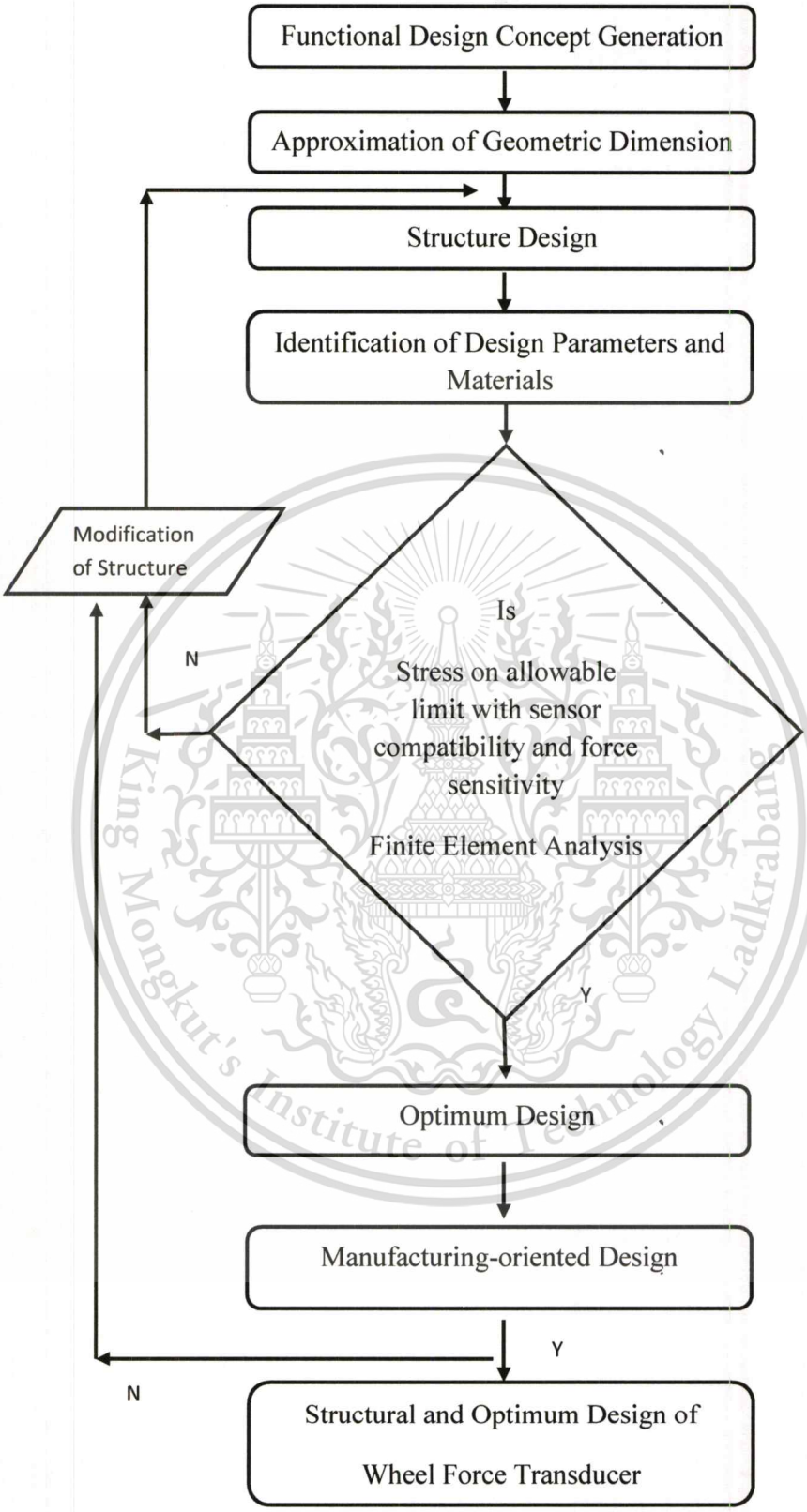


Fig 3-5. Design Flow Chart

3.4. CONCEPT DESIGN

Compared to embodiment and detail design, the conceptual design stage of the design process is more critical. Studies indicate that about 70% of the product life cycle costs are decided during conceptual design and on average, industries spends 15% of design time developing a concept. Concept can be represented as verbal or textual descriptions, sketches, paper models, block diagrams or any other form that gives an indication of how the function can be achieved.

During the conceptualization stage, a common vision of the end product had been established. This vision provides consistent set of design goals for all disciplines to maintain throughout the product development cycle. Visions for loadcell beams, rim adapter, hub adaptor and rim modification had been established during the concept design. Therefore, with a common understanding or vision within the members, set of assumptions and criteria based on only a single view of the product had been established.

A concept is an idea that is sufficiently developed to evaluate the physical principle that governs its behaviour. Confirming that a concept will operate as expected and that, with reasonable further development, it will meet the target set, is a primary goal in concept development. The primary concern of conceptual design is to identify working principles for loadcell and data acquisition mode, and based on working principles; develop design concepts that can fulfil the specified wheel force transducer design requirements.

Furthermore schematic fig 3-6 shows the concept of wheel force transducer at the preliminary stage. The concept for this wheel force transducer mechanical components is to maintain the original condition of the spindle so that there would not be any wear and tear on the spindle. Thus there would not be any risk of catastrophe during the test condition. This saves time of the research for other parts and helps to focus on transducer itself.

This figure shows the strategy to hold the loadcell in the wheel to sense the road load from the ground. In this concept original wheel rim needs to be modified at the centre. Loadcell with hollow beam shear stress principle is to be hold at the centre of rotating wheel. This loadcell concept is to be unibody structure so that it would increase the rigidity of the sensing body.

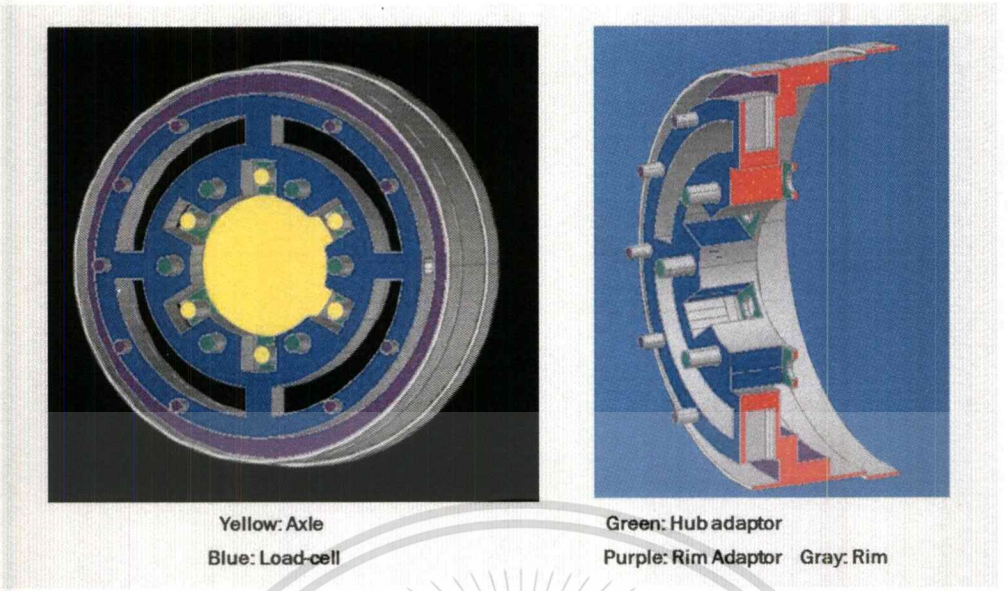


Fig 3-6. Preliminary Concept Design of Wheel Force Transducer (Mechanical Systems)

The target of functional modelling is to decompose the problem in terms of the flow of energy or force, material and information. The functional decomposition technique is very useful in the development of new products. Fig 3-7. shows the mature design concept with full function of two dimensional wheel force transducer with wireless data acquisition system.

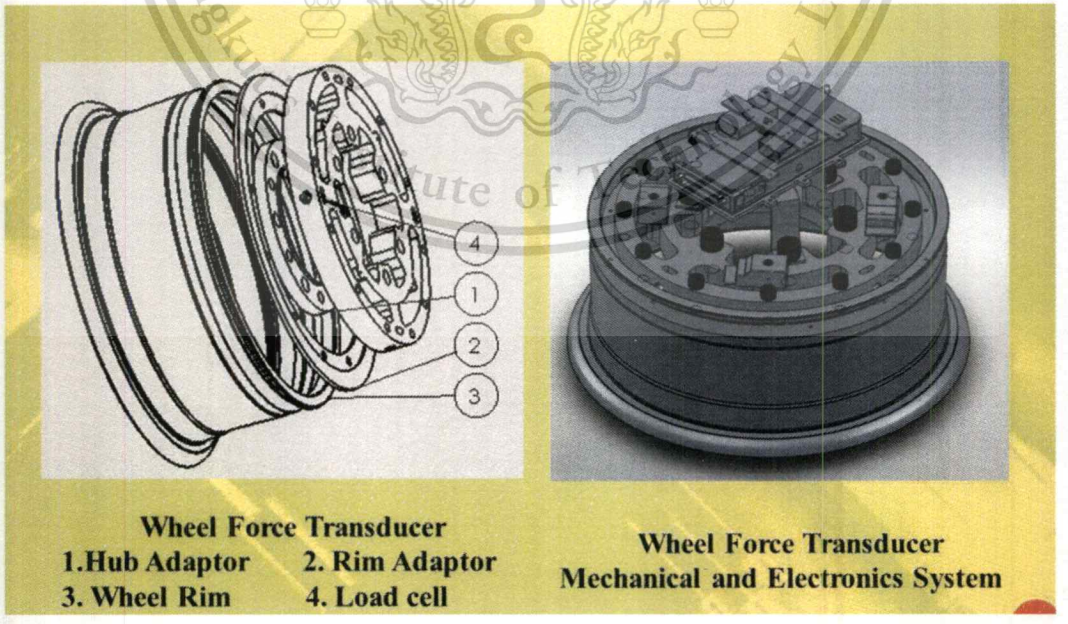


Fig 3-7. Full Phase Concept Design of Wheel Force Transducer

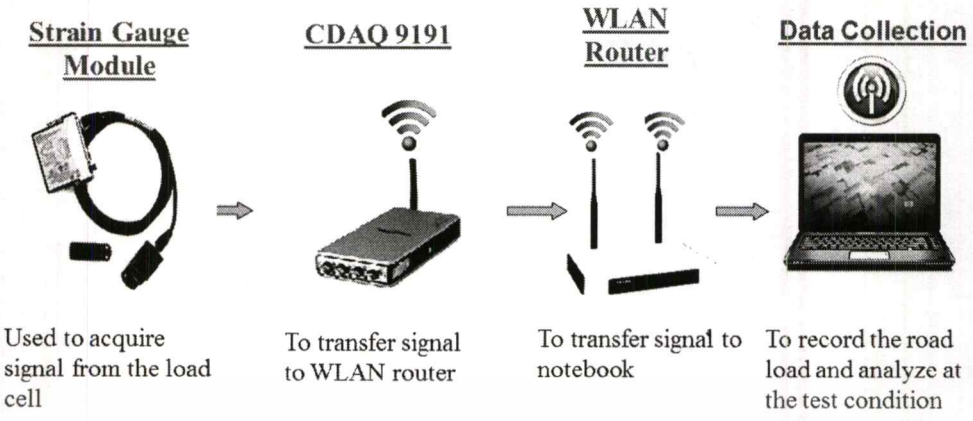


Fig 3-8. Design Concept of Wireless Data Acquisition System

For a complete wheel force transducer mechanical process and signal transmission process is essential. A new signal transmission telemetry concept has been purposed as shown in fig 3-8. Conventional design uses slip ring technology to avoid twisting of wires. Also they use amplifier and encoder to amplify signal and to convert the data from analogue to digital computer.

Purposed concept has a wireless technology, which utilizes Wireless Local Area Network by using simple router. Concept of the design is to use strain gauges arranged on Wheatstone bridge principle using NI adaptor 9149. Signals are received by input/output strain gauge module NI 9237 in combination with NI wireless cDAQ 9191. Wireless chassis module will communicate via wireless local area infrastructure network developed by a simple router to notebook. Meanwhile, data would be collected with programming in electronic software "LabView". Hence, this system eliminates signal amplifier and slip ring.

Specification for the wireless module is very important. As the device rotate on the wheel some shock and vibration need to be specified prior for its function. Some of these have been included as below.

Wireless (NI cDAQ-9191)

Radio mode	IEEE 802.11b, 802.11g
Wireless mode	Infrastructure and Ad-Hoc
Infrastructure	
Security types	WEP-40, WEP-104, WPA, WPA2
EAP types	EAP-TLS, EAP-TTLS[1], EAP-FAST, LEAP, PEAP[2],
Ad-Hoc	
Security types	WEP-40, WEP-104
Channel[3]	1–14

Antenna (NI cDAQ-9191)

Connector	Bulkhead RP-SMA connector
Electrical performance	
VSWR	Maximum 2.0 (2.4 to 2.5 GHz)
Impedance	50 Ω nominal
Directivity	Omni
Maximum gain	2.0 dBi (2.4 to 2.5 GHz)

Shock and Vibration

To meet these specifications, you must panel mount the NI cDAQ-918*x*/919*x* system and affix ferrules to the ends of the terminal lines.

Operational shock	30 g peak, half-sine, 11 ms pulse (Tested in accordance with IEC-60068-2-27. Test profile developed in accordance with MIL-PRF-28800F.)
Random vibration	
Operating	5 to 500 Hz, 0.3 g_{rms}
Non-operating	5 to 500 Hz, 2.4 g_{rms} (Tested in accordance with IEC-60068-2-64. Non-operating test profile exceeds the requirements of MIL-PRF-28800F, Class 3.)

3.5. SYSTEM DESIGN

Figure 3-9 depicts the system design of the newly designed wheel force transducer with unique wireless data acquisition features. This system has a loadcell fixed in between hub adaptor and rim adaptor in a modified rim on the vehicle spindle. Loadcell sense the load from the wheel directly after the tire contact path with the help of half bridge strain gauge attached on it.

These strain signal are transferred to strain processing module and finally to the data acquisition chassis module. Strain gauges at four radially extended beams on the loadcell help to sense compression and tension load through Wheatstone bridge principle. This cDAQ is a wireless module with Omni directional antenna. Infrastructure network has been established for the wireless module to communicate to notebook by a router.

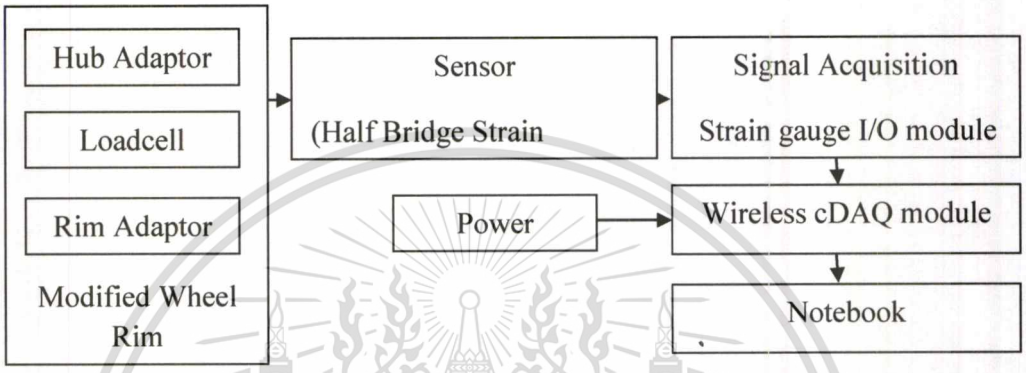


Fig 3-9. Flow Chart of Wheel Force Transducer System

Sensor installation is the most important steps for the development of transducer. Shear stress strain gauge has been selected for loadcell. Traditionally electrical components are connected together by soldering wires and so does for the strain gauge. But for this design it has been totally eliminated by the wise selection of strain gauge which has readily fixed wire. Meanwhile, Wheatstone bridge has been configured with NI 9149 adaptors. So the trouble caused by soldering iron and potentially heat up the strain gauge alloy, causing unwanted thermal effects has been totally eliminated.

The wires themselves raise some other concerns, such as wire symmetry, temperature gradients, and effective insulation of charge carrying wires. Wire symmetry is to make the wires between the gauges have a uniform length, to insure that any measured resistance changes are a result of applied strain. Excess wires have been trimmed, as any unnecessary wires in the circuit are potential sources of inaccuracies.

There are several potential dangers to the strain gauges. Other factor is strain gauge need to be protected from the environment. Strain gauges tend to be sensitive to moisture and other contaminants, so the strain gauge must be tightly sealed against these corrosive agents. Hence, protecting strain gauges would be important, so they remain unaffected for a long time.

The gauge can be sealed with a hermetic seal, wax, or rubber. The hermetic seal is the best absolute protection from environmental contaminants, sealing it within metal enclosures. However, this method is often cost prohibitive, in which case alternative seals should be used. Microcrystalline wax is a great organic sealant, within a certain temperature range, as it tends to crack at low temperatures and at high temperatures it tends to melt. Betyl rubber provides a good barrier against moisture, and it is easy to apply. Sealing the strain gauge is the final step in the design and construction of a loadcell.

3.6. DETAILED DESIGN

The detailed design phase is defined by a well-developed methodology and a rich set of CAD tools. A detailed design of each subsystem is performed with particular attention to maintaining the interface specifications. The technology selected for each subsystem is acquired and analysed in terms of functionality and performance. Analysis of the technology may necessitate changes in the subsystem specifications. During detail design after all the information has been gathered. Principle and strategy has been developed for the design of wheel force transducer. Then architecture of the loadcell, hub adaptor and rim adaptor has been determined. A strategy to attach the strain gauge had been decided as per working principle of the loadcell.

3.6.1. WHEEL DIMENSIONAL INSPECTION

Next was to get the information about the spindle axle and the wheel itself. Information of the wheel rim was taken by 3D scanner and tabulated below. Finally geometric analysis software "GOM inspect" was used to get the information more precisely in second decimal place as in fig 3-10.

Table 3-1. Different Section Diameter of the Rim

Name	Description	Diameter (mm)
Cylinder 1	Playable diameter	**363**
Cylinder 3	Bolt diameter in rim	**18**
Cylinder 4	Inner ring in rim for axle extension	**134**
Cylinder 5	External ring form bottom ring	**370**

Cylinder 6	Top side curve	**360**
Cylinder 7	Top Most	**342**
Fixing bolt	Distance of bolt diameter form inner hole	**25**

Table 3-2. Different Section Width of the Rim

Name	Description	Width(mm)
Bottom Ring Width	Bottom ring width(out of 3)	**34**
Top Ring Width	Top ring width(out of 3)	**41**
Middle Ring Width	Calculated middle ring width(out of 3)	**76**
Width	Total Width of the Disc(bottom curve excluded)	**151**

Table 3-3. Different Section Length of the Rim

Name	Description	Length(mm)
Offset	curve offset (hub angle displacement)	**18**
Thickness	Calculated thickness between bolt and inner hole	**7**
Offset weld	Distance of bottom weld part from top plane	**78**

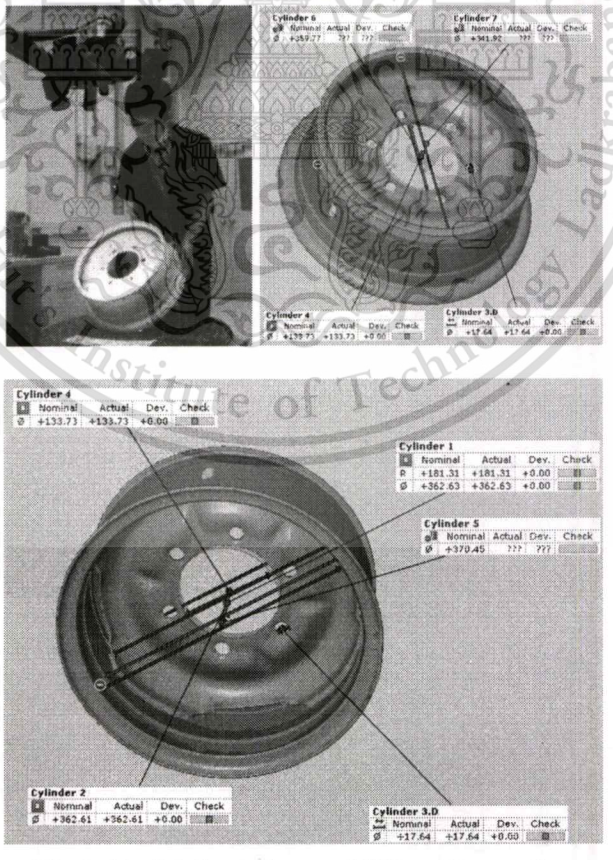


Fig 3-10. 3D Scanning and Wheel Inspection

This information was drawn to know original condition of wheel and spindle. These data was essential to design WFT to maintain original static and dynamic condition without adding extra load to wheel.

3.6.2. WHEEL FORCE TRANSDUCER PRINCIPLES AND STRATEGY

Transducer can be designed with different structures which plays a key role for the sensation of the required data parameters. While developing the strain gauge based transducer structure geometry and elastic element plays a vital role for the sensation of compression and tensions due to force. This elastic structure element should be so designed following "Hooks Law".

Wheel force transducer should be designed on the limited space in between the wheel rim and the axle of the vehicle; which has a significant contribution on sensing the force from road to the vehicle directly through the wheel.

While designing structure of loadcell different strategy and principle had been employed for its function and successful sensation of load. Some of these strategy and principle has been described briefly below

1. Loadcell designed for agriculture multipurpose truck is a unibody structure. This single integrated component helps loadcell to be more rigid and linear to the signal response. The geometry of loadcell has been so designed to reduce the stress concentration at the corners and unique geometry to fix it on wheel and NI adaptors.
2. Loadcell had been designed with geometry of four radially extended beams with inner and outer annular ring to hold it with the rim adaptor and hub adaptor. These annular rings are designed to provide the passage of the force and stress distribution to the radial beams simultaneously. Outer annular ring is designed to fix the loadcell with rim adaptor while the inner annular ring is designed to fix loadcell with hub adaptor. Two annular rings have been designed with four radially extended thin walled hollow beams with wheel configurations as shown in fig 3-11.

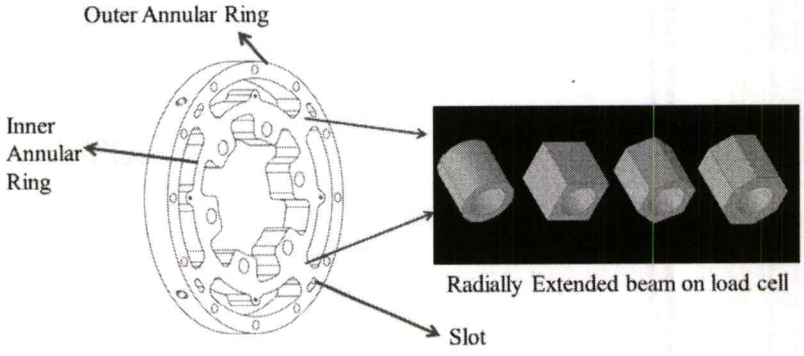


Fig 3-11. Loadcell Structure Geometry

3. Four radially extended beams are designed to sense the force from the ground, which comprises of strain sensed by the half bridge strain gauge in X and Z direction. Four full bridge Wheatstone bridge circuits have been designed for the data acquisition from the road.
4. Beams on loadcell act as cantilever beam. This beam which is clamped on one end is loaded with a force F_1 at a Distance l. The equal reactive force F_2 acts in the opposite direction. A force couple is produced as shown in Fig. 3-12. Here the points of application of the forces are separated by a large distance is of no significance for the shear stresses. Shear stresses arise in each cross-sectional plane between the points of application.

Fig 3-12. Shear Stress Distribution in Cantilever Beam

5. When we apply force on radially extended beams, at neutral axis there is a maximum shear stress and minimum bending moment as shown in figure below. Also this does not get affected to certain extent even we move the point of application of force or use the wander force as shown in fig 3-13.

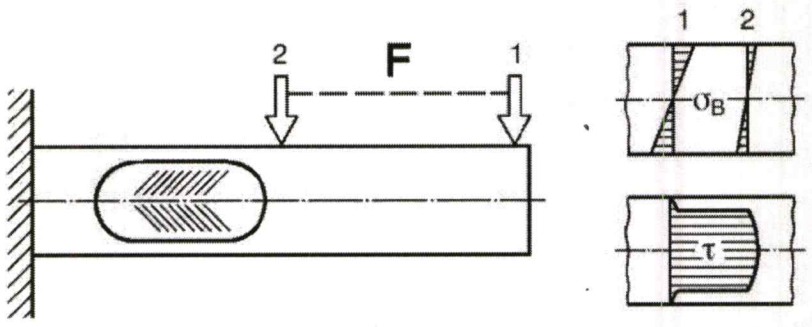


Fig 3-13. Wanderer Force Shear Stress and Bending Moment in Cantilever Beam

6. The elementary loading cases "normal" (tensile, compressive loading), "bending" and "torsion" occur very seldom, if at all, in a pure form. Usually the loading cases are superimposed to some extent whether this is desired or not. Shear stresses arise in each cross-sectional plane between the points of application. The normal stresses σ_1 and σ_2 which arise in conjunction with the shear stresses τ run as with the beam at an angle of 45° to the shear plane as in Fig 3-14 and Fig 3-15. Also the force F in the beam induces bending moment; the bending stresses thus produced are superimposed on the normal stresses. Therefore the angular value of ±45° is only exact at the level of the neutral zone, where the bending stresses are zero. Therefore it is important to mount the strain gage as close as possible to the neutral plane:

   Some of the advantages of shear beam principle structure are highlighted below:

   - $\varepsilon_{45°}$ strains become larger,
   - Bending stresses become smaller,
   - Shear stress distribution in the region of the strain gage becomes more uniform,
   - Measuring signal becomes independent of the application point of the force (in contrast to the bending beam).

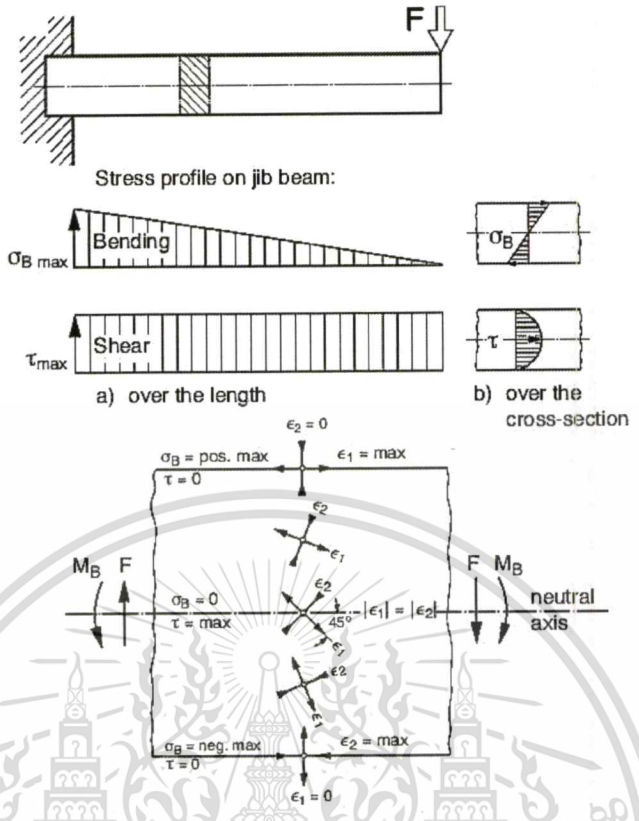


Fig 3-14. Direction of principal strain ε1 and ε2 along a cross-section line with superimposed bending and shear stresses

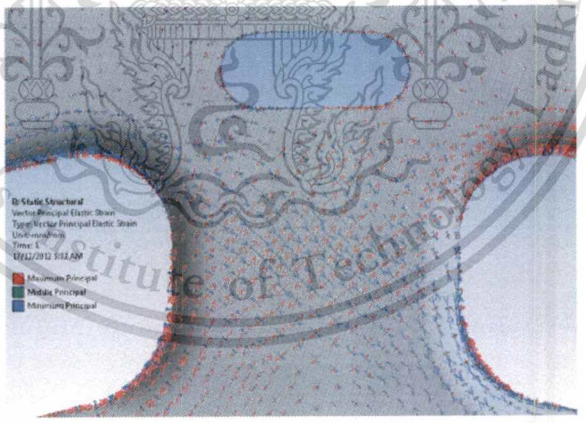


Fig 3-15. Direction of principal strain ε1 and ε2 along a cross-section line with superimposed bending and shear stresses analysed on ANSYS for Designed Loadcell

7. Slots in the flexure membrane help to pass force at 180 degree in phase in two beams. This strategy helps the beam to act as cantilever beams. Also the load would be divided to two beams than the immediate beam. Fig 16 shows application of force at a beam and fig 17 shows the corresponding effect of force application.

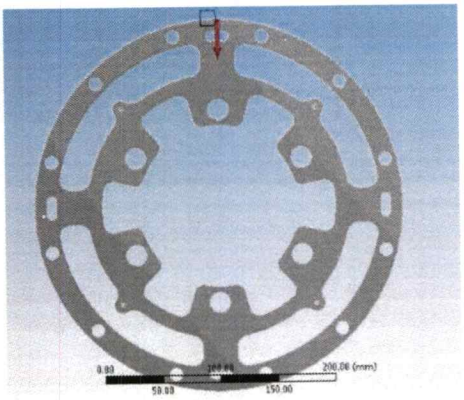


Fig 3-16. Application of force

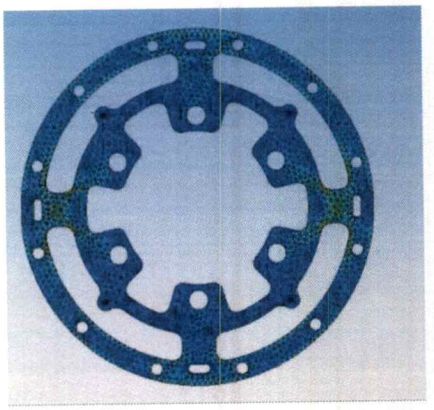


Fig 3-17.Passage of force causing shear stress max at 180 degree

3.6.3. PRINCIPLE OF FORCE MEASUREMENT DURING ROTATION

Let us consider the agricultural truck with loadcell at an angle of rotation Θ degree. A full bridge Wheatstone bridge has been configured on each beams. During this stage beam 20 (B20), beam 22 (B22) are parallel to x-axis while beam (B21), beam 23 (B23) are parallel to z axis (SAE coordinates or Vehicle coordinates).as indicated in fig 3-18. Let F_0, F_2, F_1 and F_3 be the forces in N acting perpendicularly to their corresponding beam B20, B22, B21 and B23 calculated from strain signals: strain 0, strain 2, strain 1 and stain 3 respectively (details on section 5.3). Wheel has been rotated in clockwise direction from the initial position as shown in fig 3-18 and fig 3-19.

At an equilibrium condition,

$\sum F_x = 0$, and $\sum F_z = 0$

Thus, at stationary condition or angle of rotation $\Theta = 0$ degree; we have,

$$F_z = -F_0 + F_2 \quad \text{and} \quad F_x = F_1 - F_3 \qquad (3.6.2\text{-}1)$$

When the wheel is rotated with the angle of rotation Θ, we have from fig. 3-18

$$F_z = -F_0 \cos\Theta - F_1 \sin\Theta + F_2 \cos\Theta + F_3 \sin\Theta \quad \text{(I Quadrant)} \qquad (3.6.2\text{-}2)$$

$$F_x = -F_0 \sin\Theta + F_1 \cos\Theta + F_2 \sin\Theta - F_3 \cos\Theta \quad \text{(I Quadrant)} \qquad (3.6.2\text{-}3)$$

Similarly equation 3.6.2-2 can be further simplified with quadrant angles as follows also shown in fig 3-19,

$$F_z = -F_0 \sin\Theta - F_1 \cos\Theta - F_2 \sin\Theta + F_3 \cos \quad \text{(II Quadrant)} \qquad (3.6.2\text{-}4)$$

$$F_z = F_0 \cos\Theta + F_1 \sin\Theta - F_2 \cos\Theta - F_3 \sin\Theta \quad \text{(III Quadrant)} \qquad (3.6.2\text{-}5)$$

$$F_z = -F_0 \sin\Theta + F_1 \cos\Theta + F_2 \sin\Theta - F_3 \cos\Theta \quad \text{(IV Quadrant)} \qquad (3.6.2\text{-}6)$$

Furthermore, equation 3.6.2-3 can be further simplified with quadrant angle as:

$$F_x = -F_0 \cos\Theta - F_1 \sin\Theta + F_2 \cos\Theta + F_3 \sin\Theta \quad \text{(II Quadrant)} \qquad (3.6.2\text{-}7)$$

$$F_x = F_0 \sin\Theta - F_1 \cos\Theta - F_2 \sin\Theta + F_3 \cos \quad \text{(III Quadrant)} \quad (3.6.2\text{-}8)$$

$$F_x = F_0 \cos\Theta + F_1 \sin\Theta - F_2 \cos\Theta - F_3 \sin\Theta \quad \text{(IV Quadrant)} \quad (3.6.2\text{-}9)$$

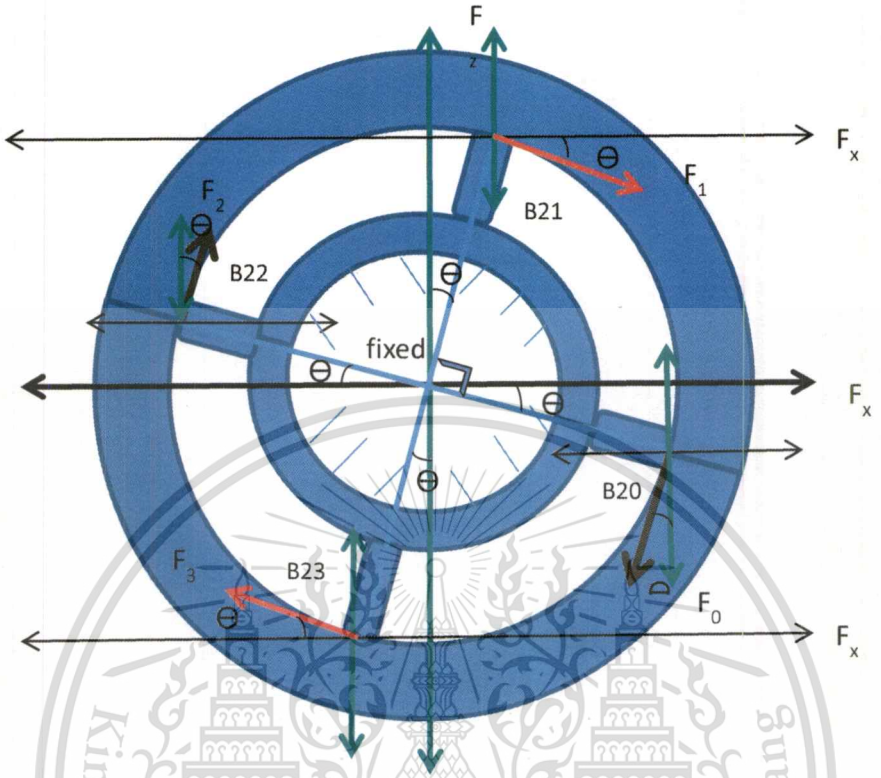


Fig 3-18. Force Model of Wheel Force Transducer

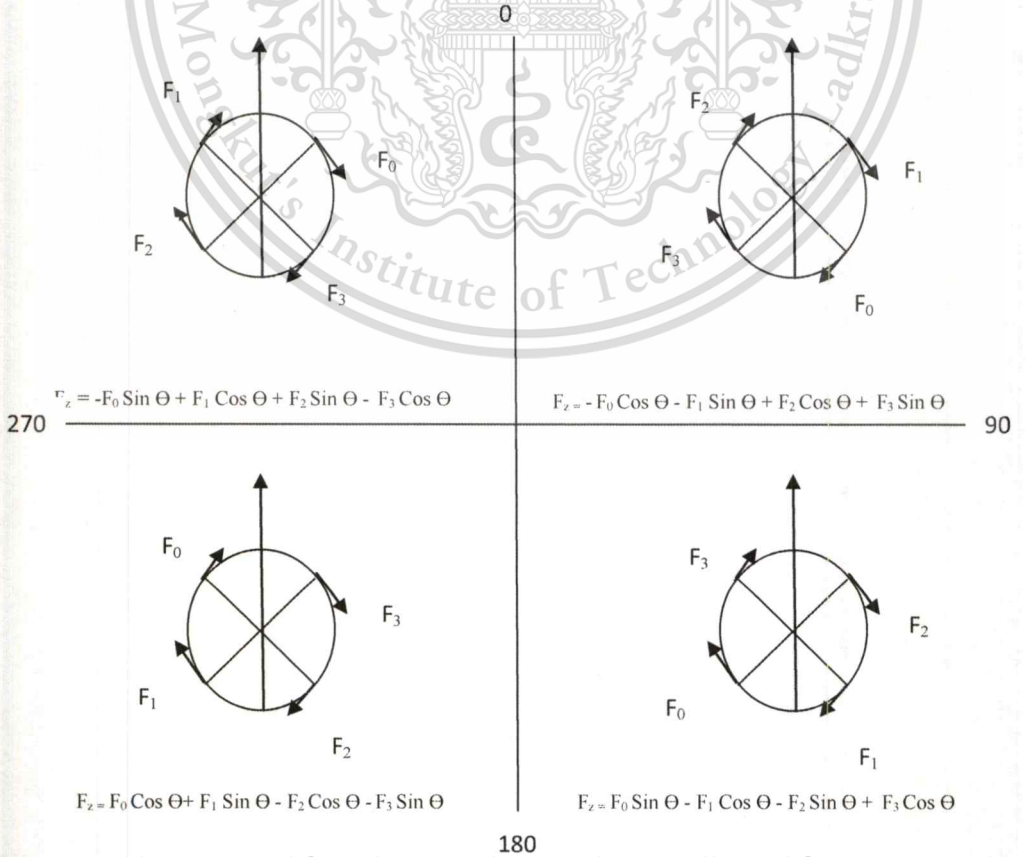


Fig 3-19. Force Model of Wheel Force Transducer at Rotation

3.6.4. THE STRAIN GAUGE AND THE WHEATSTONE BRIDGE PRINCIPLE

A Strain gauge is a device used to measure the strain of an object. The most common type of strain gauge consists of an insulating flexible backing which supports a metallic foil pattern. It basically a thin wire folded several times so that a great length of wire can occupy a small space, as in fig 3-20.

Fundamentally, the strain gauge and Wheatstone bridge are not complicated or overwhelming measurement tools. At the heart of the loadcell, the strain gauge is the real transducer that produces an electrical output from a mechanical input, while the Wheatstone bridge configuration allows the electrical output to be measured accurately, making up the electronic component of the loadcell.

Practical transducer design considerations dictate that the strain gauge be mounted in the area of highest strain. The gauge is mounted onto the surface where the strain is to be measured, so that when the surface experiences strain, the strain gauge likewise experiences strain. This produces the maximum allowable signal output consistent with the strength of the spring element material. It minimizes the likelihood of fatigue failures originating at points of stress concentration outside of the carefully designed gauging site. Maximizing the strain at only the gauge location also minimizes the spring element deflection and its detrimental effects on natural frequency and linearity.

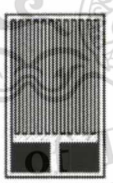


Fig 3-20. A basic strain gage

The resistance in a linear electronic component is related to its length and cross-sectional area as follows.

$$R = \frac{\rho * \ell}{A} \qquad (3.6.3\text{-}1)$$

Where: R is the resistance of the component [Ω]

ρ is the material's resistivity [Ω*m]

ℓ is the length of the component [m]

A is the cross-sectional area of the component [m^2]

So, when the gage experiences strain, its resistance will vary accordingly.

$$R = \frac{\rho * \ell}{A}$$

$$dR = \frac{\rho}{A} * d\ell$$

(3.6.3-2)

Let us assume change in cross-sectional area is negligible, compared to change in length of the gauge wire. The validity of this assumption can be quickly verified through an examination of the Poisson's ratio relationship of these quantities.

Here, ℓ is the axial length of the wire, ℓ_d is the diameter of the wire, $d\ell$ is the change in axial length of the wire, $d\ell_d$ is the change in the diameter of the wire, and ν is Poisson's ratio.

$$\frac{d\ell_d}{\ell_d} = -\nu * \frac{d\ell}{\ell}$$

$$\frac{d\ell_d}{d\ell} = -\nu * \frac{\ell_d}{\ell} \qquad (3.6.3\text{-}3)$$

Since the strain gauge wire is long and thin, the ratio of the diameter to the axial length tends to be zero. Thus, the ratio of the change in diameter (and hence, area) to the change in axial length tends to be zero.

Therefore, the change in resistance of the strain gauge is directly proportional to the change in length of the gauge. For convenience, this relationship is typically made non-dimensional and restated in terms of a constant of proportionality, the gage factor *k*.

$$\frac{dR}{R} = k * \frac{d\ell}{\ell}$$

(3.6.3-4)

In this equation, and henceforth, *R* refers to the unloaded resistance and ℓ refers to the unloaded length. The gauge factor is best determined experimentally, by applying known loads to the strain gage and measuring the resulting change in resistance. Typically, its value is approximately.

It is now apparent how strain causes a change in resistance in a single strain gage. However, only the resistance across the gauge can be measured. Since the change in resistance is very small compared to the total resistance, its effects on the total

resistance cannot be easily discerned. Thus, it is necessary to isolate this resistance change in a circuit so it can be accurately measured.

The Wheatstone bridge

The circuit that makes this measurement possible is the Wheatstone bridge, shown in fig3-21. This circuit, which was invented in 1843 by Sir Charles Wheatstone, allows unknown resistances to be measured with respect to known resistances.

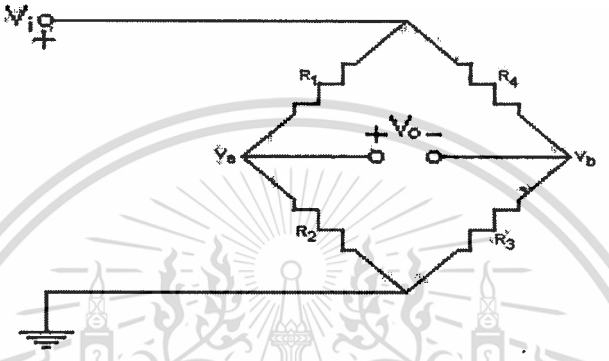


Fig 3-21. Basic Wheatstone bridge circuit

The fundamental relationship between the applied (excitation) voltage V_i and the output voltage V_o can be derived in terms of the four (strain gauge) resistances R_1, R_2, R_3, and R_4 by using the intermediate voltages V_a and V_b.

$$V_a = V_i * \frac{R_2}{R_1 + R_2}$$

$$V_b = V_i * \frac{R_3}{R_3 + R_4}$$

$$V_o = V_a - V_b$$

$$\frac{V_o}{V_i} = \frac{R_2}{R_1 + R_2} - \frac{R_3}{R_3 + R_4}$$

$$\frac{V_o}{V_i} = \frac{R_2 * R_4 - R_1 * R_3}{(R_1 + R_2) * (R_3 + R_4)}$$

(3.6.3-5)

Typically, the bridge is initially balanced, with all four resistances being equal. It is readily apparent that this situation leads to an output voltage of zero.

When a load is applied, it may act on one, two, three, or all four resistors, creating the following voltage ratio.

$$\frac{V_o}{V_i} = \frac{(R_2 + \Delta R_2)(R_4 + \Delta R_4) - (R_1 + \Delta R_1)(R_3 + \Delta R_3)}{(R_1 + R_2 + \Delta R_1 + \Delta R_2) * (R_3 + R_4 + \Delta R_3 + \Delta R_4)}$$

(3.6.3-6)

As mentioned above, the change in resistance is much smaller than the initial resistance, so in the reduction of this equation, second order terms are neglected. The initial resistances are also assumed to be equal, as per standard practice. However, this assumption does not mean that all ΔR terms are equal. These assumptions lead to the following simplified relationship.

$$\frac{V_o}{V_i} = \frac{R * \Delta R_2 + R * \Delta R_4 - R * \Delta R_1 - R * \Delta R_3}{4R}$$

$$\frac{V_o}{V_i} = \frac{1}{4} * \left(\frac{\Delta R_2}{R} + \frac{\Delta R_4}{R} - \frac{\Delta R_1}{R} - \frac{\Delta R_3}{R} \right)$$

$$\frac{V_o}{V_i} = \frac{1}{4} * \left(-\frac{\Delta R_1}{R_1} + \frac{\Delta R_2}{R_2} - \frac{\Delta R_3}{R_3} + \frac{\Delta R_4}{R_4} \right)$$

(3.6.3-7)

This equation states the general relationship between the output voltage and the change in resistance of the four loadcells, and it can also be stated in terms of the strain in each resistor.

$$\frac{V_o}{V_i} = \frac{k}{4} * \left(-\frac{d\ell_1}{\ell_1} + \frac{d\ell_2}{\ell_2} - \frac{d\ell_3}{\ell_3} + \frac{d\ell_4}{\ell_4} \right)$$

$$\frac{V_o}{V_i} = \frac{k}{4} * \left(-\varepsilon_1 + \varepsilon_2 - \varepsilon_3 + \varepsilon_4 \right)$$

(3.6.3-8)

Now, relationship between the output voltage and the strain in the four legs of the bridge has been established, the specific outputs from different loading situations can be examined.

The first possible loading scenario is when only one of the legs is subjected to strain, as seen in figure 3-22. This configuration is known as a quarter bridge, as one quarter of the bridge is under strain. Obviously, the strain in members 2, 3, and 4 is zero, so the output voltage is directly proportional to the strain in member 1.

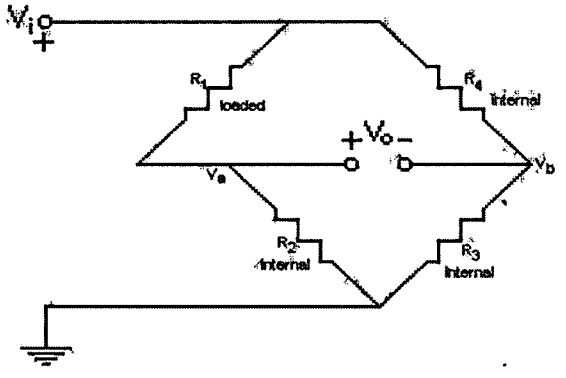


Fig 3-22. Quarter bridge circuit

$$\frac{V_o}{V_i} = \frac{k}{4}(-\varepsilon_1)$$

(3.6.3-9)

Another possible configuration is the half bridge, shown in figure 3-23. In this circuit, two of the legs are under strain. It is important that one cell be in tension and one in compression, or else their respective strains may cancel each other out. The mounting arrangement to realize this constraint depends upon the physical make-up of the load cell. The maximum output signal for a half bridge will occur if the strains in members 1 and 2 are equal in magnitude with opposite signs.

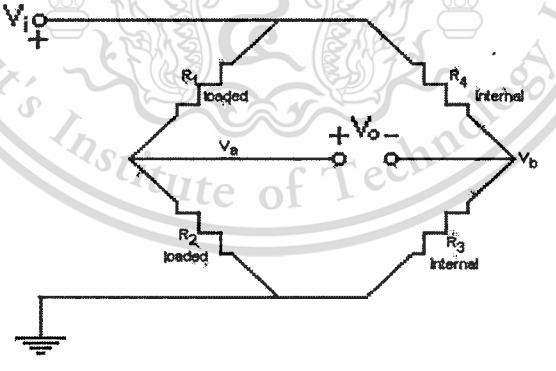


Fig 2-23. Half bridge circuit

$$\frac{V_o}{V_i} = \frac{k}{4}(-\varepsilon_1 + \varepsilon_2)$$

$$\left|\frac{V_o}{V_i}\right|_{max} = \frac{k}{2}(\varepsilon)$$

(3.6.3-10)

A third possible configuration, albeit an uncommon one, is when three legs of the bridge are loaded, as in figure 3-24. This three-quarters bridge arrangement produces a greater output when R1 and R3 are subjected to the same kind of force (tension or compression) and R2 is subjected to the opposite kind. Again, the maximum possible output results when all three forces are equal in magnitude, with members one and three having one sign and member 2 having the opposite sign.

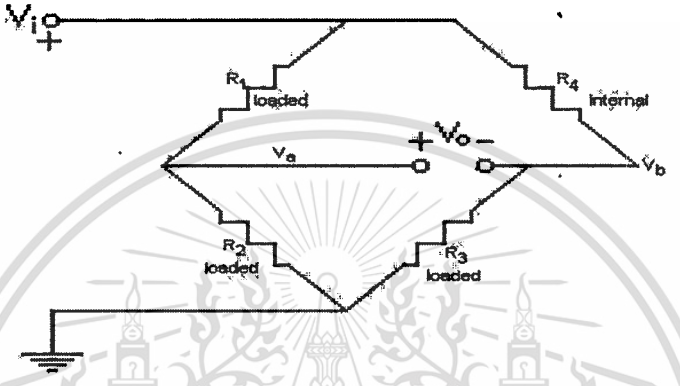


Fig 3-24. Three-quarters bridge circuit

$$\frac{V_o}{V_i} = \frac{k}{4}(-\varepsilon_1 + \varepsilon_2 - \varepsilon_3)$$

$$\left|\frac{V_o}{V_i}\right|_{max} = \frac{3k}{4}(\varepsilon) \qquad (3.6.3.11)$$

The final, and most widely used, configuration is the full bridge shown in figure 3-25. In this arrangement, the load on gauges 1 and 3 should have the opposite sign as that on gauges 2 and 4. As in the other arrangements, the maximum output voltage occurs when all four legs of the bridge have the same magnitude of strain.

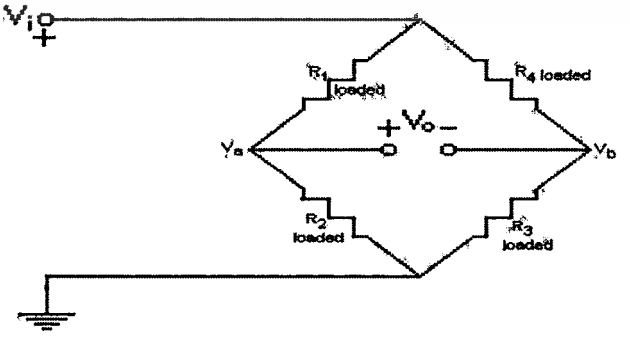


Fig 3-25. Full bridge circuit

$$\frac{V_o}{V_i} = \frac{k}{4}(-\varepsilon_1 + \varepsilon_2 - \varepsilon_3 + \varepsilon_4)$$

$$\left|\frac{V_o}{V_i}\right|_{\max} = k\varepsilon$$

(3.6.3.12)

The advantages of the full bridge circuit are fairly obvious. Primarily, it can produce the greatest output voltage for a given applied load. Also, in this circuit, it is possible to have two strain gauges in compression and two in tension, resulting in a balanced load reading.

Another important advantage of the full bridge is that it compensates for external disturbances, such as temperature variations. The strain in the strain gauges is directly affected by fluctuations in temperature, so the strain measured across each strain gauge is caused in part by the mechanical load and in part by deformation due to temperature variation. If all of the gauges in the bridge have the same properties, the temperature-induced strain will have the same magnitude and sign in all gauges.

$$\varepsilon_n = \varepsilon_{nmechanicd} + \varepsilon_{ntemperature}$$

$$\varepsilon_{1temp} = \varepsilon_{2temp} = \varepsilon_{3temp} = \varepsilon_{4temp}$$

Therefore, in a full bridge circuit, the complete voltage-strain relationship is:

$$\frac{V_o}{V_i} = \frac{k}{4}(-\varepsilon_{1mech} - \varepsilon_{1temp} + \varepsilon_{2mech} + \varepsilon_{2temp} - \varepsilon_{3mech} - \varepsilon_{3temp} + \varepsilon_{4mech} + \varepsilon_{4temp})$$

$$\frac{V_o}{V_i} = \frac{k}{4}(-\varepsilon_{1mech} + \varepsilon_{2mech} - \varepsilon_{3mech} + \varepsilon_{4mech})$$

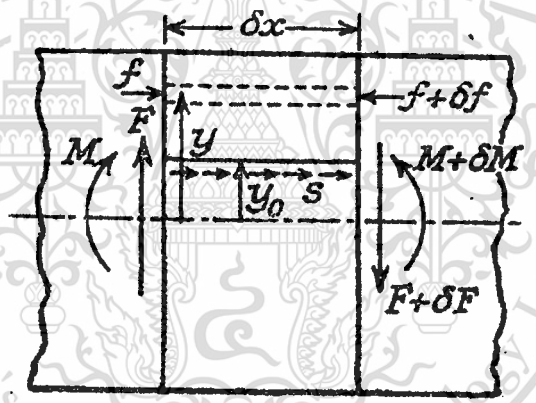
(3.6.3.13)

By inspection, it is obvious that the temperature components of strain do not cancel out in the quarter bridge and three-quarters bridge circuits. Thus, it is necessary to use a compensation gauge in these configurations. The compensation gauge is another strain gauge with the same properties as the gauge being subjected to a load, and it must be exposed to the same temperature variation as the active gauge, but it is not loaded mechanically. The resulting strain in this gauge is due exclusively to temperature effects, and it can be used to compensate for the temperature-induced strain in the active gauge.

3.6.5. SHEAR STRESS ANALYSIS ON THIN WALLED HOLLOW BEAM

In wheel force transducer, sensors are placed at the radially extended beam from the middle rigid part to the annular ring which is very short because of the limitation of the space as well as essential of linear elastic manner.The strain magnitude in the gauged area of a spring element should be uniformly distributed and at the proper level to produce the desired full-load output signal. Normally the highest strain level anywhere in the entire spring element is desired.

Let "S" be the shear stress at any cross section of the rectangular beam. This beam will set up a shear strain on transverse sections which will vary across the section. In the following analysis it has been assumed that the stress is uniform cross the width (i.e. parallel to the neutral axis) and that the presence of shear stress does not affect the distribution of bending stress. In the following diagram transverse sections are shown at a distance ∂x apart and the shearing forces will be F and F+ ∂ F and bending moments M and ∂x.



$$S=\frac{\partial M}{\partial x}\frac{A}{zI}\bar{y} \qquad (3.6.4\text{-}1)$$

$$S=F\frac{A\bar{y}}{zI} \qquad (3.6.4\text{-}2)$$

Where,

- S be the value of the complementary shear stress and hence the transverse shear stress at a distance y from the Neutral Axis
- z be the width of the cross section at y_0
- A be the area of cross section cut off by a line parallel to the Neutral Axis.
- $\bar{y}$ be the distance of the centroid of A from the Neutral Axis

First rectangular beam with rectangular hollow and circular hollow has been analyzed whose parameters are tabulated in table 3-4. The beam should be selected to be symmetrical about the neutral axis. As the sensor need to design with higher loading value 65kN force has been selected for beam analysis for initial simulation only. Rectangular beam of breadth 40mm and height 26 mm on the cross-section with rectangular hollow of 32 mm breadth to 18mm height and circular hollow of 16 mm diameter has been analyzed.

Table 3-4. Force and Moment of Inertia calculation of the rectangular beam

Hollow Rectangle		Hollow Circular	
Outer Rectangle			
Breadth(mm)	40	Breadth(mm)	40
Height(mm)	26	Height(mm)	26
Inner Rectangle		Inner Circle	
Breadth(mm)	32	Diameter (mm)	16
Height(mm)	18		
Moment of Inertia(I)(mm^4)	43035	Moment of Inertia(I)(mm^4)	55371
Force(F)(N)	65000	Force(F)(N)	65000
F/I(N/mm^4)	1.510	F/I(N/mm^4)	1.174

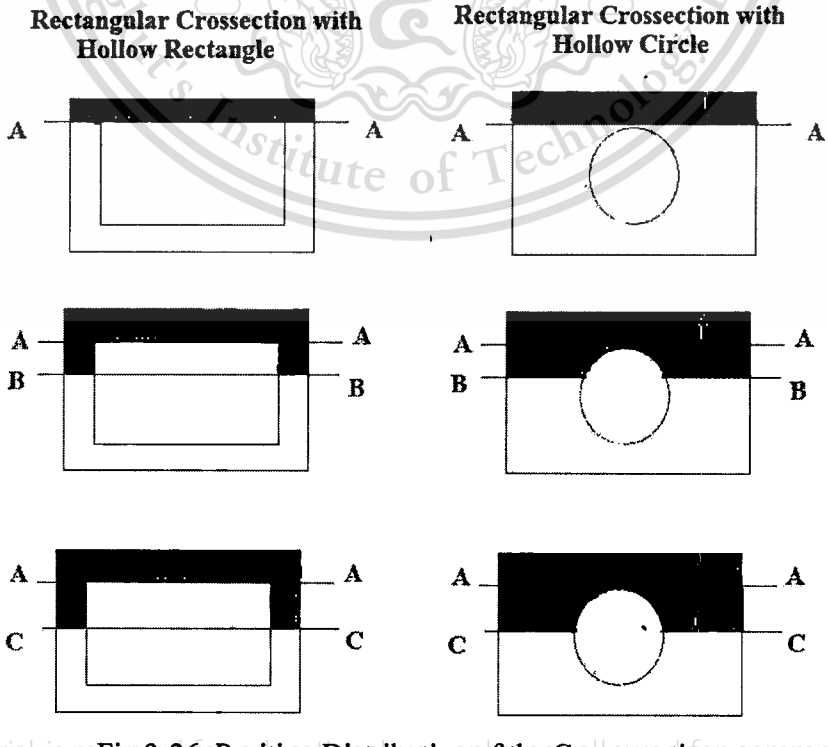


Fig 3-26. Position Distribution of the Cross-section

The figure 3-26 depicts the position for the shear stress calculation of the beam. Position 0-0 is the top part of the beam while A-A is the point where web starts. Position B-B is the mid of the web. Finally C-C is the center of the symmetry of whole cross-section. For calculation simplicity the only the half part of the beam has been taken and the other half is assumed to follow the same phenomenon.

Table 3-5. Shear stress calculation of the rectangular beam with hollow rectangle.

	Section			Area	Moment centroid	Q = A*y	Thickness (z)	Shear Stress (FQ/(I*z))
	Position	Breadth	Height	mm^2	mm	mm^3	mm	MPa
Top	O-O	40.00	0.00	0	0	0	40	0.00
Top of Web	A-A	40.00	4.00	160	11	1760	40	66.46
		40.00	4.00	160	11	1760	8	332.29
Quarter of web	B-B	40.00	4.00	160	11	1760	4	710.46
		4.00	4.50	36	6.75	243	8	
Mid of web	C-C	40.00	4.00	160	11	1760	4	725.75
		4.00	9.00	72	4.5	324	8	

Table 3-6. Shear stress calculation of the rectangular beam with hollow circle.

			Section Position	Area (mm^2)	Moment centroid	Qr= A*y	Qc= A*y	Q=Qr-Qc (mm^3)	Thickness(mm)	Shear Stress (MPa)
Top	0-0	40.0	0.0	0	0	0		0.0	40.00	0.0
Top of Web	A-A	40.0	4.0	160	11	1760		1760.0	40.00	53.5
Quarter of web	B-B	40.0	8.50	340	8.8	2975	315.7	2659.3	24.41	132.5
Mid of web	C-C	40.0	13.0	520	6.5	3380	486.0	2894.0	22.00	160.0

These calculations has been depicted on the bar chart and shown in the shear fig 3-27 below:

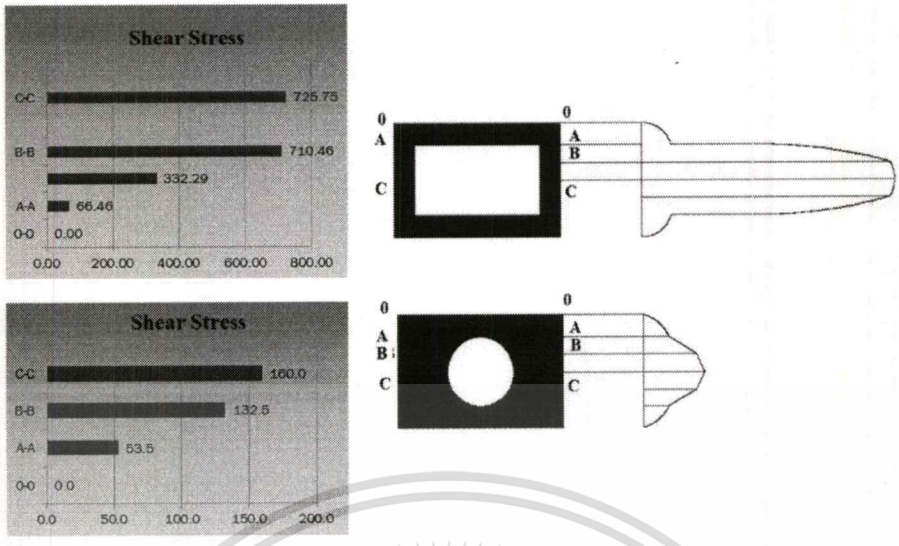


Fig 3-27. Comparison between the Shear Stress Distribution Rectangular Beam with Hollow Rectangle and Hollow circle

From the fig 3-27 we know that there is always a maximum shear stress at the neutral axis along the cross-section for the beam. Fig 3-27 shows rectangular beam with hollow rectangle is four times more sensitive to shear stress than the corresponding circular hollow. Therefore this rectangular beam with rectangular hollow would be more feasible for the loadcell extending beams.

To find the optimum design parameter and shear stress concentration the thickness of the beam has been varied. Two models of loadcell were designed for the analysis: out of which rectangular hollow beam, varying with the beam thickness of 5mm, 4mm, 3mm, 2mm, and the other circular hollow beam loadcell vary with the beam thickness of 5mm, 4mm, 3mm, and 2mm. Force of 65kN was applied to each above models at positive and negative X axis and positive and negative Z axis individually, with the central annular ring fixed.

These finite element models of steel 304 was constructed by tetrahedral element of the following range of mesh and element size for thickness 5mm to 2 mm in circular and rectangular hollow beam loadcell.

	Circular Hollow WFT		Rectangular Hollow WFT	
Nodes	36470	28293	53637	48718
Elements	20389	15189	29919	27527

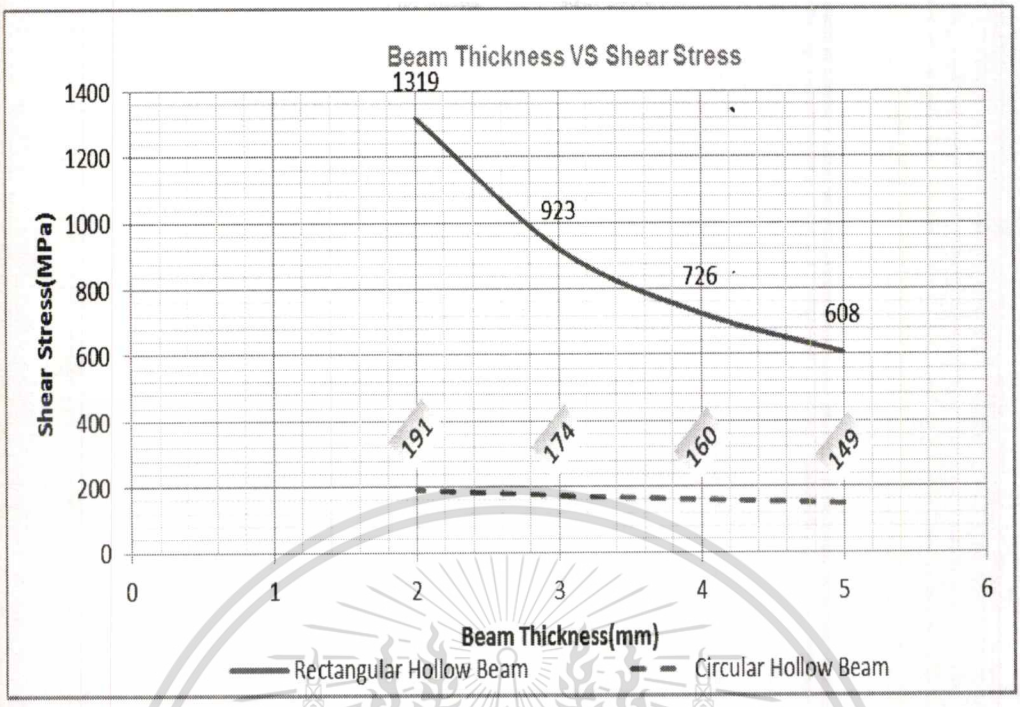


Fig 3-28. Comparison of Shear Stress of Rectangular Hollow beam and Circular Hollow beam with thickness

This graph 3-28 compares the shear stress concentration of the circular hollow beam and rectangular hollow beam theoretically with the variation of the thickness from 5mm to 2mm in descending order. With outer cross-sectional dimension of 26X40mm beam along with hollow rectangular and circular hollow it can be concluded that as the rectangular hollow increases (i.e. thickness decreases form 5mm to 2 mm) the shear stress increases in a linearly. More we reduce the material on the structure shear stress sensation on the strain gauge of the hollow beam increases. This graph shows the maximum shear stress value has been reduced far more on the loadcell. This is due to the annular ring structure where the stress has been shared. The FEA analysis shows that the behavior in the beam remains similar to the shear stress behavior in hollow beams.

3.6.6. RADIALLY EXTENDED THIN WALLED HOLLOW BEAM SELECTION

Radially extended beams on loadcell (fig 3-29) act as spokes on the wheel force transducer and practice radial tension and compression during vehicle movement. Thai agriculture multipurpose truck has been designed for maximum speed of 40km/hr with 15″ rim diameter. Thus it would have a maximum frequency of 9.28Hz and 557 rpm.

Table 3-7. Radially Extended Thin Walled Hollow Beam Area Calculation for Modelling

Structure Shape	**r/S**	**Hollow Radius**	**Length**	**Area**	**Area of mid circle**	**Net Area (sq. mm)**
Circular	12	8	25	452.16	200.96	251.20
Square	21.264	8	25	452.16	200.96	251.20
Hexagonal	13.192	8	25	452.14	200.96	251.18
Octagonal	11.508	8	25	452.16	200.96	251.20

Formula

Circular	πr^2
Square	r^2
Hexagonal	$\frac{3\sqrt{3}}{2}S^2$
Octagonal	$2(1+\sqrt{2})S^2$

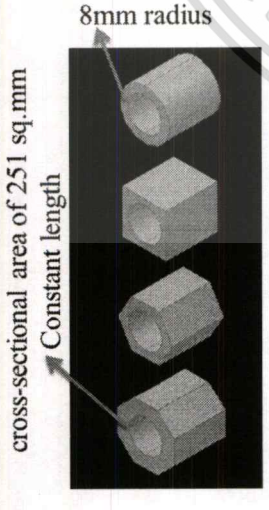


Fig 3-29. Radially Extended Beams

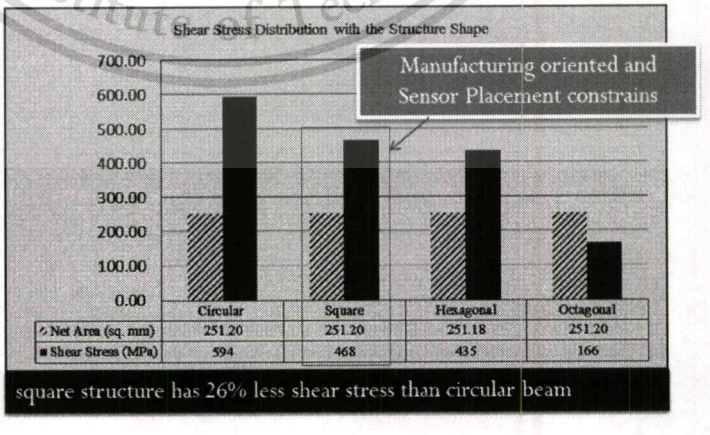


Fig 3-30. Shear Stress Distribution with the Structure Shape

Different thin wall structures i.e. circular, square, hexagonal and octagonal each with circular hollow of 8mm radius were analysed. The structures have been designed such that they have constant length with constant cross-sectional area of 251mm^2 and the volume of 6280mm^3. These structures have been analysed in a computer aided engineering program, "ANSYS", for its shear stress as wheel force transducer has been designed based on the shear stress principle with shear strain sensing sensor.

The above thin walled hollow: circular, square, hexagonal and octagonal respectively are the CAD model that has been designed for the analysis of shear stress at the neutral axis. The above bar chart depicts the loadcell radially extended structure from the central annular ring to outer annular ring where the shear stress with constant load of 30kN has been estimated at full load condition.

From the bar chart 3-30, a circular thin walled hollow structure comprises high shear stress phenomenon at the neutral axis, compared to that of square, hexagonal and octagonal thin walled hollow structure. Even though, square structure has 26% less shear stress than circular beam it has been preferred compared to the circular structure for the manufacturing compatibility and ease of sensor attachment constrains.

3.6.7. SENSOR PLACEMENT

Sensor placement is an elusive goal to all transducer design. At an early stage in the spring element design it is necessary to establish the element proportions. From the above calculation and theory it can be observed that the half bridge gauge should be placed at neutral axis for the maximum shear stress and minimum bending moment in a beam as shown in fig 3-31, fig 3-32 and fig 3-34.

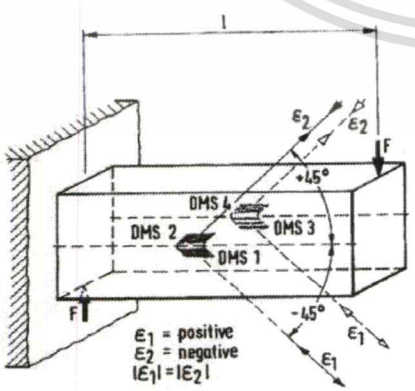


Fig 3-31. Sensor Placement at Cantilever Beam

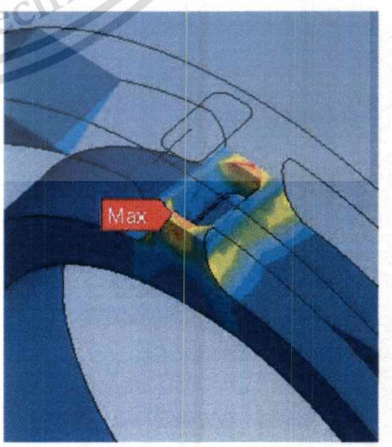


Fig 3-32. Sensor Placement at Cross Section Cut out View

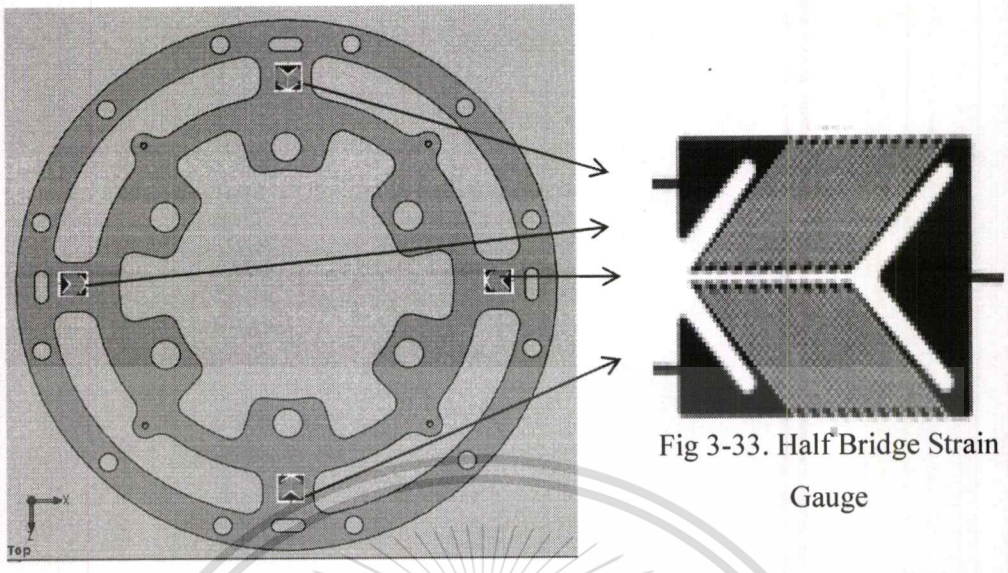


Fig 3-33. Half Bridge Strain Gauge

Fig 3-34. Half bridge Strain Placement on Loadcell

Predetermined strain level will be developed in the gauge area when the unit is subjected to rated load during operation. Consideration with other parameters such as linearity of spring material response, fatigue life of strain gauges, instrument compatibility should be made. Therefore, the spring element should always be designed with the gauge-installation process keeping on mind (or follow the recommended by the manufacturer).

Electrical output of the loadcell is limited by the maximum allowable strain level in the gauge region; this strain level should exist uniformly over the entire area of the gauge grids to maximize the signal and to improve transducer performance. Also the workmanship error or unpredictable error can be reduced by the appropriate resistor selection for the zero adjustment for this wheel force transducer

3.6.8. GEOMETRY AND SOLID MODELLING

Next step is to geometric dimensioning and solid modelling for the detail design of the wheel force transducer. A computer aided design software "SolidWorks" has been used for the design of wheel force transducer. Every component has been designed and modelled with their respective dimensions.

As the competitive industrial era and development of automotive technology, design and development of optimum WFT is essential. With the limited space on wheel rim

(fig 3-35), low cost and ease of manufacturing was the objective function of the design for Thai multipurpose agricultural truck wheel force transducer.

From the information obtained from dimensional inspection table 3-1 to table 3-3:

Playable diameter = 360 mm.

Inner diameter = 134 mm

Thus, available space = (360-134)/2 = 113 mm

Designed loadcell outer radius = 160 mm

Designed loadcell inner radius = 69 mm

Loadcell occupied Space = (160-69) = 91 mm

Remaining space for fxtures = 22 mm

Moreover, Bolt of spindle is at radius = 83 mm

Tool outer diameter = 32 mm

Available space for loadcell = (91-32) = 59 mm

Since 4 beams had been decided space required for the sensor has been decided first. Dimension of the half bridge strain gauge = 7.6mm x 5.3 mm (FCT-2-350-C4-11)

Then an estimation of 26 mm beam length and 20 mm outer annular was made for installing the strain gauge space. And finite element analysis for stress concentration at the beam edge with manufacturing compatibility

Available space for annular rings = (59-26-20) = 13 mm

Geometry for the joint had been designed as per the original condition of the rim with M16 and M10.

Finally the thickness of the loadcell (fig 3-36) has been determined by finite element analysis. The thickness from 40mm to 30mm has been analysed and selected as per the availability of the material in Thailand.

Similarly thickness of rim adaptor (fig. 39) was determined to be 8 mm, while 10 mm thickness has been determined due to the manufacturing ease. While hub adaptor (fig. 3-38) thickness has been decided by the offset to the original condition that original wheel rim had. i.e 18 mm.

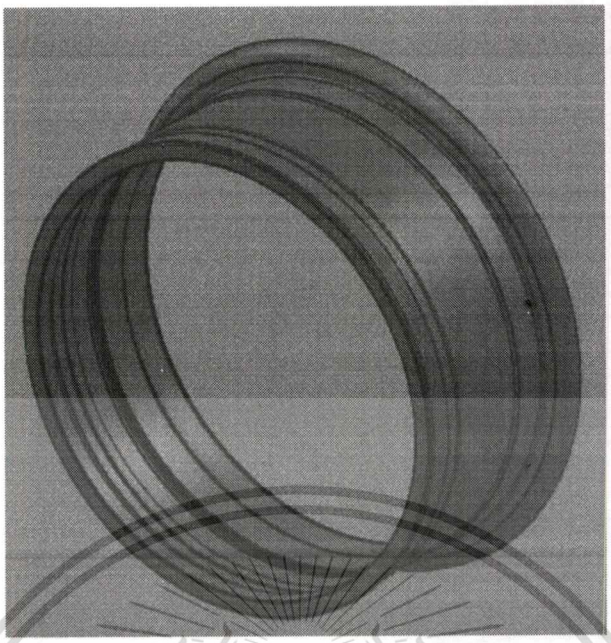


Fig 3-35. Modified Wheel Rim

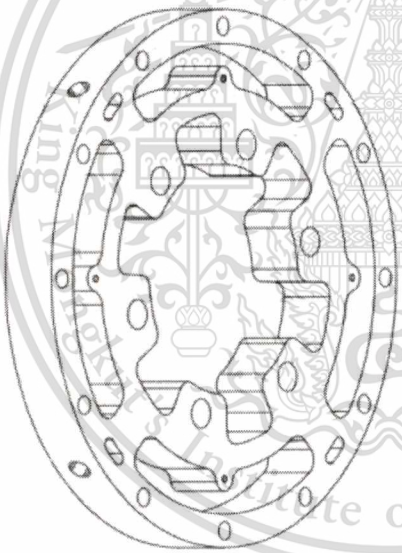


Fig 3-36. Designed Loadcell

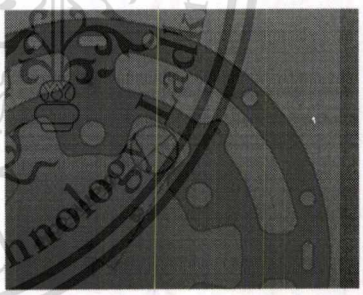


Fig 3-37. Tool Dimension

Loadcell is attached by rim adaptor and hub adaptor which should be designed as per the vehicle requirement and original wheel configuration. The offset of the original position should be maintained by the design. Rim adaptor has been designed to the original offset by adjusting its position. These offset are to maintain allowable stress for the vehicle load as per the previous design on the parts of the vehicle so that there would not be any wear of parts or failure due to overloading and misalignment. Also the components should be within the acceptable range of mass from the original structures.

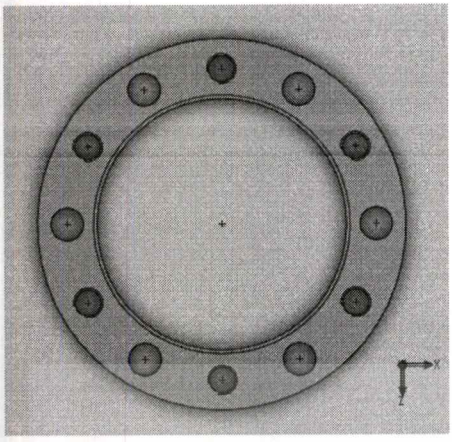


Fig. 3-38 Hub Adaptor

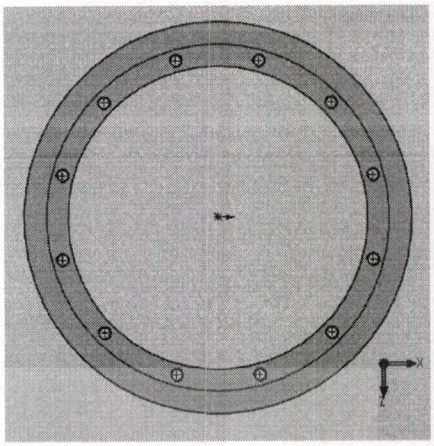


Fig. 3-39 Rim Adaptor

As hub adaptor, loadcell, rim adaptor all are fixed on wheel, which should be coaxial and concentric. It is essential for the rotating parts and to prevent misalignment during assembly. This has been done with a 2mm step turning on these parts. Misalignment would lead to error in the data acquisition which might lead to failure of the system and ultimately to accident.

In this project a simple hub adaptor has following geometry:

Thickness = 18 mm
Step Thickness = 2 mm
Inner Diameter = 138 mm
Outer Diameter = 198 mm
12 M16 (6threaded)

These 6 threaded holes are to fix the loadcell with hub adopter while other 6 through holes are to fix the system with the wheel spindle.

Thickness = 8 mm
Step Thickness = 2 mm
Inner Diameter = 280 mm
Outer Diameter = 362 mm
12 M10 (6threaded)

In case of rim adaptor it has 12 threaded holes to fix the loadcell as in fig 3-39. Meanwhile, rim adaptor would be fixed itself to the rim of the wheel by welding.

Next, component to be designed is the wireless adaptor to hold strain gauge module NI 9237, NI cDAQ 9191 and battery holder and battery for power supply to the system during operation.

This adaptor is designed with three legs to balance the electronics during rotation. This adaptor base is 97 mm x 202 mm designed to be of the NI module with groove of 2mm to grip the modules and height 63mm as the axle extrusion at the centre. Four corners of the base had been made thru holes of 4mm diameter for tool pass during milling process.

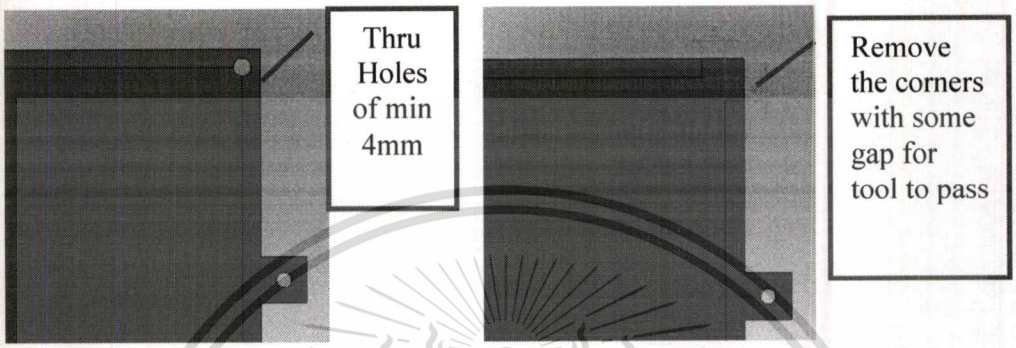


Fig 3-40. Wireless Adaptor Design Modification

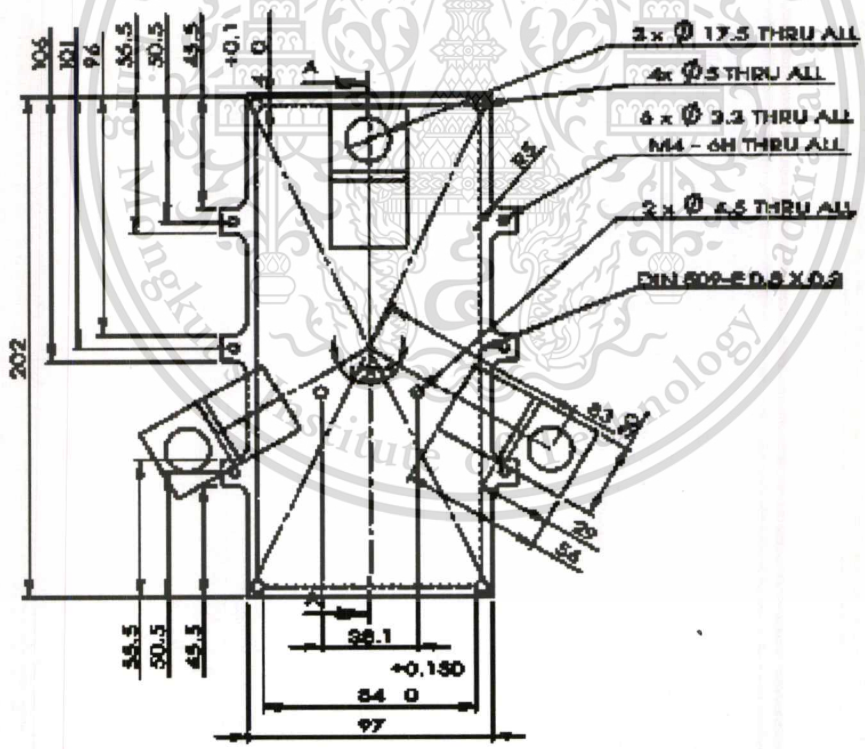


Fig 3-41. Wireless Adaptor Design

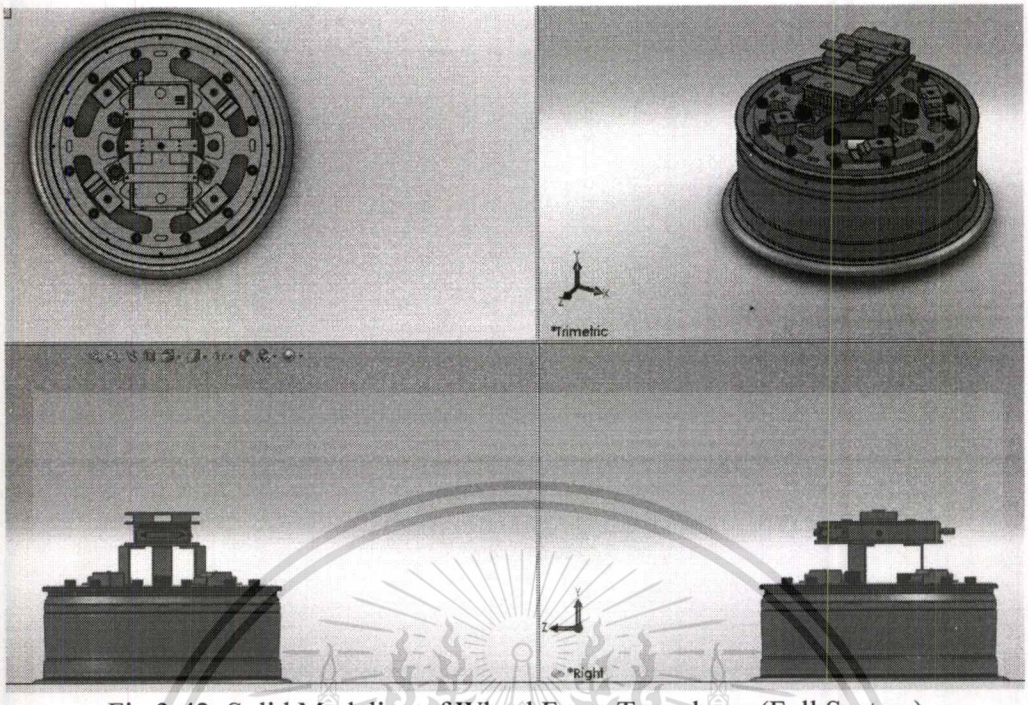


Fig 3-42. Solid Modeling of Wheel Force Transducer (Full System)

3.7. SELECTION OF MATERIAL

To design loadcell material, selection is very important for designer. Also it is obvious that material plays vital role in performance of transducer. Generally materials are regarded as the attributes of a physical structure, thus are often considered only after the physical structure of a design has been determined. Some of the materials may need to be identified at this early design stage because they may directly contribute to the fulfilment of some of the required functions. Thus, design task involving materials during conceptual design is primarily related to identifying materials with specific functionalities.

When the physical structure for a design has been determined, materials with specific properties should be selected from a set of candidates, which is commonly referred to as "materials selection". Often material selections are done after conceptual design stage such as in embodiment design or detail design. Analysis of the product is the first decision making criteria for material selection. While performance driven or cost driven makes a huge difference on this process for the designers

The most challenging task during material selection process is to define whether it is one component or a system of components working together. So when we analyse a

system we need to break the system down into individual components and then analyse each one selecting different materials for each components.

The performance of wheel force transducer is limited by the properties of material of which loadcell is made, and by the geometry of structure of it. Spring will exhibit linear elastic deformation within the range of applied forces, both in tension and compression. Obviously, if the spring structure on which the strain gauges are mounted does not exhibit linear characteristics, the output from the strain gauges will not be linear either. More often, performance depends on a combination of properties, and then the best material selected by maximizing one or more "performance indices" [16]. Performance indices are governed by the design objectives for wheel force transducer.

The basic mechanical requirement of the material is stiffness and high precision spring. As spring material must be selected, its mechanical and thermal properties are to be considered. Temperature gradients are undesirable because they cause inconsistent mechanical properties within the spring. Further, if the strain gauges do start heating up, a spring with high thermal conductivity enables the strain gages to cool down more quickly, reducing the possibility of thermal effects in them. Thermal factors are important because the spring has the possibility of transferring heat with strain gauges. A high thermal conductivity is ideal because temperature gradients are less likely to develop in a material with high thermal conductivity. On the other hand practicality of manufacturing loadcell structure from the spring material is also important.

The classical concept of a spring, such as a leaf or coil spring involves rather large deflection at rated load. In contrast, the deflection of a typical transducer spring element is only a few thousandths of an inch (say, 0.1 mm or less), even when the physical size of the transducer is quite large. Thus, the transducer element has been selected to be, in effect, an extremely low-compliance, and high-precision spring material [17].

Manufacturing techniques come into play as well. Spring element machined from one initial block of material rather than being assembled would have higher rigidity. Also, the spring is typically hardened after being machined, so materials that distort during the hardening process are undesirable.

Obviously, these factors must be weighed against one another, as no material completely satisfies all of these criteria.

Some commonly used spring materials are 4140 and 4340 alloy steels (high modulus for high capacity cells) and 2024-T4 and 2024-T351 aluminium (low modulus). However, different probable materials: two Stainless steel grade and five Aluminium material had been selected for the analysis of loadcell as listed on table 3-8 below.

Table 3-8. Material Properties

Material Properties	Stainless Steel Grade		Aluminium Grade				
	630	304	2014-T6	2024-T4	2024-T81	6061-T6	7075
Modulus of Elasticity (N/m^2)	1.96E+11	2E+11	7.31E+10	6.93E+10	7.10E+10	6.90E+10	7.20E+10
Yield Strength (N/m^2)	7.60E+08	2.10E+08	4.14E+08	3.45E+08	2.90E+08	2.41E+08	1.45E+08
Ultimate Tensile Strength (N/m^2)	1.03E+09	5.40E+08	4.83E+08	4.82E+08	3.00E+08	3.00E+08	2.76E+08
Density (kg/m^3)	7750	7900	2800	2770	2780	2700	2810

For this project same material i.e. structural steel has been chosen for rim adaptor and wireless adaptor due to its manufacturing compatibility. Aluminium Grade 7075 has been selected for the loadcell as spring material, while stainless steel Grade 1.4301 (S304) with X5CrNi18-10 has been selected for hub adaptor.

Aluminium 7075 has 2810 kg/m^3 Young's modulus of the specimen was of 72GPa and shear modulus of 76.9GPa, yield strength of 145MPa, tensile Strength of 276MPa and elongation of 9-10%.

Austenitic stainless steels provide a good combination of corrosion resistance, forming and fabrication properties. The density of Grade 1.4301(S304) Steel is 7900 kg/m^3 and poison's ratio 0.30. Young's modulus of the specimen was of 200GPa and shear modulus of 76.9GPa, yield strength of 210MPa, tensile Strength of 540~750 MPa, and elongation at fracture 45% [18].

3.8. FINITE ELEMENT ANALYSIS

Numerical analysis was made with finite element software, "ANSYS", to obtain the optimum design. With the limited space for WFT on wheel rim, low cost and ease of manufacturing was the objective function of the design for multipurpose agricultural truck wheel force transducer.

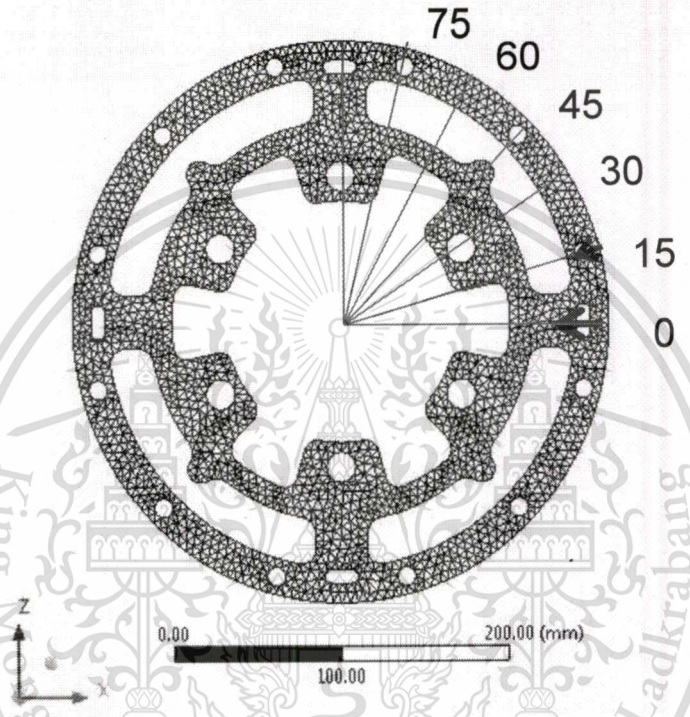


Fig 3-43. Finite Element Analysis Model

During the analysis mesh size was determined to be 4mm, which gave the consistent stress. Eventually total elements of 166990 and nodes of 255058 were found for loadcell. The force of 30kN was applied on the outer annular ring at an angle of 0, 15, 30, 60 and 75 degree; while six holes on the inner annular ring are the fixed support as in fig 3-43.

The design process of WFT structures can be based on following process to find the feasible configurations that fulfill certain desired requirements of two dimensional wheel force transducer in x and z direction.

The model was analyzed for its quarter section only as the model is symmetric and supposed to have the same behaviour on all other remaining sections. Table below indicates the data of maximum stress from the analysis.

Table 3-9. Stress Distribution on the loadcell with respect to angle of force

Loadcell (mm)	Max Stress (MPa)					
	Angle of force applied in Degree					
	0	15	30	45	60	75
38	47.3	46.7	49.0	49.7	52.0	52.7
36	46.6	50.1	51.9	51.9	55.2	55.8
34	48.7	51.3	53.2	52.9	56.9	57.4
32	50.9	54.5	56.7	56.0	59.5	59.8
30	53.1	57.2	60.0	59.5	63.9	64.6

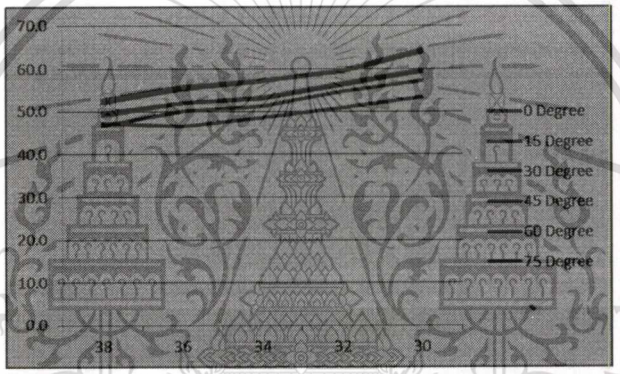


Fig 3-44. Stress Comparison on Loadcell with respect to Angle of Force

This graph depicts stress distribution on loadcell with the variation of angle of force applied on it. It has been noticed that the increase on maximum stress on 75 degree was 1.18, 1.12, 1.07and 1.01 times more than 0, 15, 30, 45 and 60 degree respectively. Thus force on 75 degree is the driving angle which has maximum effect of stress. As per the manufacturing compatibility we cannot go for less than 30mm. Thus, because of availability of the material and manufacturing ease 30 mm was selected for the optimum design.

Some of the finite element analysis result has been highlighted below for 30mm thickness and material SUS 304.

Also finite element analysis has been carried out for different 7 materials to get optimum result for weight and cost. Some compromise had been made between the factor of safety and weight. Detail of the analysis has been shown in table 3-10 & 3-11.

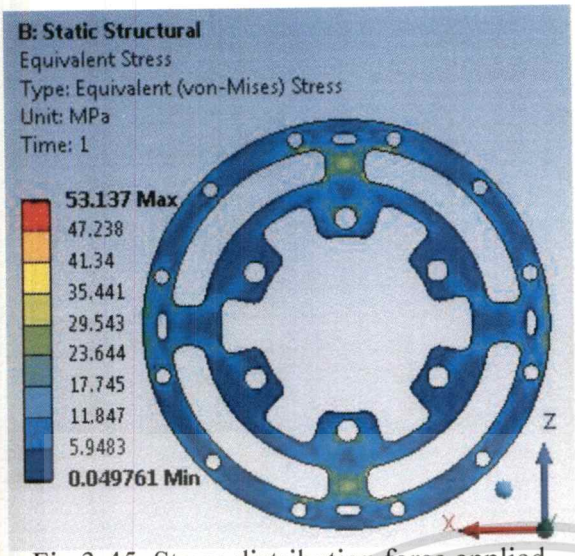


Fig 3-45. Stress distribution force applied at 0 degree

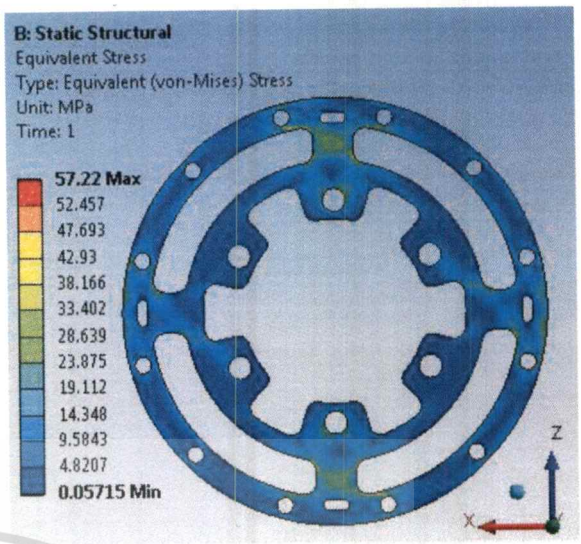


Fig 3-46. Stress distribution force applied at 15 degree

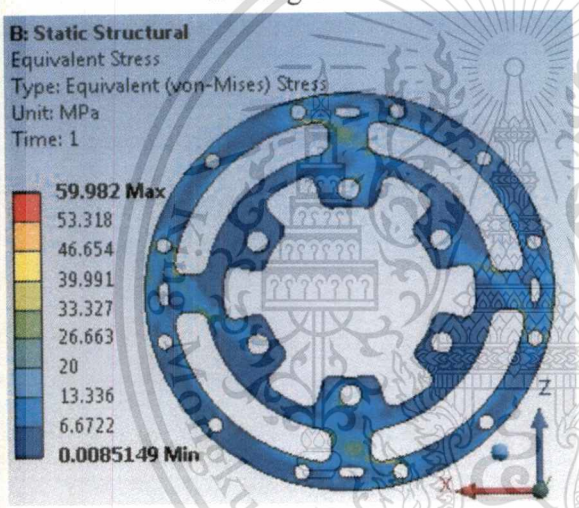


Fig 3-47. Stress distribution force applied at 30 degree

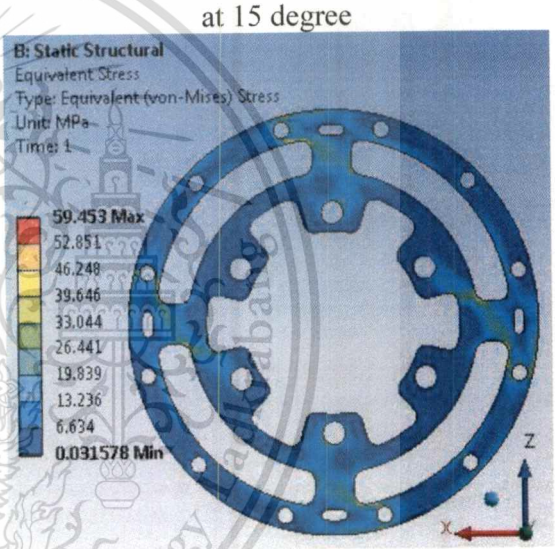


Fig 3-48. Stress distribution force applied at 45 degree

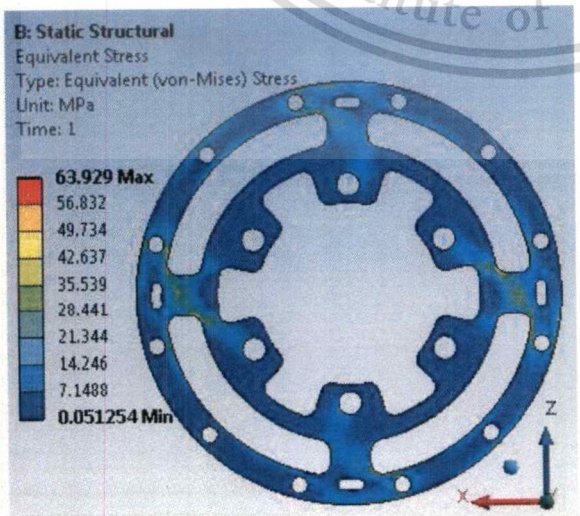


Fig 3-49. Stress distribution force applied at 60 degree

Fig 3-50. Stress distribution force applied at 75 degree

Table 3-10. Different Material Analysis

Material Properties	Stainless Steel Grade		Aluminium Grade				
	630	304	2014-T6	2024-T4	2024-T81	6061-T6	7075
Modulus of Elasticity(N/m^2)	1.96E+11	2E+11	7.31E+10	6.93E+10	7.10E+10	6.9E+10	7.20E+10
Yield Strength(N/m^2)	7.60E+08	2.10E+08	4.14E+08	3.45E+08	2.90E+08	2.41E+08	1.45E+08
Ultimate Tensile Strength(N/m^2)	1.03E+09	5.40E+08	4.83E+08	4.82E+08	3.00E+08	3.00E+08	2.76E+08
Density (kg/m^3)	7750	7900	2800	2770	2780	2700	2810
Volume (m^3)	1.14E-03						
Max Stress (F at 75^0 on ANSYS)(N/m^2)	6.47E+07	6.47E+07	6.45E+07	6.54E+07	6.54E+07	6.54E+07	6.28E+07
Calculated Factor of Safety	11.8	3.2	6.4	5.3	4.4	3.7	2.3
Element Size	4	4	4	4	4	4	4
Loadcell Weight (kg) ANSYS	8.85	9.02	3.20	3.16	3.18	3.08	3.16
Loadcell Weight (kg) Calculated	8.85	9.02	3.20	3.16	3.18	3.08	3.21
Without Loadcell Weight (kg)	7.89						
Total WFT Weight on Wheel	16.74	16.91	11.09	11.05	11.06	10.97	11.05

Table 3-11. Weight Calculation of Different Components

	Hub Adaptor	Rim Adaptor	Wireless adaptor	Clamping plate	Antenna Clamp	NI 9191	NI 9237	NI 9949	WFT Cover	Misc	Weight without Load cell
Weight (kg) (ANSYS)	1.82	2.89	0.61	0.08	0.05				0.62		
Weight (kg) (Calc)	1.82	2.87	0.61	0.08	0.05	0.49	0.15	0.17	0.62	1	7.89
Volume (m^3)	2.31E-04	3.68E-04	7.80E-05	5.17E-06	6.58E-06				6.48E+05		
Material	Stainless steel	Structural steel	7.80E-05	5.17E-06	6.58E-06				6.48E-04		
Density (kg/m^3)	7900	7805							Polytenene		

Finally with various changes to minimize the stress concentration on the loadcell following geometry had been developed. Meanwhile, material has been changed to 7075 so that the weight has been reduced from 9.02 kg to 3.21 kg. Fig 3-51~ fig 3-56 shows the FEA of 7075 loadcell.

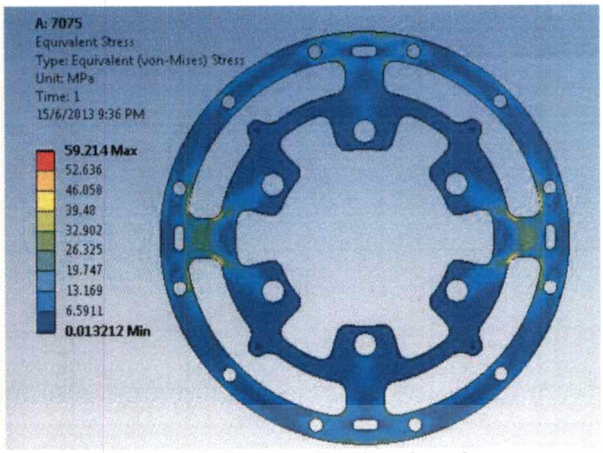


Fig 3-51. Stress distribution force applied at 0 degree

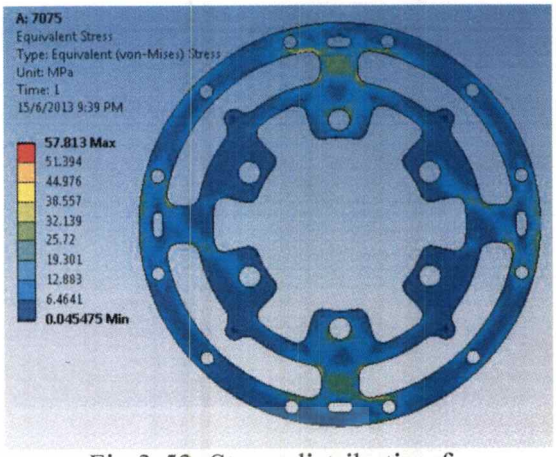


Fig 3-52. Stress distribution force applied at 15 degree

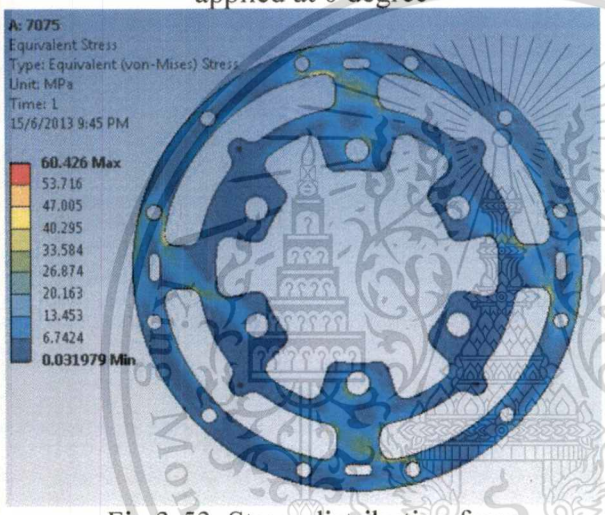


Fig 3-53. Stress distribution force applied at 30 degree

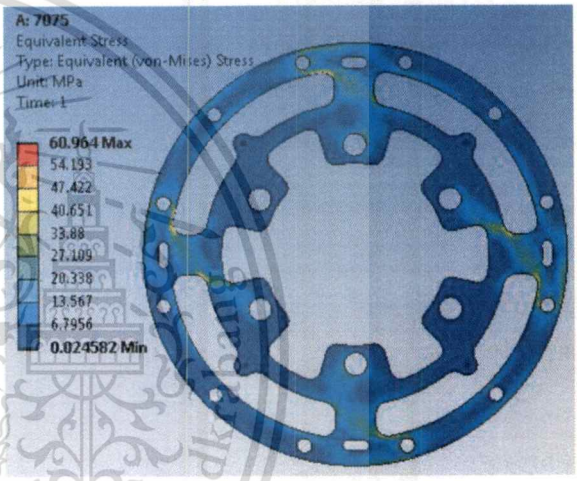


Fig 3-54. Stress distribution force applied at 45 degree

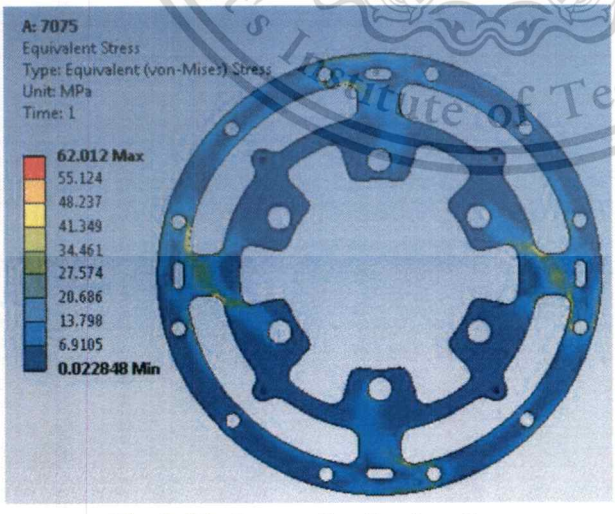


Fig 3-55. Stress distribution force applied at 60 degree

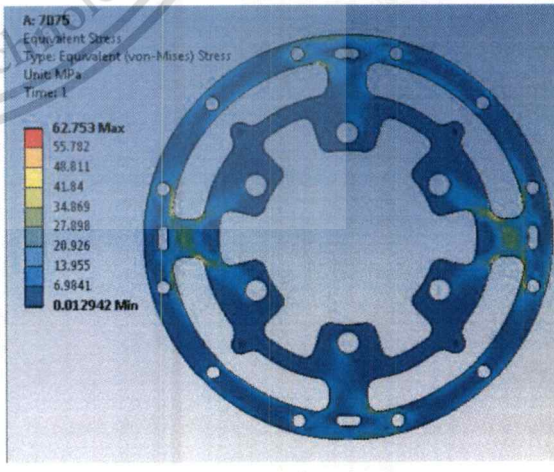


Fig 3-56. Stress distribution force applied at 75 degree

CHAPTER 4
DEVELOPMENT OF WHEEL FORCE TRANSDUCER

After the design of all the components of wheel force transducer, finally it has been sent for the manufacturer. All of the final design had been made with mutual understanding between the manufacturer and design principles. Manufacturer used special tool for the loadcell. Also its geometry was unique and complex; laser cutter was used to get its geometry. While for other components normal manufacturing process had been employed.

4.1. WHEEL FORCE TRANSDUCER INTEGRATED COMPONENTS

Wheel force transducer comprises of different components integrated together. These integrated components can be categorised in three different terms as shown in fig 4-1 below. Designed wheel force transducer need to be assembled on rear wheel of multipurpose agricultural truck thus special precaution need to be taken during design as it rotates with the speed of the vehicle.

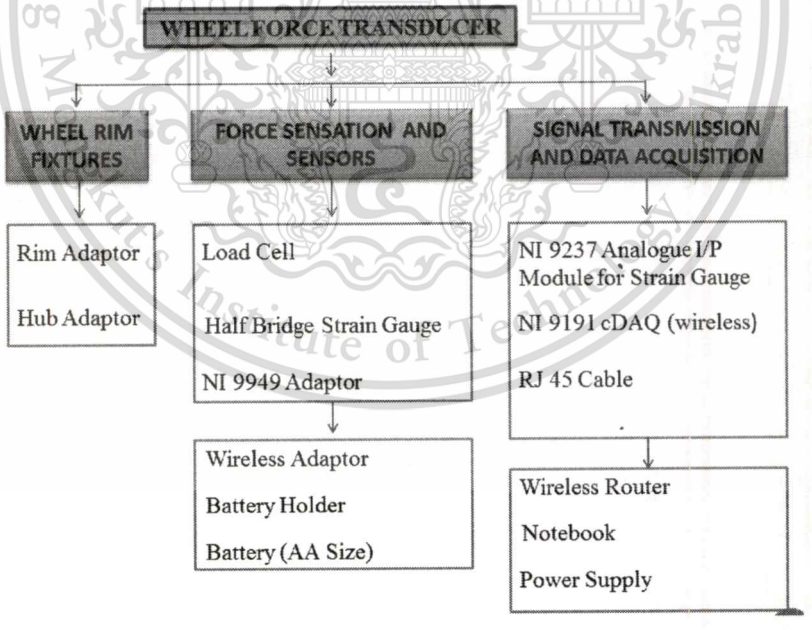


Fig 4-1 Wheel Force Transducer Integrated Components

4.1.1. WHEEL RIM FIXTURES

Wheel rim fixtures indicate fixtures used to hold the loadcell and other signal transmission device. These fixtures are designed for, to align at original condition so

that previous design condition; force and stress flow on these parts would remain same. On the other hand, there would not be any overload and wear and tear due to misalignment during operation. Also this is very essential for the transducer so that there would not be any exaggeration or attenuation of the signal generated.

A wheel rim fixture consists of two adaptors which are described in brief below:

Rim Adaptor

Rear wheel rim of the multipurpose truck has been modified by removing the central metals. After the original rim has been modified i.e. removing central part, rim adaptor would be welded to inner part of the wheel rim at previous position. Thus alignment between rim and axle would remain same as original on multipurpose truck axle. In this context, original weld part for the central metal of the rim was at 27mm from the top of wheel rim as shown on fig 4-2 and fig 4-3 below has been maintained. Meanwhile, it has 12 threaded holes to fix the loadcell and 2mm of offset to avoid misalignment during installation and operation.

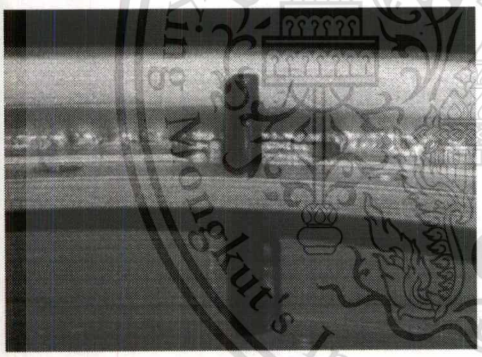


Fig 4-2. Rim Adaptor offset

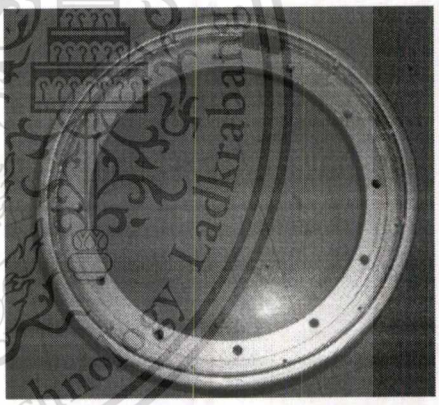


Fig 4-3. Rim Adaptor on Rim

Hub Adaptor

In this project a simple hub adaptor has been designed with six through holes and six threaded holes as shown in fig 4-4. These six threaded holes are to fix the loadcell with hub adopter while other six through holes are to fix the system with the wheel spindle. This hub adaptor was designed for 18 mm thickness to compensate offset at original condition.

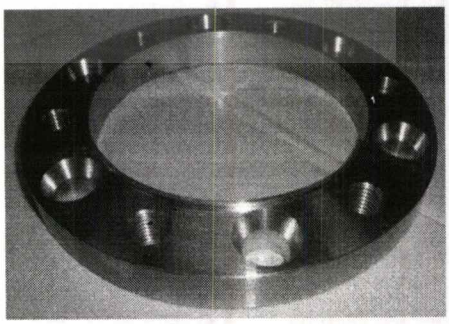


Fig 4-4. Hub Adaptor

4.1.2. FORCE SENSATION AND SENSORS

Force sensation is the key for any transducer design. Loadcell is the heart of wheel force transducer. Special consideration has been made during the design, including for sensation of force, sensor attachment on loadcell to its attachment on adaptors within the limited space. Four full bridge Wheatstone bridge configurations have been employed from eight half bridge strain gauges. These half bridge strain gauge are attached on either side of four radially extended beam on the loadcell to sense force on X and Z direction only. Furthermore, to protect the system from harsh condition three layers of coating has been performed.

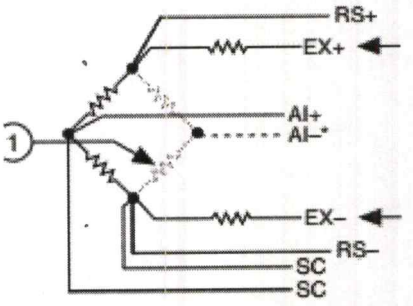


Fig 4-5. Wheatstone bridge

Loadcell

Loadcell on wheel force transducer sense the load from the road load with those sensors arranged on Wheatstone bridge principle. Half bridge strain-gage on load cells convert the load acting on them into electrical signals. The gauges themselves are bonded onto a beam or structural member that deforms when there is load. In most cases, four strain gages are used to obtain maximum sensitivity and temperature compensation. Other load cells are fading into obscurity, as strain gage loadcells continue to increase their accuracy and lower their unit costs [2]. When load is applied, the strain changes the electrical resistance of the gauges in proportion to the load. To cope with strain developed and sensor compatibility, structure of the loadcell is one of the major factors that determine road load data.

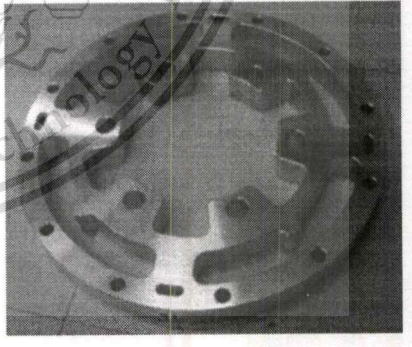


Fig 4-6. Loadcell

Loadcell body includes:

1. Rigid central member
2. A rigid annular ring
3. Number of radial member extending radially and joining the central member to the annular ring

Sensing Circuit

A careful selection of sensor and design of sensing circuit determines transducers sensation and capacity or electrical measurement of mechanical quantities. For this wheel force transducer strain gauge technology has been determined. At the meanwhile, shear strain based strain gauge has been designed. Finally strain gauges have been protected for moisture with multi-layer coatings.

Half Bridge Strain Gauge

To achieve greatest possible sensitivity relative to the measured variable, a full Wheatstone bridge be built. Two half bridge strain gauges have been designed on full bridge Wheatstone bridge for the sensing circuit on each of the four arm of loadcell to determine road load data.

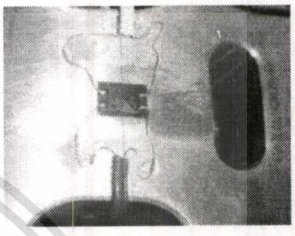


Fig 4-7. Strain Gauge Installation

NI Adaptor 9949

This adaptor is used to connect the sensing circuit to the wireless data acquisition device with the help of RJ 45 cable. It is also used to configure Wheatstone bridge configuration for strain gauge sensors for sensing circuit.

Fig 4-8. NI 9949

Wireless Adaptor

This adaptor is designed to hold sensing device and its accessories on wheel. This adaptor helps to hold device, battery pack and the strain gauge module with its connectors on loadcell with its rotation. It also helps to hold the antenna at the center of the transducer with modification to enhance the signal.

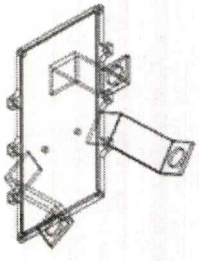


Fig 4-9. Wireless Adaptor

Battery Holder

Power needs to be supplied to the DAQ system during the dynamic test. Thus a power supply unit has to be installed on the wheel in conjunction with the DAQ system. It holds two AA size lithium ion batteries with 3.5V each resulting 7V on one battery back. Two

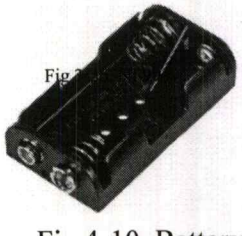


Fig 4-10. Battery Holder

such battery adaptors have been used to give 14V supply for the DAQ system on the center.

4.1.3. SIGNAL TRANSMISSION AND DATA ACQUISITION SYSTEM

The signal conditioning electronics may have a minimum configuration such as an Analogue to Digital Converter to convert the analogue signal into a digital format for retransmission. It may incorporate additional electronic devices to store various loadcell performance characteristics and optimise these by the use of software algorithms.

NI 9237 Strain gauge Module

This module converts the signal from the strain gauge via NI 9949 adaptors. This module converts 4 full bridge strain gauge signals from the loadcell through 4 channels to the cDAQ. Four LAN cables are used to connect NI9949 adaptor to NI 9237 module. This module converts the analogue signal of strain gauge strain to the wireless module for further processing.

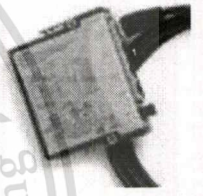


Fig 4-11. NI 9237

NI cDAQ 9191 wireless Module

This module is the main module to transmit the data from the wheel to the notebook. This module communicates to the notebook through a router developed infrastructure network. A 15 volt power supply has been provided for the power in the modules through this module. All of these modules are attached on the wireless adaptors to rotate on the wheel.

Fig 4-12. NI 9191

4.2. LOADCELL DEVELOPMENT

Sensor installation is the most important steps for the development of transducer. Shear stress strain gauge has been installed on designed loadcells. A typical procedure has been followed for the installation which

Fig 4-13. Loadcell Development Materials

has been described on brief. Before you go for attaching the strain gauge you need to prepare some materials listed below:

1. Shear Strain gauge
2. Bonding Adhesive
3. Tape
3. Cleaning Tissue paper
4. Solder equipment
5. Abrasive paper
6. Measuring Devices
7. Loadcell
8. Polyethylene sheet, etc.

Fig 4-14. Loadcell Allocated Gauge Area

Step 1: Allocate Gauge Area

Before installing the strain gauge the space has been allocated on the loadcell where strain gauge has to be installed. This area should be the maximum shear stress area on the central of the loadcell beams i.e. Upper and lower surface of the four radially extended beams has been determined.

Step 2: Surface Preparation

The allocated surface had been cleaned for bonding, removing all dust, grease, etc. Surface has been made fine and smooth uniformly with 600, 1000, 2000 abrasive paper sequentially.

Fig 4-15. Surface Preparation

Fig 4-16. Abrasive Sand Papers

Step 3: Fine Cleaning

Bonding and surface finished areas had been cleaned by tissue paper until the tissue comes away with completely free of contamination. Also the cleaning agent or spray could be used for cleaning. The gauge had been installed before the surface get covered with an oxidizing membrane or newly contaminated film.

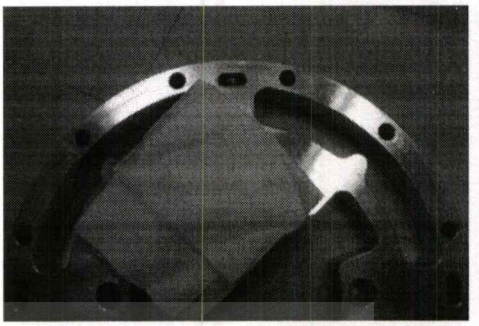


Fig 4-17. Surface Cleaning

Step 4: Positioning of Gauge

Exact measurement had been done for the attachment of strain gauge. Position had been determined at the center of the beam with scale and vernier-calliper. Marking of the centre has been done with pencil.

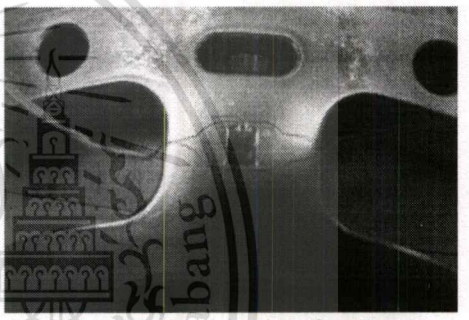


Fig 4-18. Positioning for Gauge

Then the strain gauge had been attached to a tape for the ease of positioning and trial for the beginning. Center mark on the strain gauge and beam marking had been matched during its trial attachment with tape on the loadcell.

Step 4: Apply Bonding Adhesive

To apply bonding adhesive the tape had been peeled till the end of the strain gauge so that stain gauge would have been stick on the tape with front face. Then bonding adhesive had been applied with proper amount, thin and uniform. This adhesive had been spread over the back of the strain gauge with its adhesive nozzle.

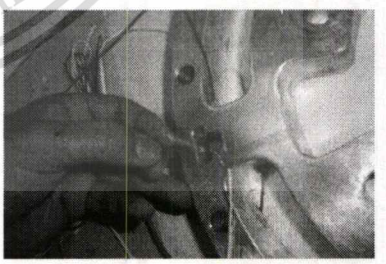


Fig 4-19. Adhesive application

When bonding the strain gauges, the most suitable adhesive should be selected for each application. A typical installation procedure is described below using the fast-curing adhesive CN.

Step 5: Curing, Pressing and Removal of Tape

After applying the adhesive on the backing layer place the strain gauge was placed as per the previous position as the on the tape. Then strain gauge was constantly pressed using the thumb for more than 1 min. This process was done immediately after the application of the adhesive on the baking layer. After few minutes for curing tape was removed with extensive care from one side.

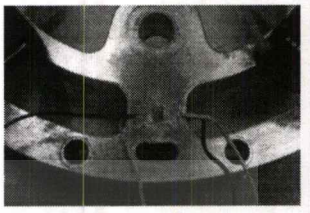


Fig 4-20. Curing

Step 6: Wire Connection

A full bridge connection has been made with two half strain gauge installations. All the 8 wires has been so arranged on 4 terminals according to the NI adaptor configuration and NI strain gauge module 9237 full bridge connection.

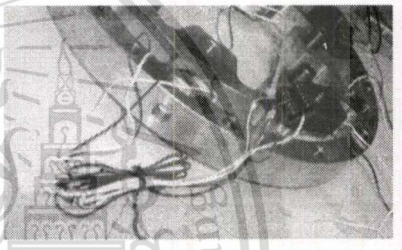


Fig 4-21. Wiring of Gauge

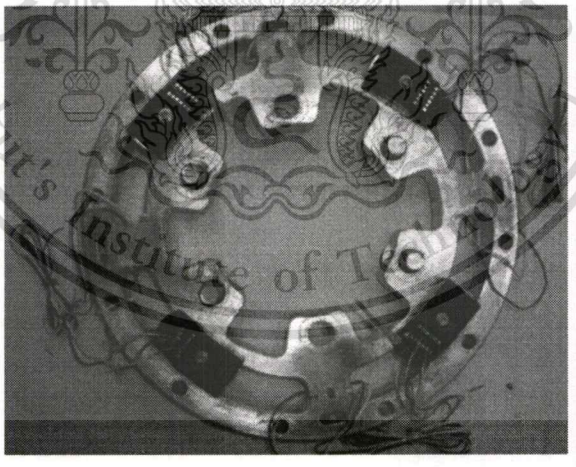


Fig 4-22. Electrical Configuration

Finally all eight strain gauge has been installed successfully with four Wheatstone full bridge configurations as shown on figure above. One full bridge at each beam and two half bridge strain gauges on either side of the beam at maximum shear stress point and minimum bending stress point has been installed.

4.3. COATING

Wheel force transducer, loadcell goes under different field condition which may damage the sensors. Moreover, for long term use or field measurement the strain gauges require protection from ambient moisture. Thus coating is essential for safe handling and protection of the sensors. This coating has been performed for water or moisture proofing over bonded strain gauges.

Normally, single layer coating is insufficient so multiple layer coatings have been combined to protect the strain gauge. Multi-layer Coatings are recommended for strain gauge protection by the manufacturer as well.

A typical coating has been performed with 3 layers W-1, SB tape and black tape respectively.

W-1 is microcrystalline wax used for coating TML strain gauges to protect it from moisture and water proofing of strain gauges bonded on metal or non- metal surfaces. The operating temperature for W-1 is 0~+50 °C. For the curing it needs to be heated 100~120 °C and cooling under room condition.

SB tape

It is a butyal tape for the second layer coating for the strain gauge to protect it from moisture and water proofing. The operating temperature for SB tape is -30~ 80 °C and applied with gentle pressure.

W-1 Coating

Solid W-1 was kept on a small beaker and heated in a temperature controlled oven at 108 °C for 10 minutes continuously. When W-1 melts and turns into light yellow transparent liquid then it is ready for use.

Then after with the help of brush W-1 was applied on the surface of the strain gauge and extruded adhesive. W-1 gets hard as soon as cooling and turns to be light yellow. A thick layer of W-1 was applied over the strain gauge.

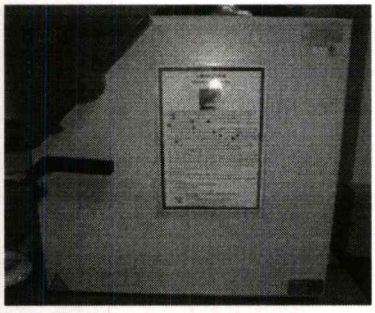


Fig 4-23. Electrical Oven

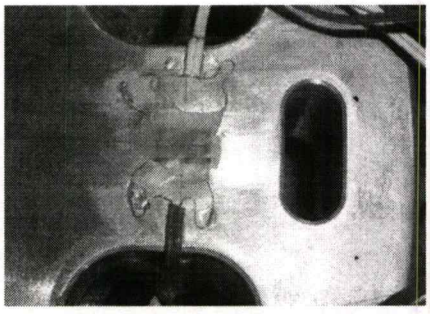


Fig 4-24. W1-First layer

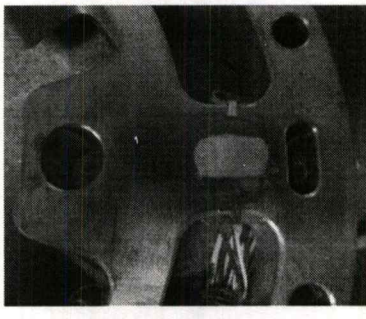


Fig 4-25. W1-Final layer

SB Tape Coating

An enough length of SB tape was cut for the application over the strain gauge and W-1 coating. It was then applied over W-1 and pressed gently with the separating paper to spread over enough space over the specific area.

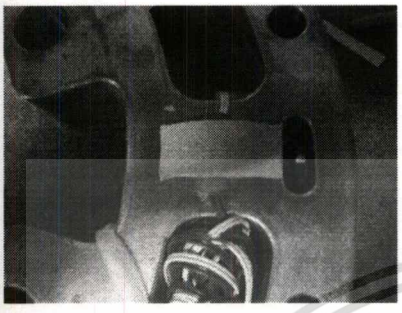


Fig 4-26. SB Tape

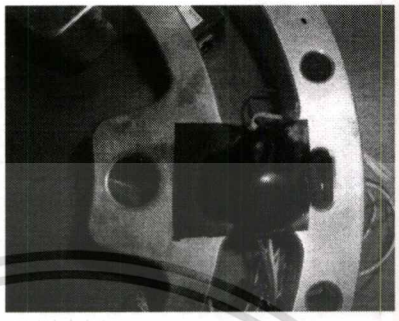


Fig 4-27. Black Tape

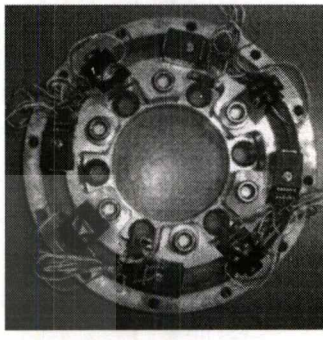


Fig 4-28. Final Coating

4.4. SETUP FOR DATA ACQUISITION

This system has been designed and developed with "LabView" software for electronic communication. Data acquisition has been designed with two processing method.

4.4.1. PRE-PROCESSING

Pre-process is the initial processing of the data from wheel to notebook. It acquires the raw data through wireless communication through DAQ devices and stores the data in computer storage.

During the raw data acquisition the 4 channel data would be obtained through 4 full Wheatstone bridge configurations. This stain need to be calibrated at the beginning for the zero balance. Obtained strain would be recorded on a file for the post processing shown in fig 4-29

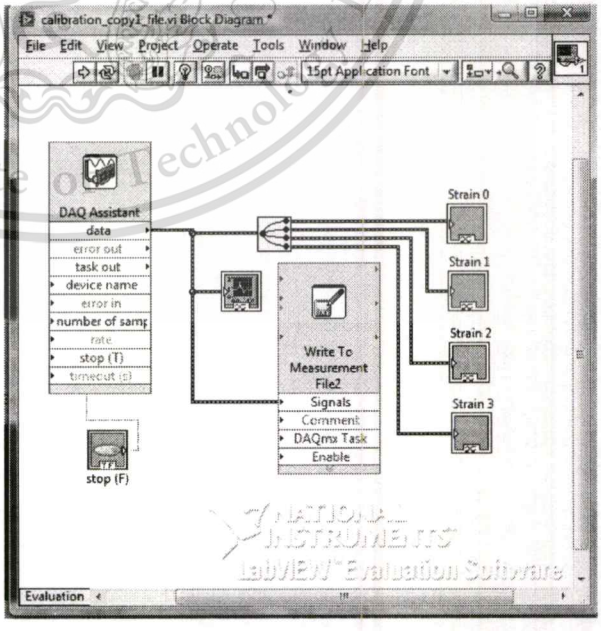


Fig 4-29. Software Programming Block Diagram

Data acquisition setup need to be performed as shown in fig 4-30 where gauge factor of 2.08 has been employed form the strain gauge specification and excitation voltage for full Wheatstone bridge is defined to be 2.5 V.

Meanwhile, the sampling rate was kept to be 100Hz for stationary calibration condition and sample to read to be 100 at N Samples configuration. During the dynamic condition N Sample configuration needs to be changed to be a Continuous Sample Configuration.

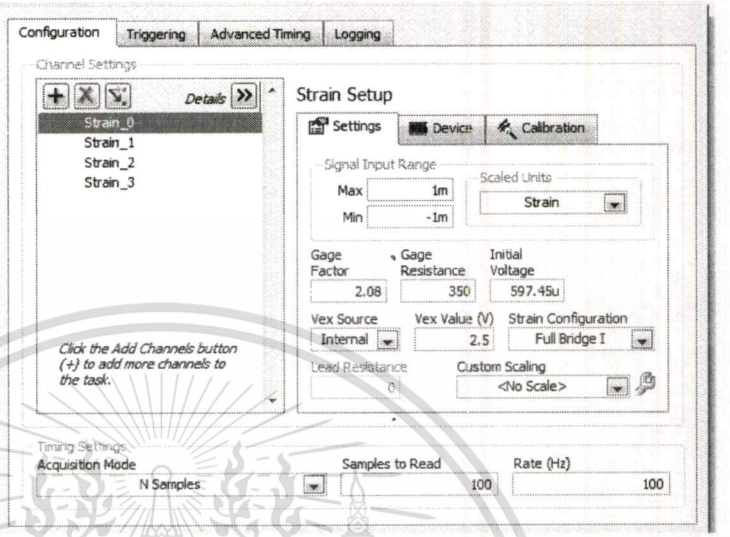


Fig 4-30. Data Acquisition Setup

4.4.2. POST-PROCESSING

In post-processing the data has been extracted from pre-processing storage file. These data would then be processed to obtain final result. In this case, raw strain has been obtained from storage file as in Appendix B. These data has been calculated using different correlation and calculation to obtain forces. Please see chapter 5 and 6 for detail calculations.

4.5. ASSEMBLY AND DISSAMBLY

Assembly of the components has been designed as described below and shown in figure below.

Fig.4-31. Assembly and Disassembly of Wheel Force Transducer Components

Procedure for Assembly

1. First attach loadcell on rim adaptor welded on modified wheel rim with bolts with vehicle lifted.
2. Secondly, attach the hub adaptor with bolts to loadcell assembly leaving bolts to attach wireless adapter. This makes modified rim, rim adapter loadcell and hub adapter as a single unit.
3. Thirdly fix above single unit to wheel spindle thru hub adapter with spindle nuts tightly.
4. Fourthly, fix wireless adapter with three legs on loadcell.
5. Fifthly, connect cDAQ with strain gauge adaptors on the loadcell.
6. Sixthly, clamp cDAQ with two aluminium clamp bars and in-build battery pack as attached on the clamp.
7. Finally arrange a LAN setup with router with cDAQ and notebook and obtain the data.

CHAPTER 5
TESTING AND PROCEDURE

5.1. STRUCTURE TEST

Structural test of the system had been carried out after all the components had been manufactured as per the designed specifications.

5.1.1. PROCEDURE

1. Follow assembly procedure 1 to 3 on section 4.5 while loadcell was not completely developed as shown in fig 5.1 i.e. without strain gauged and adaptors attached.
2. Run agricultural truck in curve track and bumps at maximum speed it can go through for 2 hours as in fig 5.2.
3. Check for any damage or anomalies (visual inspection).

Fig 5-1. WFT Mounted on Axle

Fig 5-2. Structure Test on Bumps

5.1.2. RESULT

After repeated test on bumps it showed that the structure was rigid enough for the transducer measurement. There was not any damage or distortion after 2 hours of test run.

5.2. SIGNAL TRANSMISSION TEST

After the structure test has been successfully accomplished. Loadcell was prepared with all electrical configurations to sense the load. Finally a test run was done to check all the function of the transducer. A complete wheel force transducer and its signal transmission test is shown in fig 5-3 and fig 5-4 respectively.

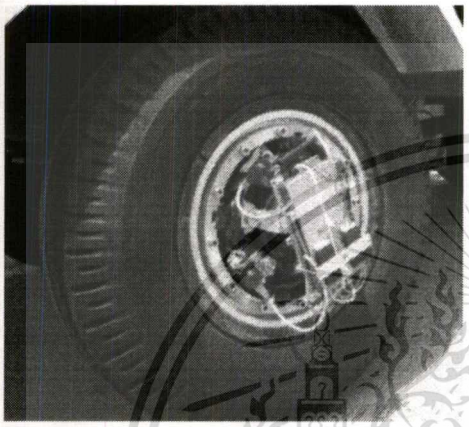


Fig 5-3. Complete WFT Mounted on Axle

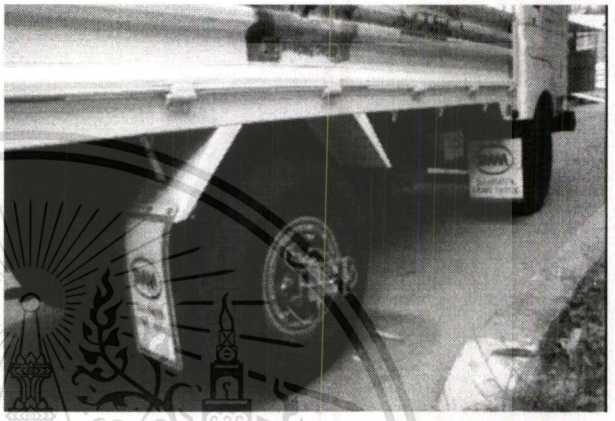


Fig 5-4. Signal Transmission Test

5.2.1. PROCEDURE

1. Follow assembly procedure 1 to 7 on section 4.5
2. Run agricultural truck in paved road at maximum speed it can go through for 1 hour.
3. Check for data transfer during the dynamic condition.

5.2.2. RESULT

During the test it was able to transfer the data from the wheel to the notebook via wireless LAN communication with some interruption. This interruption was due to vibration. Unfortunately the LAN router was malfunction during the test.

5.3. STATIC CALIBRATION

Designed and developed wheel force transducer prototype need to be calibrated before actual measurement. Static calibration was carried out for force in z direction. Two weighing machine was used for reference measurement for the calibration. A light water tank was loaded on the truck for the variation of load.

Calibration was carried out with 4 different positions of angles with 90 degree rotation. At each orientation, the rear wheel was lifted off the wheel scale using a hydraulic jack. This provided the zero load condition. The jack was then slowly released until the digital readout on the wheel scale.

This process was continued in 3728 N to 6867N increments with 981 N (100kg) was carried out. At each loading condition, the wheel scale reading was manually recorded and the strain gauge bridge responses were recorded using the notebook based data acquisition (DAQ) system. Much of the work done with load wheels is for wheel or chassis load measurement with a frequency of interest below 100 Hz. Sampling rate of 100 samples/second was used.

5.3.1. EXPERIMENTAL SETUP

With completing the special procedure to setup the wheel force transducer, it was installed on the agricultural truck wheel. The truck was loaded with an empty tank to provide the load at stationary condition.

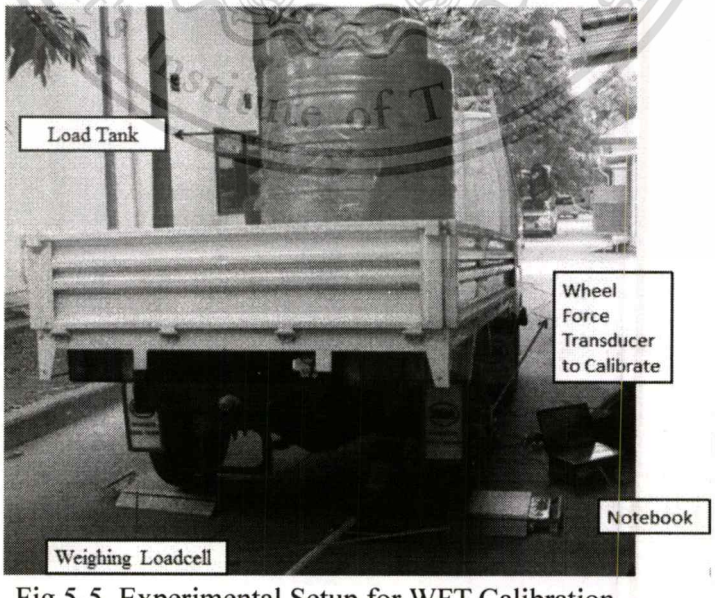


Fig 5-5. Experimental Setup for WFT Calibration

Two weighing loadcell was placed on the rear wheel of the truck. Measurement was correlated with the weighing loadcell directly related or beneath the wheel force transducer. Arrangement of the calibration setup has been shown in the fig 5-5.

Before the calibration process had been carried out software calibration has been done with the software "LabView" for the zero offset. This calibration helps the strain gauge to maintain zero position with the compensation of errors during the installation.

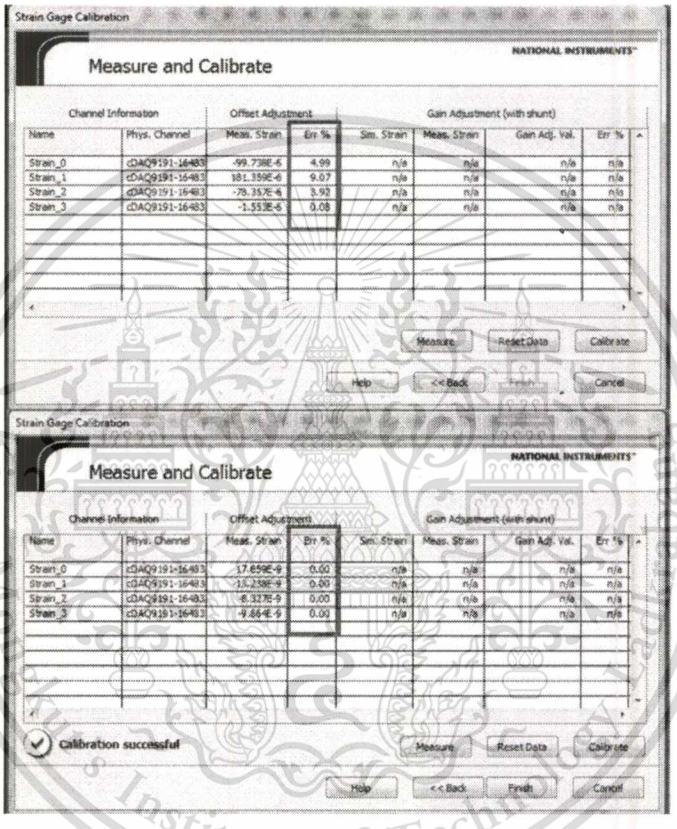


Table 5-1. Strain gauge Calibration for Zero Offset

Table 5-1 shows the offset value due to human error during the installation. While next table indicates successful calibration of the strain gauges with offset adjustment error to be zero.

5.3.2. EXPERIMENTAL PROCEDURE

1. Follow assembly procedure 1 to 7 on section 4.5.
2. The test on has been carried out on a flat hard surface road.
3. Two scale has been used, one for the correlation or calibration and other as a dummy to lift the wheel to the same level.

4. Strain has been measured and recorded for 4 orientations at 90 degrees.
5. Sampling frequency of 100 Hz had been employed at stationary condition and a constant sample of 100 had been recorded from each full bridge configuration from 4 beams.
6. Wheel was lifted off the wheel scale using a hydraulic jack to provide zero load condition and wheel was manually rotated to the 90 degree angle as per the manual marking of 15 degree differences around the wheel rim.
7. Wheel was slowly released to have a load condition on the wheel scale, and then the data was recorded for the strain.(Appendix C).
8. The load was increased by 100kg for the next loading condition by adding water on the tank.
9. Process 5, 6 and 7 was repeated for 4 different loads at increasing order.
10. Again load was decreased by 100kg for the next loading condition by removing the water from the tank through a valve.
11. Process 5, 6 and 9 was repeated for 4 different loads at decreasing order.

5.3.3. CALIBRATION

After the data has been recorded, it has been processed for the calibration. Following calibration flowchart had been developed for the calibration of the wheel force tr

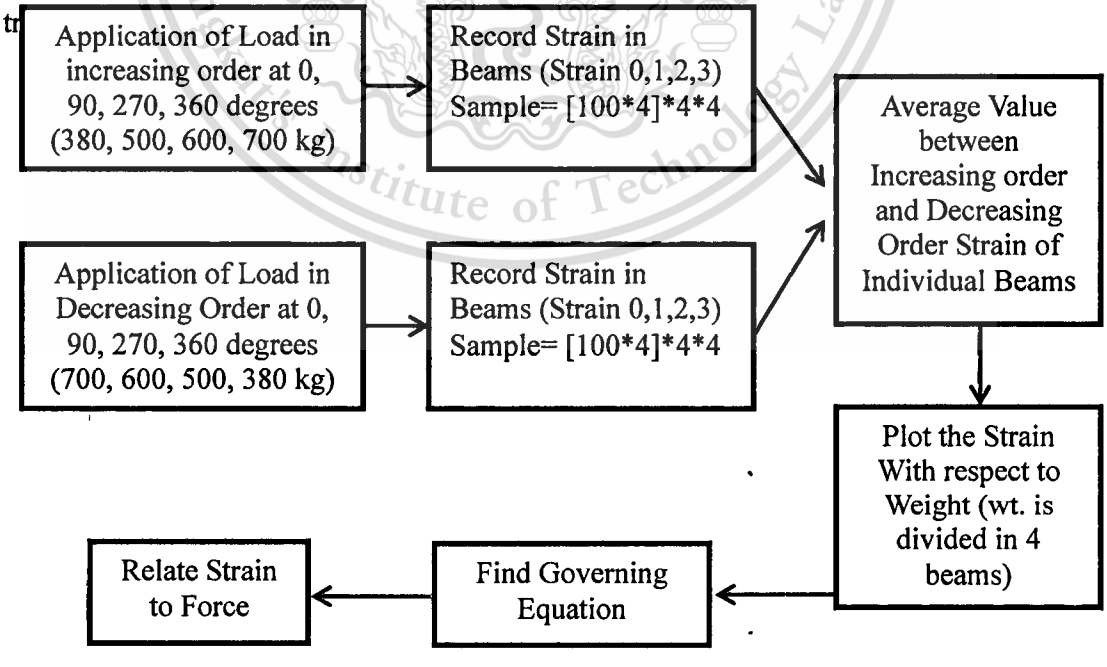


Fig 5-6. Flowchart for WFT Calibration

During this process four strain values have been recorded from each Wheatstone bridge from each beam via a four channel NI 9237 and NI 9191 module. First the four strain value with increasing order of load from 380, 500, 600 and 700 kg was employed and eventually on the decreasing order. Secondly the sample was recorded i.e. 400 sample at each time on four beams with four varying loads was recorded. Then the average of each 100 samples was calculated from each strain 0, strain 1, strain 2 and stain 3 from beam 20, 21, 22 and 23 respectively. Thirdly, these recorded samples of same load on same beam with increasing and decreasing load was averaged. Fourthly, these strain value was plotted on graph with respect to half of measured weight. Finally the graph was found to be linear and the equation has been developed for the correlation. Then it was converted to the force.

Following tables 5-2, 5-3, 5-5,5-6, 5-8, 5-9, 5-11, 5-12 and 5-14 are the calculations obtained from Appendix C following the flowchart fig 5-6.

Table 5-2. Load at Beam 21 and Strain on Beams (Load applied on Increasing order)

Weight	Strain 0	Strain 1	Strain 2	Strain 3
kg	mm mm^-1			
380	-3.84E-05	-2.19E-05	3.47E-05	-1.23E-05
500	-5.09E-05	1.31E-05	4.90E-05	-5.46E-06
600	-6.07E-05	1.17E-05	6.06E-05	-3.35E-05
700	-7.05E-05	1.02E-05	6.98E-05	1.89E-05

Table 5-3. Load at Beam 21 and Strain on Beams (Load applied on Decreasing Order)

Weight	Strain 0	Strain 1	Strain 2	Strain 3
kg	mm mm^-1			
380	-3.84E-05	-2.19E-05	3.47E-05	-1.23E-05
500	-4.96E-05	1.21E-05	4.94E-05	-2.46E-05
600	-5.97E-05	1.10E-05	5.93E-05	4.22E-05
700	-6.92E-05	1.05E-05	6.94E-05	5.19E-05

Table 5-4. Average Strains of Beam 21

Weight	Strain 0	Strain 1	Strain 2	Strain 3
kg	mm mm^-1			
380	-3.84E-05	-2.19E-05	3.47E-05	-1.23E-05
500	-5.02E-05	1.26E-05	4.92E-05	-1.50E-05
600	-6.02E-05	1.14E-05	5.99E-05	4.39E-06
700	-6.98E-05	1.03E-05	6.96E-05	3.54E-05

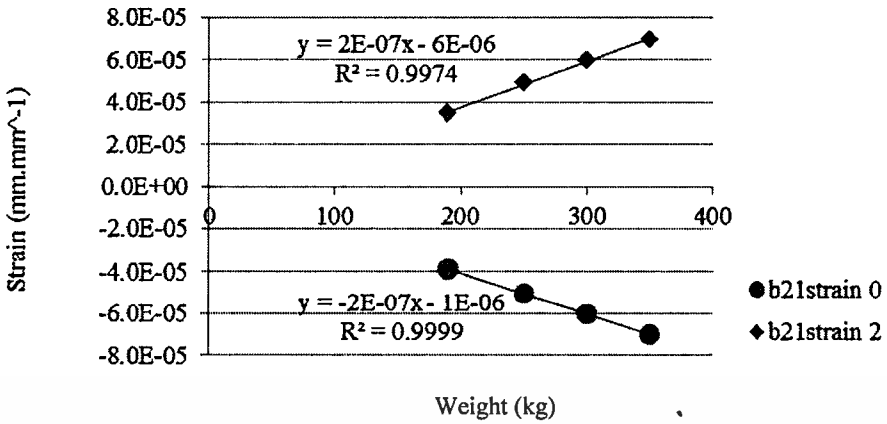


Fig 5-7. Measured Strain 0 and Strain 2 Vs. Weight at 0 degree

Table 5-4 was plotted on the graph as illustrated in fig5-7. Load is transferred to two beams. Thus, weight distributions are assumed to be half as the orientation was 0 degree by beam principle. This figure depicts strain 0 and strain 2 at beam 20 and beam 22 with respect to weight measured; which is linear.

The equation of the graph was found to be:

0 Degree (Load at Beam 21)

Strain 0 $y = (-2 \times 10^{-7})x - 1 \times 10^{-6}$ (5.3-1)

Strain 2 $y = (2 \times 10^{-7})x - 6 \times 10^{-6}$ (5.3-2)

Table 5-5. Load at Beam 23 and Strain on Beams (Load applied on Increasing Order)				
Weight	**Strain 0**	**Strain 1**	**Strain 2**	**Strain 3**
kg	**mm mm^-1**			
380	3.11E-05	-9.17E-06	-4.59E-05	1.90E-05
500	4.90E-05	2.32E-05	-5.09E-05	-3.81E-05
600	5.93E-05	2.39E-05	-5.97E-05	-1.61E-07
700	6.98E-05	2.37E-05	-6.96E-05	3.07E-08

Table 5-6. Load at Beam 23 and Strain on Beams (Load applied on Decreasing Order)				
Weight	**Strain 0**	**Strain 1**	**Strain 2**	**Strain 3**
kg	**mm mm^-1**			
380	3.11E-05	-9.17E-06	-4.59-05	1.90E-05
500	4.91E-05	2.31E-05	-5.03E-05	-2.78E-05
600	5.91E-05	2.34E-05	-5.98E-05	-1.61E-07
700	6.96E-05	2.37E-05	-7.14E-05	3.06E-05

Table 5-7. Average Strains of Beam 23				
Weight	**Strain 0**	**Strain 1**	**Strain 2**	**Strain 3**
kg	**mm mm^-1**			
380	3.11E-05	-9.17E-06	-4.59E-05	1.90E-05
500	4.90E-05	2.31E-05	-5.06E-05	-3.30E-05
600	5.92E-05	2.36E-05	-5.97E-05	-1.61E-07
700	6.97E-05	2.37E-05	-7.05E-05	1.53E-05

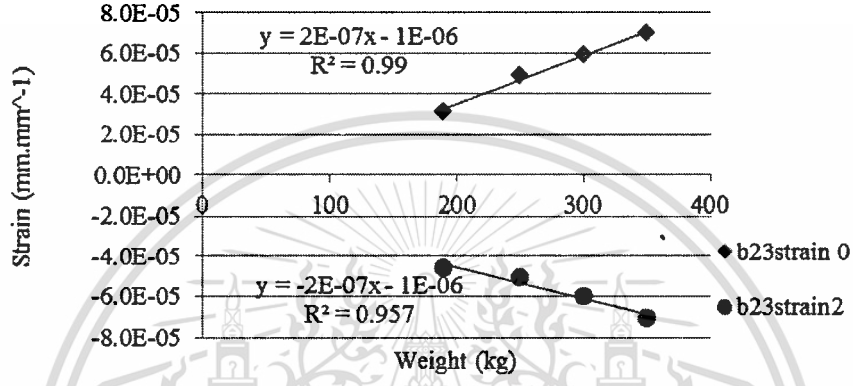


Fig 5-8. Measured Strain 0 and Strain 2 Vs. Weight at 180 degree

Table 5-7 was plotted on the graph as illustrated in fig5-8. Load is transferred to two beams. Thus, weight distributions are assumed to be half as the orientation was 180 degree by beam principle. This figure depicts strain 0 and strain 2 at beam 20 and beam 22 with respect to weight measured; which is linear.

The equation of the graph was found to be:

180 Degree (Load at Beam 23)

Strain 0 $$y = (2 \times 10^{-7})x - 1 \times 10^{-6} \quad (5.3\text{-}3)$$

Strain 2 $$y = (-2 \times 10^{-7})x - 1 \times 10^{-6} \quad (5.3\text{-}4)$$

Table 5-8. Load at Beam 22 and Strain on Beams (Load applied on Increasing Order)				
Weight	**Strain 0**	**Strain 1**	**Strain 2**	**Strain 3**
kg	**mm mm^-1**			
380	-3.43E-06	-3.72E-05	-1.59E-07	3.76E-05
500	-3.30E-07	-4.92E-05	1.29E-06	4.72E-05
600	1.82E-07	-5.92E-05	-4.19E-07	5.68E-05
700	8.17E-07	-6.94E-05	-1.10E-06	6.72E-05

Table 5-9. Load at Beam 22 and Strain on Beams (Load applied on Decreasing Order)				
Weight	**Strain 0**	**Strain 1**	**Strain 2**	**Strain 3**
kg	**mm mm^-1**			
380	-3.43E-06	-3.95E-05	-1.59E-07	3.50E-05
500	1.26E-06	-4.91E-05	-9.94E-07	4.71E-05
600	1.16E-06	-5.91E-05	-1.05E-06	5.70E-05
700	8.17E-07	-6.94E-05	-1.10E-06	6.81E-05

Table 5-10. Average Strains of Beam 22				
Weight	**Strain 0**	**Strain 1**	**Strain 2**	**Strain 3**
kg	**mm mm^-1**			
380	-3.43E-06	-3.84E-05	-1.59E-07	3.63E-05
500	4.63E-07	-4.91E-05	1.46E-07	4.71E-05
600	6.71E-07	-5.92E-05	-7.33E-07	5.69E-05
700	8.17E-07	-6.94E-05	-1.10E-06	6.77E-05

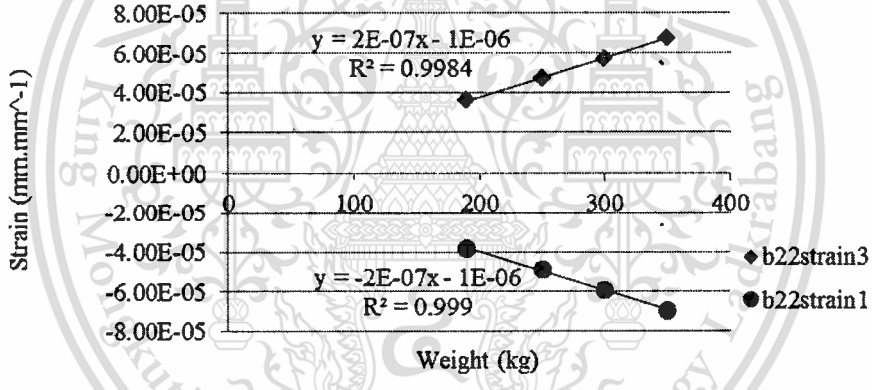


Fig 5-9. Measured Strain 1 and Strain 3 Vs. Weight at 90 degree

Table 5-10 was plotted on the graph as illustrated in fig5-9. Load is transferred to two beams. Thus, weight distributions are assumed to be half as the orientation was 90 degree by beam principle. This figure depicts strain 1 and strain 3 at beam 21 and beam 23 with respect to weight measured; which is linear.

The equation of the graph was found to be:

90 Degree (Load at Beam 22)

Strain 1 $$y = (-2 \times 10^{-7})x - 1 \times 10^{-6} \quad (5.3\text{-}5)$$

Strain 3 $$y = (2 \times 10^{-7})x - 1 \times 10^{-6} \quad (5.3\text{-}6)$$

Table 5-11. Load at Beam 20 and Strain on Beams (Load applied on Increasing Order)				
Weight	**Strain 0**	**Strain 1**	**Strain 2**	**Strain 3**
kg	**mm mm^-1**			
380	-3.86E-06	2.99E-05	3.08E-06	-4.46E-05
500	1.76E-06	5.16E-05	4.26E-06	-4.96E-05
600	1.68E-06	6.20E-05	4.47E-06	-5.92E-05
700	1.46E-06	6.73E-05	4.39E-06	-6.82E-05

Table 5-12. Load at Beam 20 and Strain on Beams (Load applied on Decreasing Order)				
Weight	**Strain 0**	**Strain 1**	**Strain 2**	**Strain 3**
kg	**mm mm^-1**			
380	-3.86E-06	2.99E-05	3.08E-06	-4.46E-05
500	-1.34E-07	5.17E-05	4.07E-06	-4.95E-05
600	5.07E-07	6.22E-05	4.32E-06	-5.91E-05
700	1.46E-06	6.82E-05	4.39E-06	-6.82E-05

Table 5-13. Average Strains of Beam 20				
Weight	**Strain 0**	**Strain 1**	**Strain 2**	**Strain 3**
kg	**mm mm^-1**			
380	-3.86E-06	2.99E-05	3.08E-06	-4.46E-05
500	8.15E-07	5.16E-05	4.17E-06	-4.95E-05
600	1.09E-06	6.21E-05	4.40E-06	-5.91E-05
700	1.46E-06	6.78E-05	4.39E-06	-6.82E-05

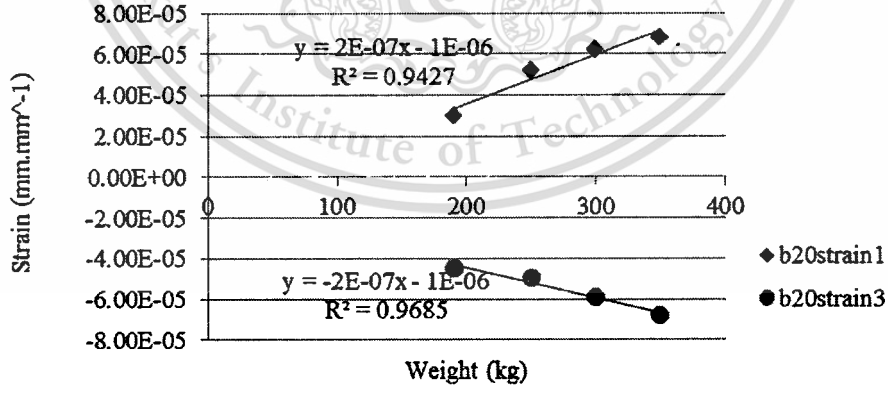


Fig 5-10. Measured Strain 1 and Strain 3 Vs. Weight at 270 degree

Table 5-13 was plotted on the graph as illustrated in fig 5-10. Load is transferred to two beams. Thus, weight distributions are assumed to be half as the orientation was

270 degree by beam principle. This figure depicts strain 1 and strain 3 at beam 21 and beam 23 with respect to weight measured; which is linear.

The equation of the graph was found to be:

270 Degree (Load at Beam 20)

Strain 1 $$y = (2 \times 10^{-7})x - 1 \times 10^{-6} \quad (5.3\text{-}7)$$

Strain 3 $$y = (-2 \times 10^{-7})x - 1 \times 10^{-6} \quad (5.3\text{-}8)$$

Thus strain gauges are governed by following equations (5.3-1~ 5.3-8):

Strain 0, Strain 1 and Strain 3 $$x = \frac{y + 1 \times 10^{-6}}{2 \times 10^{-7}} \quad (5.3\text{-}9)$$

Strain 2 $$x = \frac{y + 3 \times 10^{-6}}{2 \times 10^{-7}} \quad (5.3\text{-}10)$$

These calibrations had been checked for calculating weight and force to evaluate strain 0, strain 1, strain 2 and strain 3. Tables below shows calculation of wheel force transducer data.

Table 5-14. Measured Strain at Each Beam at 0 - 360 degree

Angle	Weight	Strain 0	Strain 1	Strain 2	Strain 3
Degree	kg	mm.mm^-1			
0	380	-3.84E-05	-2.19E-05	3.47E-05	-1.23E-05
	500	-4.96E-05	1.21E-05	4.94E-05	-2.46E-05
	600	-5.97E-05	1.10E-05	5.93E-05	4.22E-05
	700	-6.92E-05	1.05E-05	6.94E-05	5.19E-05
90	380	-3.43E-06	-3.72E-05	-1.59E-07	3.76E-05
	500	-3.30E-07	-4.92E-05	1.29E-06	4.72E-05
	600	1.82E-07	-5.92E-05	-4.19E-07	5.68E-05
	700	8.17E-07	-6.94E-05	-1.10E-06	6.72E-05
180	380	3.11E-05	-9.17E-06	-4.59E-05	1.90E-05
	500	4.91E-05	2.31E-05	-5.03E-05	-2.78E-05
	600	5.91E-05	2.34E-05	-5.98E-05	-1.61E-05
	700	6.96E-05	2.37E-05	-7.14E-05	3.06E-05
270	380	-3.86E-06	2.99E-05	3.08E-06	-4.45E-05
	500	-1.34E-07	5.17E-05	4.07E-06	-4.95E-05
	600	5.071E-07	6.217E-05	4.316E-06	-5.909E-05
	700	1.46E-06	6.82E-05	4.39E-06	-6.82E-05

Table 5-15. Measured Weight at Each Beam at 0 - 360 degree

Angle	Weight	W0	W1	W2	W3
Degree	kg				
0	380	-186.9	-104.6	188.7	-56.5
	500	-242.8	65.4	261.8	-118.1
	600	-293.5	60.1	311.4	216.2
	700	-340.8	57.3	362.2	264.3
90	380	-12.2	-181.0	14.2	193.1
	500	3.3	-240.8	21.4	240.9
	600	5.9	-291.1	12.9	289.1
	700	9.1	-341.9	9.5	340.9
180	380	160.3	-40.8	-214.3	100.3
	500	250.4	120.4	-236.6	-134.1
	600	300.6	122.1	-284.0	-75.3
	700	353.1	123.6	-342.1	157.8
270	380	-14.3	154.3	30.4	-217.7
	500	4.3	263.3	35.4	-242.3
	600	7.5	315.8	36.6	-290.5
	700	12.3	346.1	37.0	-336.0

These weight from each beam have been used on equation 3.6.2-2 to 3.6.2-6 to find the force in Z-axis with respect to its angle, which has been calculated in the following table with error value

Table 5-16. Measured Weight and Force at 0 - 360 degree

Angle	Calculated Weight	Measured Weight	Calculated Force in Z axis	Measured Force in Z axis	Error
Degree	kg		N		%
0	376	380	3684	3728	1.2
	505	500	4950	4905	0.9
	605	600	5935	5886	0.8
	703	700	6896	6867	0.4
90	374	380	3670	3728	1.5
	482	500	4725	4905	3.7
	580	600	5691	5886	3.3
	683	700	6698	6867	2.5
180	375	380	3675	3728	1.4
	487	500	4777	4905	2.6
	585	600	5735	5886	2.6
	690	700	6771	6867	0.7
270	372	380	3649	3728	2.1
	506	500	4960	4905	1.1
	606	600	5948	5886	1.0
	682	700	6691	6867	2.6

5.4. VALIDATION

After calibration of the device it has been tested for major two different loads at different angles of rotation which have been validated as highlighted below:

5.4.1. STATIC TEST PROCEDURE

1. Follow assembly procedure 1 to 7 on section 4.5.
2. The test on has been carried out on a flat hard surface road.
3. Two scale has been used, one for the correlation and other as a dummy to lift the wheel to the same level.
4. Strain has been measured and recorded for 12 orientations round the clock.
5. Sampling frequency of 100 Hz had been employed at stationary condition and a constant sample of 100 had been recorded from each full bridge configuration from 4 beams.
6. An arbitrary load which was not used for calibration was applied with water tank loaded on the vehicle.
7. Wheel was lifted off the wheel scale using a hydraulic jack to provide zero load condition and wheel was manually rotated to respective degree angle as Appendix D.
8. Wheel was slowly released to have a load condition on the wheel scale, and then the data was recorded as pre-processing setup (Section 4.4).
9. Process 6 and 7 was repeated for 12 different angles at increasing order.
10. Data recorded at step 8 has been post-processed as described below.

5.4.2. ANALYSIS (LOAD 450 KG)

Data obtained from the transducer that has been recorded (Appendix D) has been post-processed. The result of the calculation has been shown below in tables.

Table 5-17. Stress on beams at load 450 kg

Angle	Strain 0	Strain 1	Strain 2	Strain 3
Degree	mm.mm^-1			
0	-4.24E-05	6.33E-06	4.05E-05	2.08E-06
30	-3.65E-05	-1.51E-05	3.72E-05	2.09E-05
60	-2.13E-05	-3.14E-05	2.48E-05	3.85E-05
90	5.80E-06	-4.67E-05	5.47E-06	4.30E-05

120	2.55E-05	-3.67E-05	-2.60E-05	3.44E-05
150	3.88E-05	-3.49E-05	-3.19E-05	1.42E-05
180	4.89E-05	1.18E-05	-3.96E-05	-1.00E-05
210	4.49E-05	3.28E-05	-2.79E-05	-1.51E-05
240	2.38E-05	3.78E-05	-3.06E-05	-3.01E-05
270	1.38E-05	4.77E-05	-3.27E-06	-3.84E-05
300	-6.52E-06	4.55E-05	1.50E-05	-4.23E-05
330	-2.33E-05	2.96E-05	3.16E-05	-4.32E-05

Above strain value has been correlated to weight value by equations 5.3-9 and 5.3-10 employed to each beam.

Table 5-18. Correlation of Strain to Weight in Each Beam

Angle	**W20**	**W21**	**W22**	**W23**
Degree		**kg**		
0	-207.2	36.6	217.5	15.4
30	-177.7	-70.5	200.8	109.6
60	-101.3	-152.1	138.8	197.5
90	34.0	-228.6	42.4	219.9
120	132.6	-178.3	-115.2	177.1
150	198.8	-169.5	-144.5	75.9
180	249.6	64.1	-182.9	-45.1
210	229.5	169.0	-124.5	-70.5
240	124.0	194.0	-138.2	-145.5
270	73.9	243.3	-1.3	-187.1
300	-27.6	232.6	90.1	-206.5
330	-111.5	153.0	173.0	-211.0

5.4.3. RESULT (LOAD 450 KG)

These weights from each beam have been used on equation 3.6.2-2 to 3.6.2-6 to find the force in Z axis with respect to its angle, which has been calculated in the following table with error value. It also shows that wheel force transducer has successfully detected the force in z axis with minimum error at different orientation. This error is the result of human error.

Table 5-19. Calculation for the Force in Z axis

Angle	Calculated Weight	Measured Weight	Calculated Force in Z axis	Measured Force in Z axis	Error %
Degree	kg		N		
0	425	450	4166	4415	5.6
30	418	448	4100	4395	6.7
60	423	446	4147	4375	5.2
90	448	446	4400	4375	0.6
120	432	449	4235	4405	3.8
150	420	449	4120	4405	6.5
180	432	448	4242	4395	3.5
210	426	450	4182	4415	5.3
240	425	448	4171	4395	5.1
270	430	450	4223	4415	4.3
300	439	450	4308	4415	2.4
330	428	450	4203	4415	4.8

5.4.4. ANALYSIS (LOAD 540 KG)

On the same way next experiment had been carried out at 540 kg which are illustrated below:

Table 5-20. Stress on Beams at Load 540 kg

Angle	Strain 0	Strain 1	Strain 2	Strain 3
Degree	mm.mm^-1			
Angle	Strain 0	Strain 1	Strain 2	Strain 3
0	-4.37E-05	1.56E-05	5.50E-05	-2.54E-08
30	-3.61E-05	-2.25E-05	5.03E-05	3.56E-05
60	-2.12E-05	-4.94E-05	2.97E-05	4.10E-05
90	4.15E-06	-5.36E-05	1.01E-05	4.98E-05
120	2.49E-05	-5.66E-05	-1.60E-05	4.45E-05
150	4.81E-05	-5.29E-05	-3.19E-05	3.42E-05
180	5.94E-05	1.07E-05	-5.04E-05	-1.56E-06
210	5.38E-05	3.79E-05	-3.70E-05	-3.84E-05
240	3.68E-05	4.58E-05	-2.42E-05	-4.40E-05
270	1.44E-05	5.28E-05	-2.94E-06	-5.65E-05
300	-1.15E-05	5.34E-05	2.24E-05	-5.72E-05
330	-1.13E-05	6.80E-05	2.01E-05	-7.54E-05

Above strain value has been correlated to weight value by equations 5.3-9 and 5.3-10 employed to each beam.

Table 5-21. Correlation of Strain to Weight in Each Beam

Angle	W20	W21	W22	W23
Degree	kg			
0	-213.6	83.1	290.2	4.9
30	-175.5	-107.3	266.4	183.0
60	-101.2	-242.0	163.3	209.9
90	25.8	-262.9	65.7	254.2
120	129.7	-278.2	-65.2	227.6
150	245.5	-259.5	-144.5	176.0
180	302.0	58.5	-236.9	-2.8
210	273.9	194.7	-170.2	-187.0
240	189.0	234.2	-106.1	-214.9
270	77.2	269.0	0.3	-277.3
300	-52.7	272.0	127.1	-280.8
330	-51.6	344.8	115.3	-372.0

5.4.5. RESULT (LOAD 540 KG)

These weights from each beam have been used on equation 3.6.2-2 to 3.6.2-6 to find the force in Z axis, which has been calculated in the following table with error value.

Table 5-22. Calculation for the Force in Z axis

Angle	Calculated Weight	Measured Weight	Calculated Force in Z axis	Measured Force in Z axis	Error
Degree	kg		N		%
0	504	540	4942	5297	6.7
30	528	540	5178	5297	2.3
60	524	540	5137	5297	3.0
90	517	548	5072	5376	5.7
120	535	544	5253	5337	1.6
150	555	539	5449	5288	3.1
180	539	538	5287	5278	0.2
210	575	541	5644	5307	6.4
240	536	541	5262	5307	0.8
270	546	542	5360	5317	0.8
300	569	542	5578	5317	4.9
330	503	540	4934	5297	6.9

After performing different test at static condition it can be said that wheel force transducer has been able to detect the force in z axis with minimum error ranging upto 7% at different orientation. This error is the result of human error.

CHAPTER 6
RESULT AND FUTURE WORKS

This thesis presents "Design and Development of wheel force transducer to obtain road load data from multipurpose agricultural truck". A wheel force transducer prototype with sensor sensing the force in x and z direction has been designed and developed. The most challenging section of the transducer was the telemetry part which has been accomplished by wireless system. A wireless local area infrastructure network was created by a simple router for the communication between transducer hardware and notebook during data transfer.

There would always be limited space for the design of WFT; with consideration of all its fixtures on the wheel. While designing WFT the original condition and its alignment need to be focused for every component design. Also the stress and shear stress is an important which has been designed with safety factor 2. Moreover, material selection and stress distribution would always play a vital role in mechanical engineering design.

To get a complete road load data a vehicle need wheel force transducer as per its number of wheel i.e. minimum of four wheel force transducer. Thus reduction or improvement on one part would be the advantage equivalent to the number of wheels. In other words, if a test is carried on with four wheel vehicle, single component reduction would be equivalent to four component reduction in the project. In this system signal amplifier and slip ring has been totally replaced with wireless cDAQ system, making it robust and compact. Not only this, it is user friendly and ease for inter-changeability with less effort and training.

Design and development of a system was not a simple task. Compromise had been made for some design parameters during the designs of the components, like wise for the material selection. Although the main aim of the project to have a full functional one has always given special effort as this is the first prototype on National Science and Technology Development Agency and most probably in Thailand. No doubt, it is the first prototype for the multipurpose agricultural truck in Thailand.

This wheel force transducer is able to detect force with an error of less than 7% (Section 5.4.2and Section 5.4.4). This WFT has been calibrated starting from initial weight of agricultural truck so it can measure the load starting from 3800N to 30000N.

This wheel force transducer had 14 different parts as shown in wheel force transducer integrated chart. Among them 11 parts rotate with the wheel itself. Moreover 4 main components had been designed to achieve this transducer which has been written on 10 sheets of engineering drawing language. These drawing have been achieved after different brainstorming and modifications. The final design drawings which had been sent for manufacturer and have been successfully prototyped are highlighted on appendix A.

To make a product different research from different point of view need to be done. As design and development of wheel force transducer has been completed, there are many other aspects to be done. Some of them are highlighted below:

1. Take a challenge to reduce the error from 7% to lower figure by improving the system performance.
2. Perform dynamic calibration.
3. Test related to dynamic problems.
4. Analysis of dynamic data.

CHAPTER 7
CONCLUSION

This thesis presents "Design and Development of wheel force transducer to obtain road load data from multipurpose agricultural truck". Some of the conclusions drawn during the design and development have been highlighted below:

- We need to concern about design of loadcell and the strain gauge arrangement strategies for the design of wheel force transducer.
- Half bridge strain gauge must be placed in symmetry with neutral axis with the appropriate proportion of the beam length where the signal could be gain with high precision and accuracy.
- Installation of strain gauge should be identical to each beam.
- The maximum shear stress position, at centre of the beam with strain gauge symmetry on the neutral axis, effect of bending moment would be negligible.
- Thin walled square hollow beam is most suitable for the wheel force transducer from sensor placement, manufacturing compatibility.
- Four slots in outer annular ring help to distribute the force to other 180 phase beams through the flexures.
- This wheel force transducer has ease in inter-changeability among the vehicle's spindles as well as between spindles of different vehicles.
- Designed and developed wheel force transducer prototype has been calibrated for force in Z direction and tested; which was able to measure the load with minimum error of less than 7%.

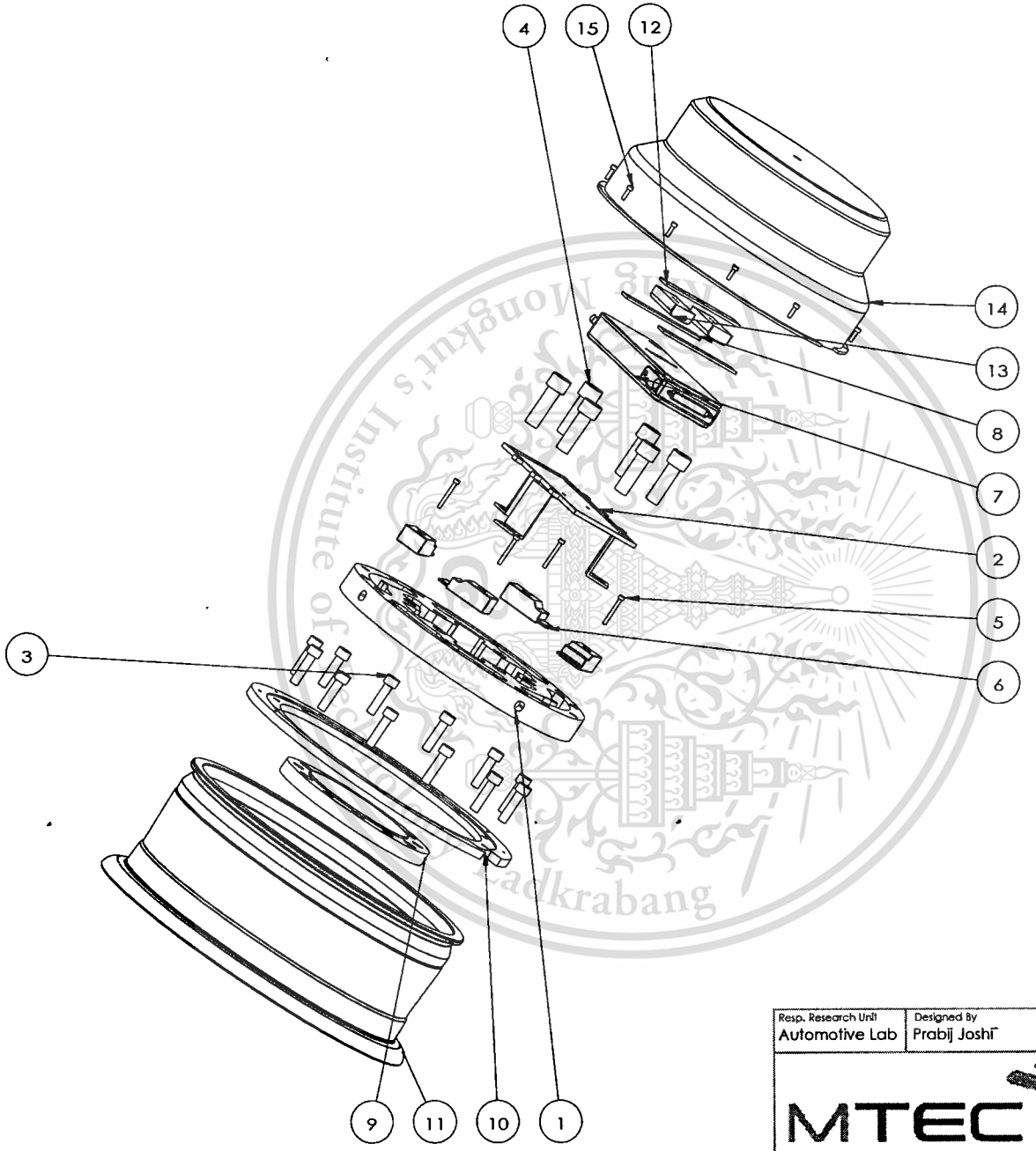
REFRENCES

1. Henri Leturque, Steve Winggins. Thailand's progress in agriculture: Transition and sustained productivity growth.
2. Library of Congress- Federal Research Division, Country Profile: Thailand July 2007.
3. Sommerfeld, J. and Meyer, R. Correlation and Accuracy of a Wheel Force Transducer as Developed and Tested on a Flat-Trac® Tire Test System. SAE Technical Paper 1999-01-0938, 1999, doi:10.4271/1999-01-0938.
4. Weiblen and Hofmann, T. Evaluation of Different Designs of Wheel Force Transducers. SAE Technical Paper 980262, 1998, doi:10.4271/980262.
5. Gerhard Pahl, Wolfgang Beitz,Ken Wallace. Engineering Design: A Systematic Approach. Second Edition, Springer-Verlag London Limited 1996.
6. Weiblen, Walter, Bernd Oelmann. Measurement of Multiaxial Wheel Forces and Application of the Results for the Fatigue Life Evaluation of Vehicles. SIAT '96/SAE tech.Paper 962505, pp 329 - 336, Pune, India 1996.
7. Darragh Murphy. Automated Road Load Data Analysis for Verification of Data Integrity. SAE – FD & E Road Load Data Acquisition Division MTS System presentation, October 16 2001.
8. Weiblen, W., Kockelmann, H., and Burkard, H. Evaluation of Different Designs of Wheel Force Transducers (Part II). SAE Technical Paper 1999-01-1037, 1999, doi:10.4271/1999-01-1037.
9. Scale Manufacturers Association. Load Cell Application and Test Guideline. Columbus, Ohio April 2010.
10. Grevis-James, I.W. and Bloome, P.D. A tractor power monitor. Trans. ASAE, 25: pp 595-597, 1982.
11. Amin, Moeness, Yimin Zhang, Vincent Mancuso, and Ahmad Hoorfar. Applications of Smart Antennas to Rotorcrafts. Digital Signal Processing 12, January 2002, pp 159–174. doi:10.1006/dspr.2002.0446.
12. Tompkins, F.D, & L.R. Wilhelm. Microcomputer -based tractor data acquisition system. Transactions of the ASAE. 25(6), 1982.
13. Malcolm,S.W. Searcy, et al. Instrumentation package for monitoring tractor performance. Transactions of the ASAE 28(2), 1985.

14. Al-Janobi, Ahmed S. Sabeir, et al. A Precision Wheel Torque and Weight Transducer for Most Common Agricultural Tractors. Agricultural Mechanization in Asia, Africa and Latin America 28, 1997.
15. Musunda, G.C. Zoerb, et al. Four wheel drive tractor instrumentation for traction studies. St. Joseph, MI, 1983.
16. Evers, W., J. Reichel, R. Eisenkolb, and I. Enhart. The Wheel Dynamometer as a Tool for Chassis Development. ATA-TORINO- 59, 2006.
17. Euro Inbox and The Steel Construction Institute. Design Manual for Structural Stainless Steel, Third Edition 2006.
18. M.F. Ashby and D. Cebon. Material Selection In Mechanical Design. Troisieme Conference Europeene sur les Materiaux et les Procedes Advances Euromat, Paris, June 8 -10 1993.

BIBLIOGRAPHY

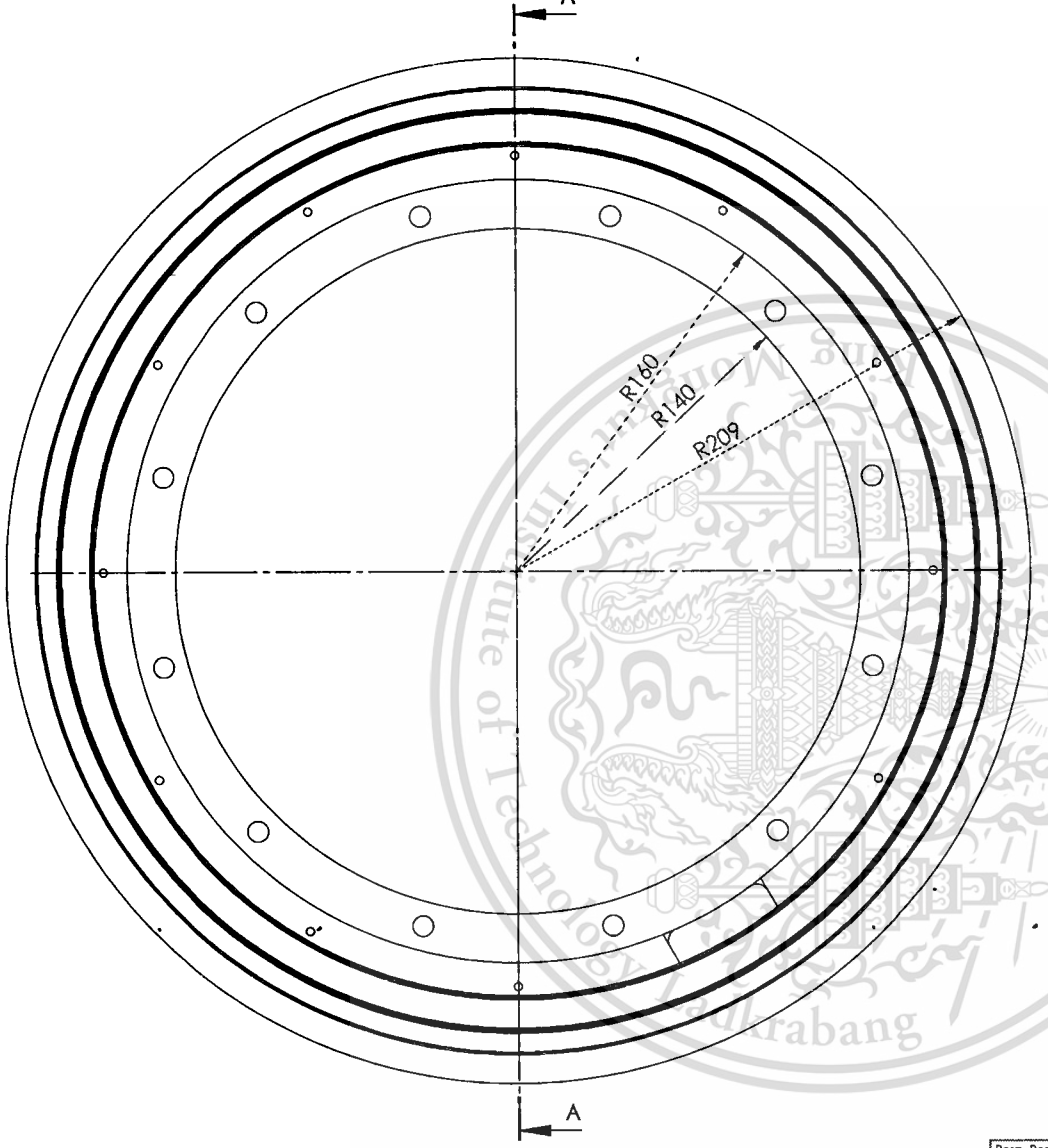
1. David G. Ullman. The Mechanical Design Process. 4th ed. New York: McGraw Hill 2010.
2. Ulrich Fischer, et al. Mechanical and Metal Trades Handbook. 2nd English ed. Germany: Nourney, Vollmer GmbH & Co. KG 2010.
3. Saeed Moaveni. Finite Element Analysis: Theory and Application with ANSYS. New Jersey:Prentice Hall Inc 1999.
4. Karl Hoffmann. An Introduction to Measurements using Strain Gages. Hottinger Baldwin Messtechnik GmBH, Darmstadt 1989.
5. Currier, Patrick Norman. Development of an Automotive Ground Vehicle Platform for Autonomous Urban Operations. Embry Riddle Aeronautical University 2008. http://scholar.lib.vt.edu/theses/available/etd-05082008-110806.
6. Farhadi, Payam, Ahmad Mohsenimanesh, Reza Alimardani, and Hojat Ahmadi. Design and Fabrication of a Single Wheel Tester. Journal of Science and Today's World 2, 2013.
7. Lackas, G. M., R. D. Grisso, M. Yasin, and L. L. Bashford. Portable Data Acquisition System for Measuring Energy Requirements of Soil-engaging Implements.Computers and Electronics in Agriculture 5, no. 4, 1991.
8. Turner, R. A Simple System for Determining Tractive Performance in the Field. ASAE Paper (American Society of Agricultural Engineering) 1993.
9. Naderi, M., R. Alimardani, R. Abbaszadeh, and H. Ahmadi. Assessment of Dynamic Load Equations Through Drive Wheel Slip Measurement. Am-Euras. J. Agric. & Environ. Sci., *3 (5)* 2008. http://www.idosi.org/aejaes/jaes3(5)/18.pdf.
10. Ouahi, Mohamed, Joanny Stéphant, and Dominique Meizel. Torques and Vehicle State: An Automotive Application of Unknown Inputs Observer. In IEEE International Symposium on Industrial Electronics (ISIE), Gdansk, Poland 2011. http://perso.ensil.unilim.fr/~stephant/publications/0766-gf-002062.pdf.



ITEM NO.	PART NUMBER	QTY.
1	LOAD-CELL	1
2	WIRELESS ADAPTOR	1
3	M10 x 40	12
4	M16 x 50	6
5	M4 x 35	4
6	NI ADAPTOR_9949	4
7	NI cDAQ_9191	1
8	CLAMPING PLATES	2
9	HUB ADAPTOR	1
10	RIM ADAPTOR	1
11	MODIFIED WHEEL RIM	1
12	ANTENNA CLAMPING PLATE	1
13	BATTERY HOLDER	2
14	WFT COVER	1
15	M4 x 14	11

SCALE 1:5
ALL DIMENSIONS ARE IN MM

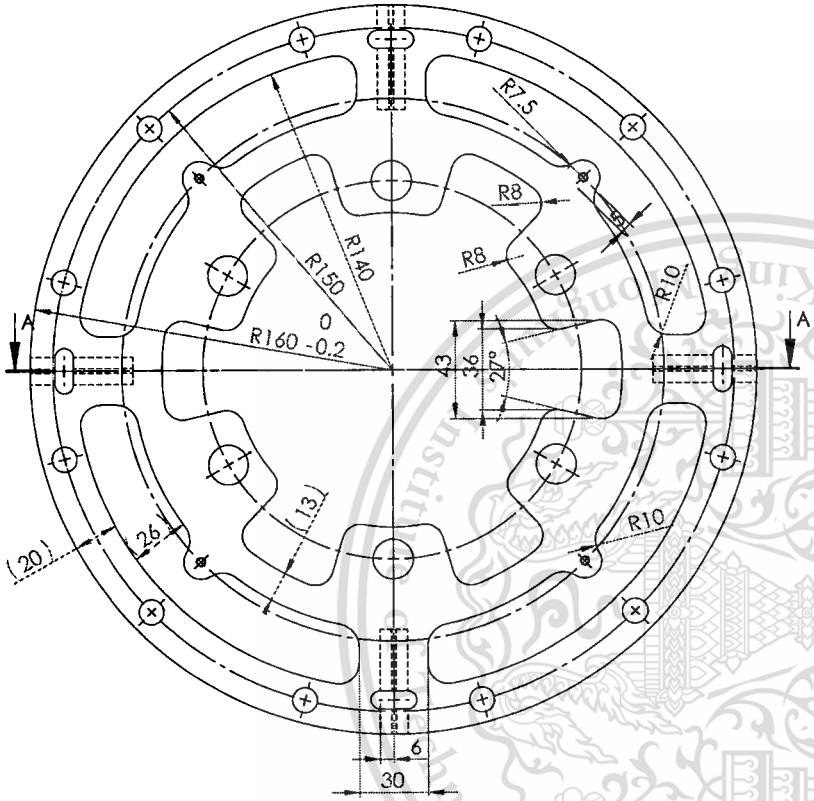
Resp. Research Unit: Automotive Lab	Designed By: Prabij Joshi	Approved by: Chadchai Srisurangkul	General tolerances: DIN ISO 2768-1	Material: As Parts Specification
MTEC a member of NSTDA	Document type: Assembly Drawing		Document status: Done	
	Title, Description: Design and Development of Wheel Force Transducer To Obtain Road Load Data From Multipurpose Agi. Truck		WFT-001-012	
		Changes: A	Released date: JULY 30, 2012	L: en / Sheet: 1/1

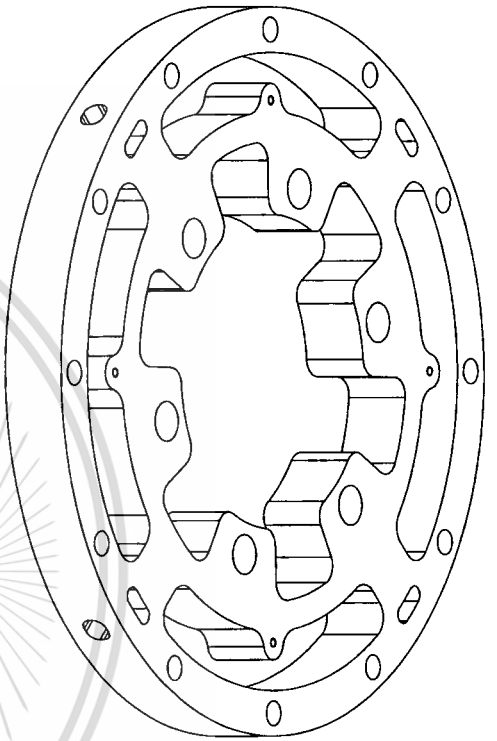


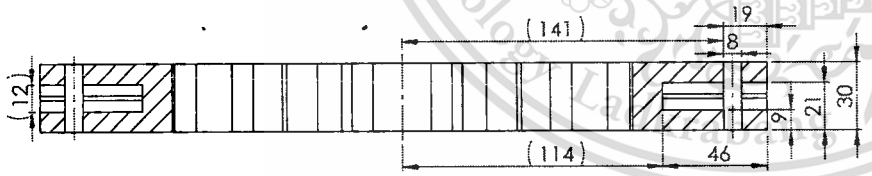
SECTION A-A

SCALE 1:2
ALL DIMENSIONS ARE IN MM

Resp. Research Unit: Automotive Lab	Designed By: Prablj Joshi	Approved by: Chadchai Srisurangkul	General tolerances: DIN ISO 2768-1	Material: Structural Steel: SS400 Series
MTEC a member of NSTDA		Document type: Assembly Drawing	Document status: Done	
		Title, Description: Design and Development of Wheel Force Transducer To Obtain Road Load Data From Multipurpose Agi. Truck	Rim-001-012	
			Changes: A; Released date: JULY 30, 2012; L: en; Sheet: 2/

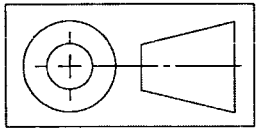






SECTION A-A
SCALE 1 : 2

SCALE 1:2
ALL DIMENSIONS ARE IN MM



Resp. Research Unit	Designed By	Approved by	General tolerances	Material
Automotive Lab	Prabij Joshi	Chadchai Srisurangkul	DIN ISO 2768-1:f:H	DIN EN AW-7075

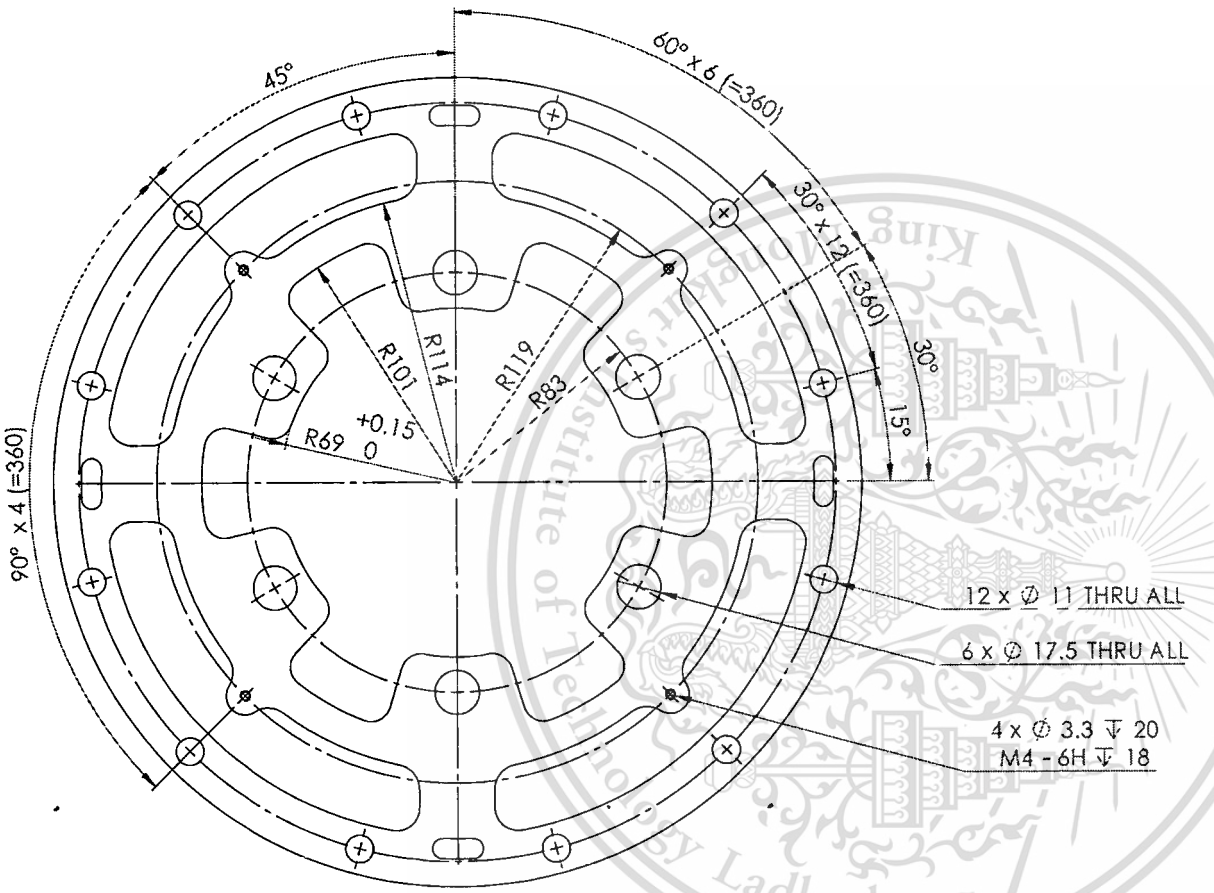
MTEC
a member of NSTDA

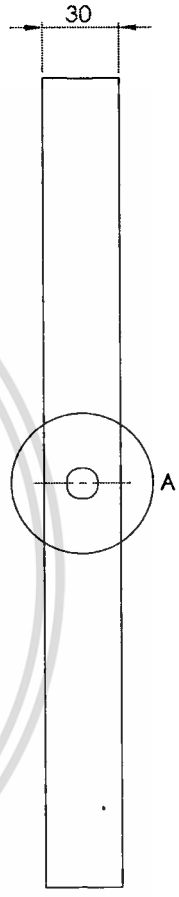
Document type:	Document status:
Part Drawing	Done

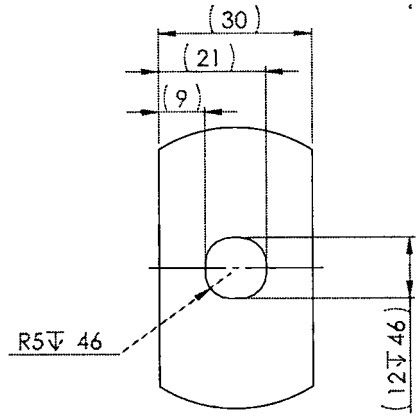
Title, Description:
Design and Development of Wheel Force Transducer To Obtain Road Load Data From Multipurpose Agi. Truck

LOAD-CELL-001-012

Changes	Released date	L.	Sheet
B	Aug 10, 2012	en	3/13







DETAIL A
SCALE 1 : 1

SCALE 1:2
ALL DIMENSIONS ARE IN MM

Resp. Research Unit	Designed By	Approved by	General tolerances	Material
Automotive Lab	Prabij Joshi	Chadchai Srisurankul	DIN ISO 2768-1:f:H	DIN EN AW-7075

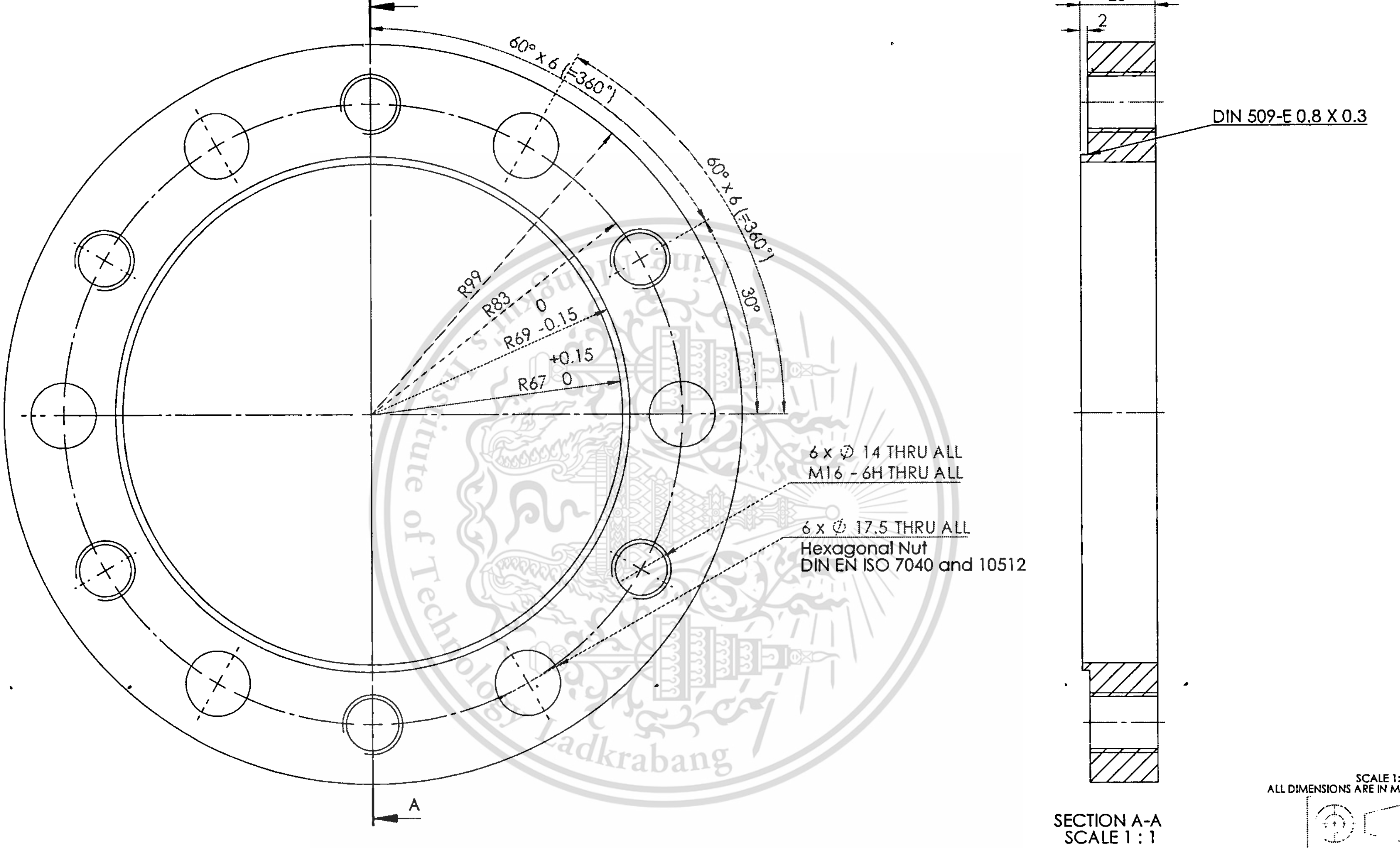
MTEC
a member of NSTDA

Document type:	Document status:
Part Drawing	Done

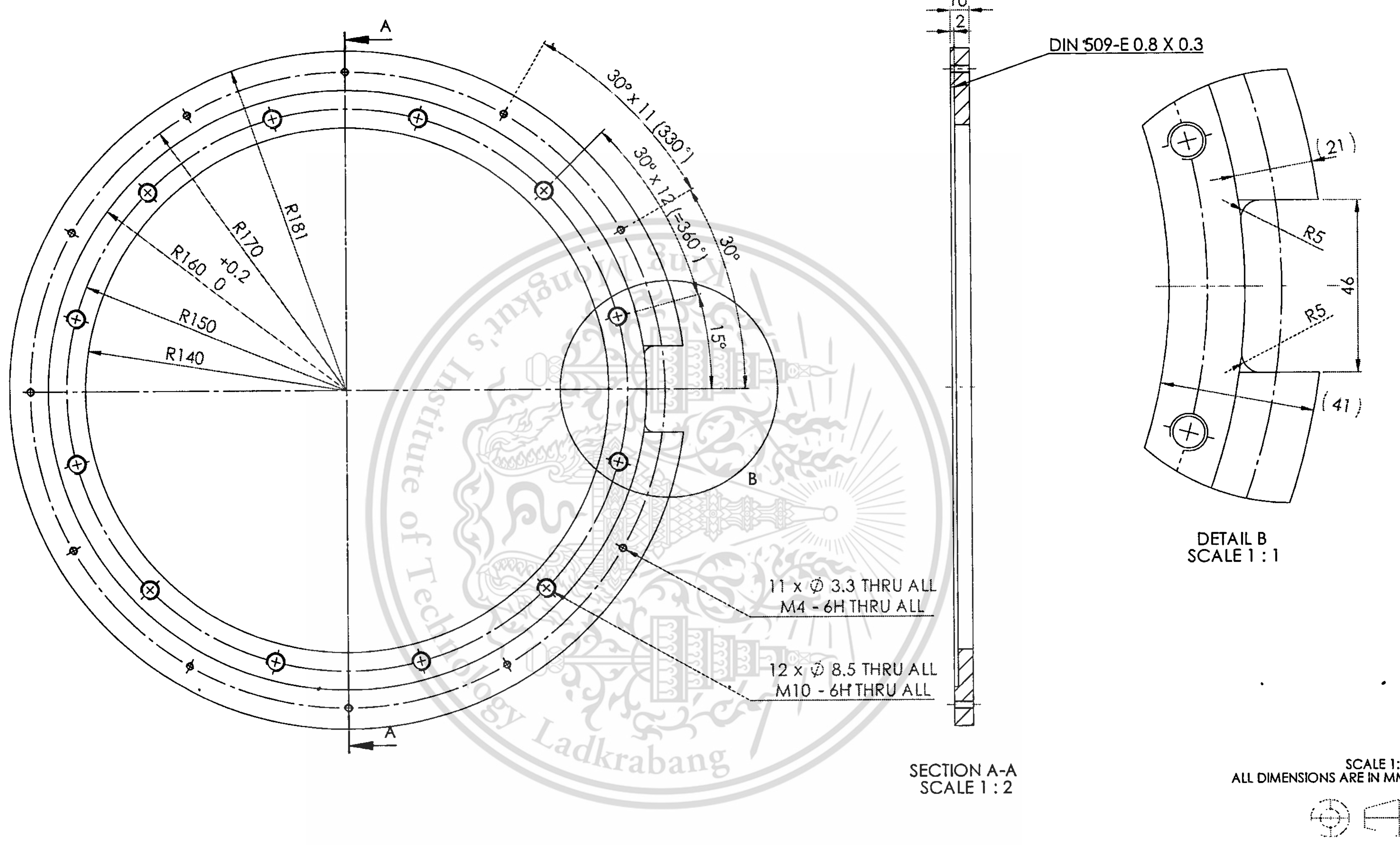
Title, Description:
Design and Development of Wheel Force Transducer To Obtain Road Load Data From Multipurpose Agi. Truck

LOAD-CELL-001-012

Changes	Released date	L.	Sheet
B	Aug 10, 2012	en	4/06

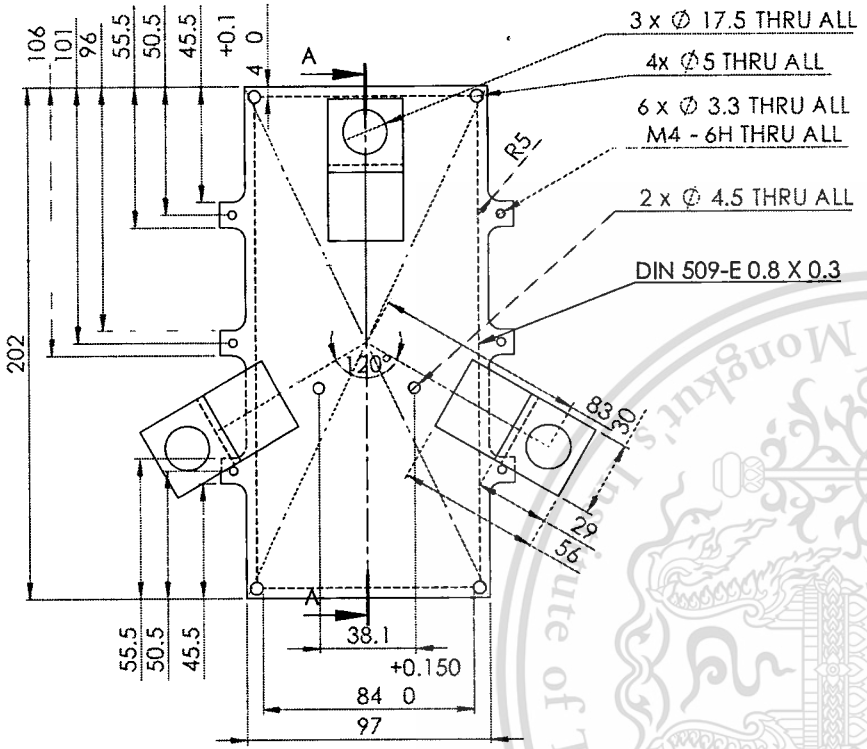


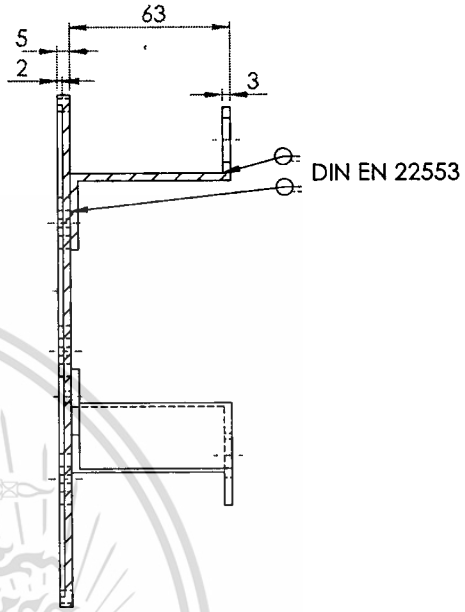
Resp. Research Unit	Designed By	Approved by	General tolerances	Material
Automotive Lab	Prabij Joshi	Chadchai Srisurangkul	DIN ISO 2768-1:f:H	DIN EN 10088-2/3 :1.4301 (SUS 304)
MTEC a member of NSTDA		Document type: Part Drawing	Document status: Done	
		Title, Description: Design and Development of Wheel Force Transducer To Obtain Road Load Data From Multipurpose Agi. Truck	HUB-ADP-001-012	
			Changes: B / Released date: Aug 10, 2012 / L: en	Sheet: 5/10



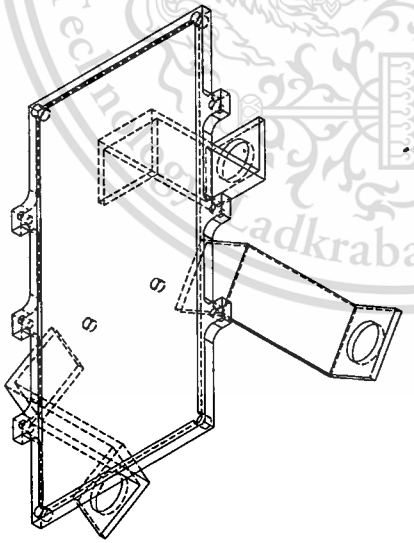
SCALE 1:2
ALL DIMENSIONS ARE IN MM

Resp. Research Unit: Automotive Lab	Designed By: Prabij Joshi	Approved by: Chadchai Srisurangkul	General tolerances: DIN ISO 2768-1:f:H	Material: Structural Steel: SS400 series
MTEC a member of NSTDA		Document type: Part Drawing	Document status: Done	
		Title, Description: Design and Development of Wheel Force Transducer To Obtain Road Load Data From Multipurpose Agi. Truck	RIM-ADP-001-012	
			Changes: A / Released date: JULY 30, 2012 / L: en	Sheet: 6/10



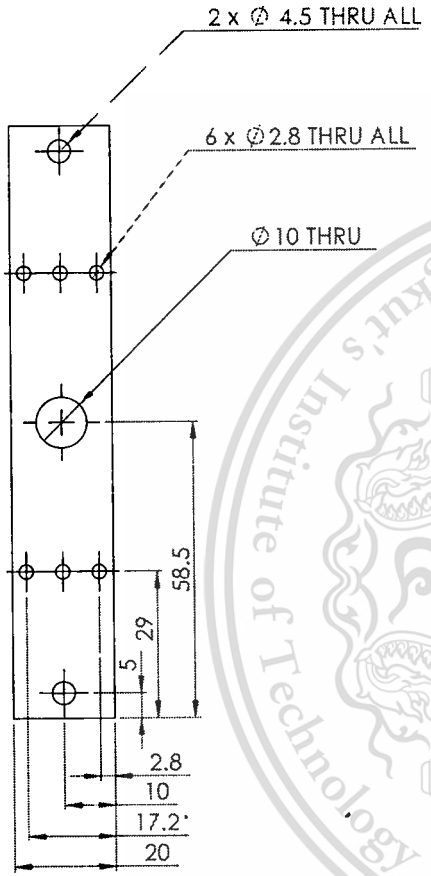


SECTION A-A



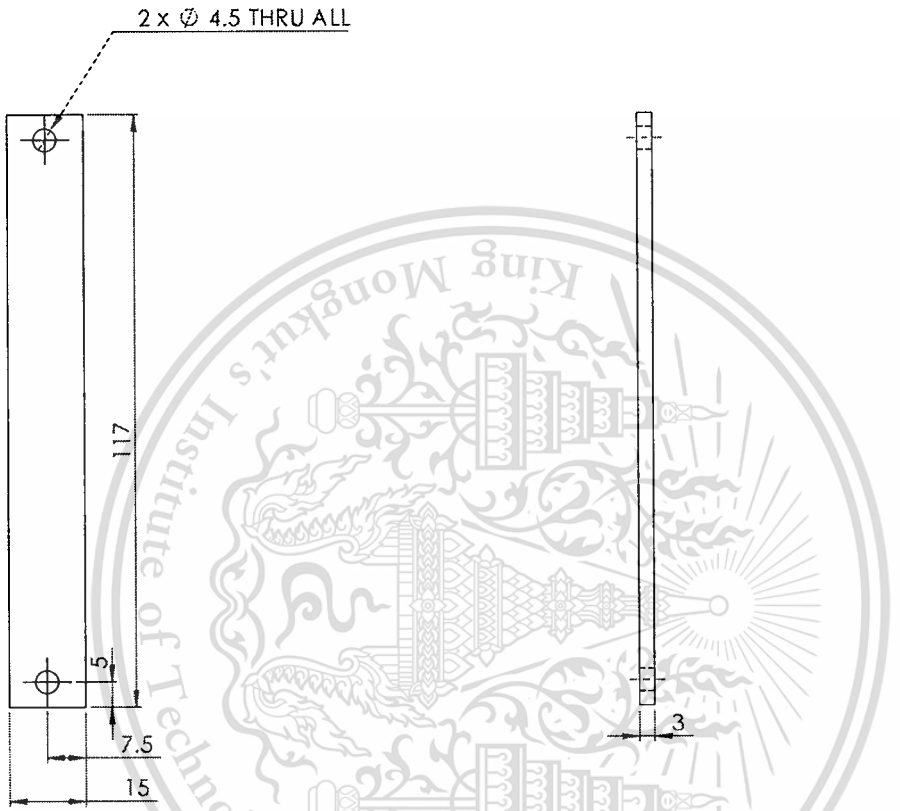
SCALE 1:2
ALL DIMENSIONS ARE IN MM

Resp. Research Unit: Automotive Lab	Designed By: Prabij Joshi	Approved by: Chadchai Srisurangkul	General tolerances: DIN ISO 2768-1:f	Material: Structural Steel: SS400 Series
MTEC a member of NSTDA	Document type: Part Drawing		Document status: Done	
	Title, Description: Design and Development of Wheel Force Transducer To Obtain Road Load Data From Multipurpose Agi. Truck		WIRELESS-ADP-001-012	
			Changes: B	Released date: Aug 10, 2012 / L.: en / Sheet: 7/09



SCALE 1: 1
ALL DIMENSIONS ARE IN MM

Resp. Research Unit: Automotive Lab	Designed By: Prabij Joshi	Approved by: Chadchai Srisurangkul	General tolerances: DIN ISO 2768-1	Material: Aluminium
MTEC a member of NSTDA		Document type: Part Drawing	Document status: Done	
		Title, Description: Design and Development of Wheel Force Transducer To Obtain Road Load Data From Multipurpose Agi. Truck	ANTENNA-CLAMP-001-012	
			Changes: A; Released date: July 30, 2012; L.: en; Sheet: 8/90	



SCALE 1:1
ALL DIMENSIONS ARE IN MM

Resp. Research Unit	Designed By	Approved by	General tolerances	Material
Automotive Lab	Prabij Joshi	Chadchai Srisurangkul	DIN ISO 2768-1	Aluminium

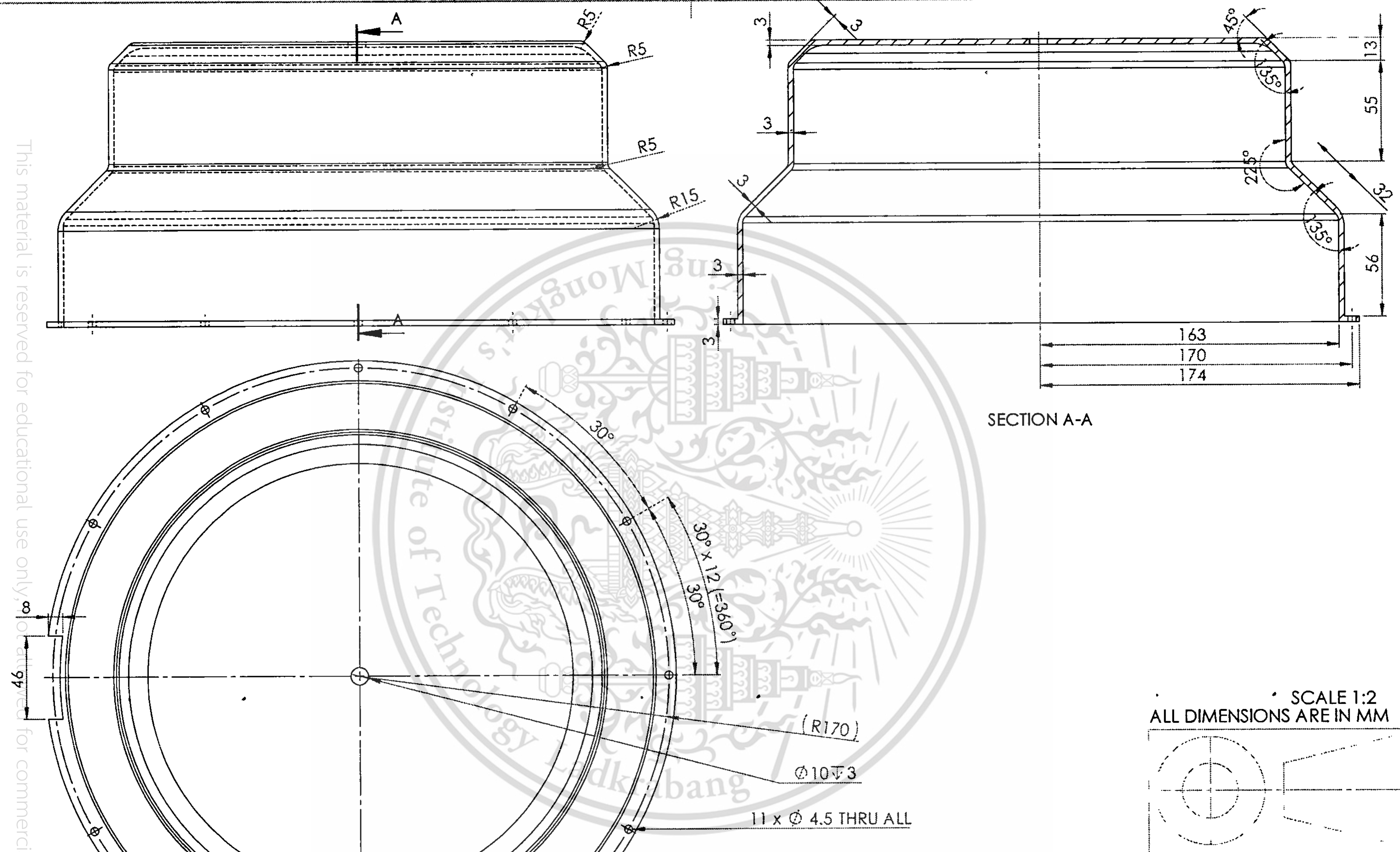
MTEC
a member of NSTDA

Document type:	Document status:
Part Drawing	Done

Title, Description:
Design and Development of Wheel Force Transducer To Obtain Road Load Data From Multipurpose Agi. Truck

WIRELESS-CLAMP-001-012

Changes	Released date	L	Sheet
A	July 30, 2012	en	9 of 9



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MTEC a member of NSTDA		Document type: Part Drawing	Document status: Done		
		Title, Describtion: Design and Development of Wheel Force Transducer To Obtain Road Load Data From Multipurpose Agi. Truck	WFT-COVER-001-012		
			Changes: A	Released date: JULY 30, 2012	L.: en	Sheet: 10/10

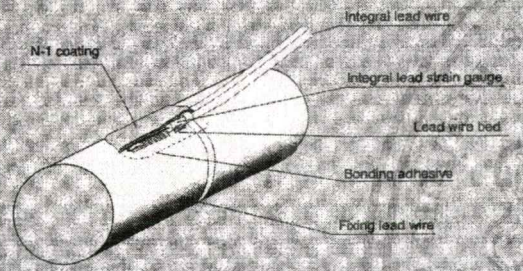
STRAIN GAUGE APPLICATIONS

Strain gauges are normally installed by bonding with adhesive or by spot welding. For bondable strain gauges, the surface of the test specimen must be suitably prepared, followed by bonding, wiring, and the application of a protective coating. For weldable strain gauges, rustproofing, welding and wiring are required. The following are typical installation procedures for various specimens.

WITH BONDABLE STRAIN GAUGES

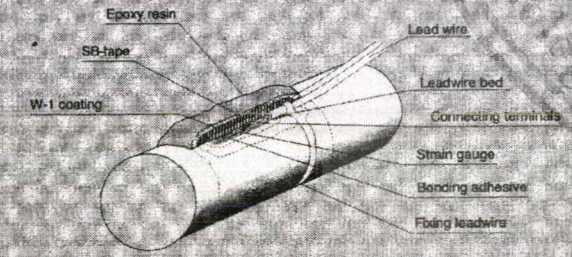
Metal surfaces

■Typical installation with bonding to metal surface for use in relatively well conditions such as in laboratory and short term period.



Metal specimen

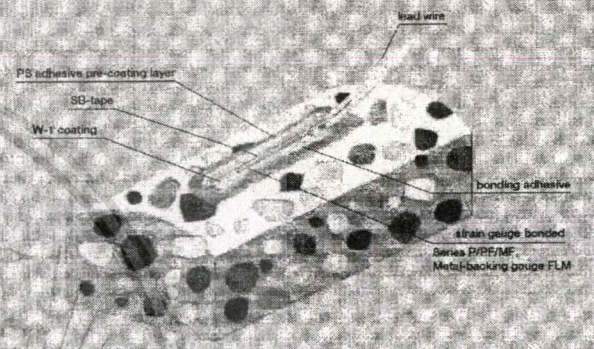
■Typical installation onto a metal surface for use in harsh conditions, such as under water for a long period or onto a rainforcing bar to be embedded into concrete.



Metal specimen

Concrete surfaces

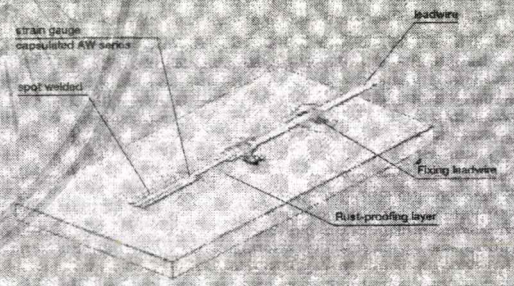
■Gauges are typically installed onto concrete surface or concrete specimens for loading tests. Stran gauges with an integral lead do not require lead wire connection with connecting terminals.



Concrete specimen

WITH WELDABLE STRAIN GAUGES SERIES AW

■These gauges are typicaily installed by spot-welding onto metal surfaces for use in harsh environments, such as on engines, heated turbines, or field sites for long periods.



Metal specimen

N.B.: For underwater use, an overcoating is strongly recommended to maintain the rust-proofing effect.

APPENDIX B

TML STRAIN GAUGE TEST DATA

63/80

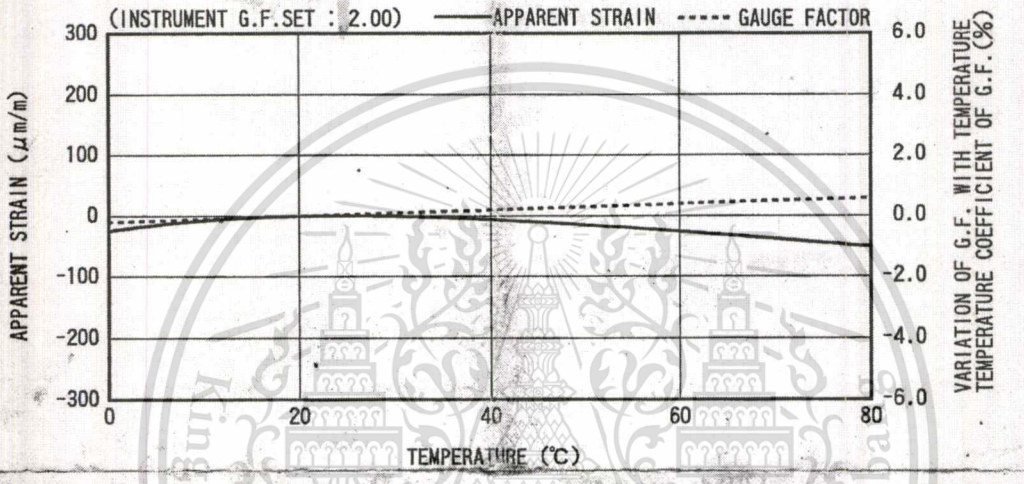
GAUGE TYPE	: FCT-2-350-C4-11	TESTED ON	: SS 400
LOT NO.	: 4A401571	COEFFICIENT OF THERMAL EXPANSION	: 11.8 $\times 10^{-6}$/℃
GAUGE FACTOR	: 2.08 ±1%	TEMPERATURE COEFFICIENT OF G.F.	: +0.1±0.05 %/10℃
ADHESIVE	: P-2	DATA NO.	: A0664

THERMAL OUTPUT (ε app : APPARENT STRAIN)

$\varepsilon app = -2.57\times10^{1}+2.45\times T^{1}-6.90\times10^{-2}\times T^{2}+5.78\times10^{-4}\times T^{3}-1.85\times10^{-6}\times T^{4}$ (μm/m)

TOLERANCE : ±0.85 [(μm/m)/℃] , T : TEMPERATURE

2,163
119,611



ひずみゲージ取扱いの注意事項

- ●上記の特性データは、リード線の取付けによる影響を含んでおりません。裏面記載のリード線の測定値への影響に従って補正してください。
- ●ゲージの使用温度は、接着剤の耐熱温度などにより変わります。
- ●絶縁抵抗などの点検は、印加電圧を５０Ｖ以下にしてください。
- ●ゲージリード線に無理な力を加えないでください。
- ●ゲージ裏面に接着剤を塗布して接着してください。
- ●ひずみゲージの裏面は脱脂洗浄してありますので、汚さないように取扱いしてください。
- ●ゲージの包装を開封後は、乾燥した場所で保管してください。
- ●ご使用に際してご不明な点などがございましたら、当社までお問い合わせください。

CAUTIONS ON HANDLING STRAIN GAUGES

- ● The above characteristic data do not include influence due to lead wires. Correct the data in accordance with the influence of lead wires on measured values described overleaf.
- ● The service temperature of strain gauge depends on the operating temperature of adhesive, etc.
- ● Check of insulation resistance, etc. should be made at a voltage of less than 50V.
- ● Do not apply an excessive force to the gauge leads.
- ● Apply an adhesive to the back of a strain gauge and stick the gauge to a specimen.
- ● As the back of strain gauge has been degreased and washed, do not contaminate it.
- ● After unpacking, store strain gauges in a dry place.
- ● If you have any questions on strain gauges or installation, contact TML or your local agent.

Made in Japan

TML 株式會社 東京測器研究所

〒 140-8560 東京都品川区南大井 6 - 8 - 2
TEL 03 - 3763 - 5611
FAX 03 - 3763 - 6128

Tokyo Sokki Kenkyujo Co., Ltd.

8 - 2, Minami - Ohi 6 - Chome
Shinagawa - ku, Tokyo 140-8560

APPENDIX C

	Load at Beam 20 with 380 kg				Load at Beam 20 with 500 kg			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	-3.77E-06	3.00E-05	3.13E-06	-4.44E-05	1.29E-06	5.17E-05	4.02E-06	-4.95E-05
0.00062	-3.77E-06	3.02E-05	3.20E-06	-4.49E-05	2.11E-06	5.18E-05	4.50E-06	-4.96E-05
0.00124	-4.18E-06	2.99E-05	3.37E-06	-4.50E-05	1.81E-06	5.19E-05	4.13E-06	-4.92E-05
0.00186	-4.17E-06	3.02E-05	3.19E-06	-4.43E-05	1.75E-06	5.15E-05	4.59E-06	-5.01E-05
0.00248	-4.29E-06	2.97E-05	2.95E-06	-4.42E-05	1.72E-06	5.19E-05	4.76E-06	-4.99E-05
0.0031	-3.69E-06	3.00E-05	2.57E-06	-4.45E-05	1.92E-06	5.16E-05	4.46E-06	-4.97E-05
0.00372	-3.89E-06	2.94E-05	2.77E-06	-4.48E-05	1.85E-06	5.18E-05	4.52E-06	-4.93E-05
0.00434	-4.08E-06	2.98E-05	3.25E-06	-4.42E-05	1.89E-06	5.14E-05	3.91E-06	-4.96E-05
0.00496	-3.56E-06	3.00E-05	2.92E-06	-4.45E-05	1.94E-06	5.17E-05	4.34E-06	-4.95E-05
0.00558	-4.13E-06	2.98E-05	3.19E-06	-4.50E-05	2.02E-06	5.12E-05	4.29E-06	-5.00E-05
0.0062	-3.81E-06	2.99E-05	2.97E-06	-4.46E-05	1.56E-06	5.15E-05	4.16E-06	-4.96E-05
0.00682	-3.57E-06	3.02E-05	3.42E-06	-4.45E-05	2.11E-06	5.16E-05	4.81E-06	-4.95E-05
0.00744	-4.08E-06	3.01E-05	2.90E-06	-4.49E-05	1.47E-06	5.16E-05	4.47E-06	-4.94E-05
0.00806	-3.69E-06	3.05E-05	3.13E-06	-4.47E-05	2.16E-06	5.15E-05	4.20E-06	-4.96E-05
0.00868	-3.23E-06	2.98E-05	3.53E-06	-4.46E-05	1.67E-06	5.12E-05	4.59E-06	-4.94E-05
0.0093	-3.84E-06	3.01E-05	2.95E-06	-4.50E-05	1.58E-06	5.12E-05	4.17E-06	-4.97E-05
0.00992	-3.96E-06	3.01E-05	2.68E-06	-4.48E-05	1.71E-06	5.19E-05	4.29E-06	-4.98E-05
0.01054	-3.86E-06	2.99E-05	2.76E-06	-4.43E-05	2.00E-06	5.16E-05	4.33E-06	-4.97E-05
0.01116	-4.35E-06	2.98E-05	3.01E-06	-4.53E-05	1.65E-06	5.17E-05	4.13E-06	-4.94E-05
0.01178	-4.12E-06	2.99E-05	2.69E-06	-4.45E-05	1.84E-06	5.15E-05	4.61E-06	-4.98E-05
0.0124	-4.19E-06	3.04E-05	2.61E-06	-4.46E-05	1.56E-06	5.17E-05	4.07E-06	-4.96E-05
0.01302	-3.63E-06	2.92E-05	2.51E-06	-4.43E-05	1.67E-06	5.13E-05	4.16E-06	-4.94E-05
0.01364	-3.94E-06	2.99E-05	3.05E-06	-4.46E-05	1.72E-06	5.16E-05	4.11E-06	-4.94E-05
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0.01488	-3.82E-06	3.04E-05	3.19E-06	-4.44E-05	1.64E-06	5.13E-05	4.17E-06	-4.95E-05
0.0155	-4.07E-06	2.97E-05	3.78E-06	-4.44E-05	1.32E-06	5.16E-05	4.00E-06	-4.91E-05
0.01612	-3.87E-06	3.03E-05	2.87E-06	-4.47E-05	1.48E-06	5.13E-05	3.91E-06	-4.95E-05
0.01674	-3.92E-06	2.95E-05	3.12E-06	-4.48E-05	1.78E-06	5.15E-05	4.85E-06	-4.97E-05
0.01736	-3.67E-06	2.95E-05	3.23E-06	-4.46E-05	2.10E-06	5.12E-05	4.33E-06	-4.93E-05
0.01798	-3.39E-06	3.02E-05	3.45E-06	-4.43E-05	1.94E-06	5.15E-05	4.35E-06	-4.90E-05
0.0186	-3.81E-06	2.98E-05	3.20E-06	-4.47E-05	1.65E-06	5.14E-05	3.91E-06	-4.93E-05
0.01922	-3.88E-06	2.98E-05	2.93E-06	-4.46E-05	1.70E-06	5.14E-05	4.78E-06	-4.99E-05
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0.02108	-4.18E-06	2.98E-05	3.42E-06	-4.46E-05	1.57E-06	5.15E-05	4.19E-06	-4.98E-05
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0.02294	-3.90E-06	2.96E-05	3.24E-06	-4.46E-05	1.83E-06	5.12E-05	4.13E-06	-5.00E-05
0.02356	-3.85E-06	2.99E-05	2.96E-06	-4.49E-05	1.66E-06	5.17E-05	3.74E-06	-4.96E-05
0.02418	-3.87E-06	2.96E-05	2.80E-06	-4.51E-05	1.92E-06	5.18E-05	4.15E-06	-4.97E-05
0.0248	-3.52E-06	2.99E-05	3.51E-06	-4.48E-05	1.47E-06	5.17E-05	3.58E-06	-4.97E-05
0.02542	-4.20E-06	3.01E-05	3.18E-06	-4.42E-05	1.45E-06	5.17E-05	3.97E-06	-4.95E-05
0.02604	-3.32E-06	2.95E-05	2.61E-06	-4.45E-05	2.11E-06	5.17E-05	5.15E-06	-4.99E-05
0.02666	-3.78E-06	3.00E-05	3.23E-06	-4.46E-05	1.84E-06	5.13E-05	4.18E-06	-5.03E-05
0.02728	-3.53E-06	2.98E-05	3.50E-06	-4.47E-05	1.38E-06	5.12E-05	4.39E-06	-4.97E-05
0.0279	-3.78E-06	2.99E-05	3.36E-06	-4.44E-05	1.83E-06	5.18E-05	4.23E-06	-4.95E-05
0.02852	-3.54E-06	2.98E-05	3.04E-06	-4.45E-05	1.64E-06	5.15E-05	4.24E-06	-4.98E-05
0.02914	-3.69E-06	3.02E-05	3.35E-06	-4.45E-05	1.86E-06	5.14E-05	4.41E-06	-4.98E-05
0.02976	-4.23E-06	2.96E-05	2.55E-06	-4.51E-05	1.67E-06	5.14E-05	4.39E-06	-4.95E-05
0.03038	-4.23E-06	2.93E-05	2.49E-06	-4.44E-05	1.55E-06	5.12E-05	4.18E-06	-4.95E-05
0.031	-3.79E-06	3.02E-05	3.12E-06	-4.45E-05	1.51E-06	5.10E-05	4.63E-06	-4.94E-05
0.03162	-4.09E-06	2.95E-05	3.13E-06	-4.48E-05	1.60E-06	5.16E-05	4.62E-06	-4.93E-05
0.03224	-3.91E-06	3.02E-05	3.22E-06	-4.47E-05	2.15E-06	5.11E-05	4.73E-06	-4.95E-05
0.03286	-3.97E-06	3.00E-05	3.35E-06	-4.49E-05	1.79E-06	5.14E-05	4.49E-06	-4.94E-05
0.03348	-4.01E-06	2.97E-05	3.02E-06	-4.49E-05	2.26E-06	5.17E-05	4.30E-06	-4.92E-05
0.0341	-3.82E-06	2.98E-05	2.95E-06	-4.46E-05	1.72E-06	5.18E-05	4.46E-06	-4.97E-05
0.03472	-3.88E-06	3.00E-05	3.34E-06	-4.41E-05	1.70E-06	5.18E-05	4.08E-06	-4.94E-05
0.03534	-4.13E-06	3.00E-05	2.78E-06	-4.46E-05	1.65E-06	5.15E-05	4.30E-06	-4.96E-05
0.03596	-3.53E-06	2.98E-05	3.03E-06	-4.44E-05	1.42E-06	5.14E-05	4.53E-06	-4.93E-05
0.03658	-4.18E-06	2.97E-05	3.54E-06	-4.53E-05	1.37E-06	5.18E-05	4.09E-06	-4.97E-05
0.0372	-4.18E-06	3.02E-05	3.24E-06	-4.48E-05	1.56E-06	5.14E-05	4.18E-06	-5.01E-05
0.03782	-4.01E-06	3.01E-05	2.93E-06	-4.46E-05	2.01E-06	5.17E-05	3.86E-06	-5.02E-05
0.03844	-3.93E-06	3.03E-05	2.84E-06	-4.43E-05	1.93E-06	5.16E-05	4.26E-06	-4.99E-05
0.03906	-4.04E-06	3.00E-05	2.91E-06	-4.46E-05	2.06E-06	5.18E-05	4.53E-06	-5.00E-05
0.03968	-3.60E-06	2.97E-05	3.47E-06	-4.41E-05	1.88E-06	5.16E-05	4.30E-06	-4.98E-05
0.0403	-3.93E-06	2.96E-05	2.90E-06	-4.47E-05	1.79E-06	5.17E-05	4.43E-06	-4.89E-05
0.04092	-3.66E-06	2.99E-05	2.73E-06	-4.44E-05	1.77E-06	5.16E-05	4.39E-06	-4.94E-05
0.04154	-4.02E-06	2.94E-05	2.83E-06	-4.48E-05	1.85E-06	5.17E-05	4.41E-06	-4.93E-05
0.04216	-3.45E-06	2.98E-05	3.15E-06	-4.44E-05	1.54E-06	5.17E-05	4.49E-06	-4.98E-05
0.04278	-3.35E-06	3.06E-05	3.36E-06	-4.46E-05	1.81E-06	5.11E-05	4.44E-06	-4.97E-05
0.0434	-3.79E-06	3.00E-05	2.67E-06	-4.42E-05	1.77E-06	5.15E-05	3.93E-06	-4.94E-05
0.04402	-3.58E-06	2.96E-05	3.06E-06	-4.47E-05	1.90E-06	5.14E-05	4.51E-06	-4.98E-05
0.04464	-3.77E-06	2.98E-05	3.03E-06	-4.46E-05	1.90E-06	5.14E-05	3.83E-06	-4.97E-05
0.04526	-3.87E-06	2.99E-05	2.79E-06	-4.49E-05	1.81E-06	5.17E-05	4.14E-06	-4.98E-05
0.04588	-4.14E-06	2.96E-05	3.22E-06	-4.48E-05	1.60E-06	5.13E-05	4.14E-06	-4.93E-05
0.0465	-4.07E-06	2.96E-05	2.48E-06	-4.45E-05	1.29E-06	5.19E-05	4.19E-06	-4.93E-05
0.04712	-3.93E-06	2.98E-05	2.62E-06	-4.48E-05	2.11E-06	5.16E-05	3.80E-06	-4.88E-05
0.04774	-3.97E-06	2.95E-05	2.55E-06	-4.49E-05	1.98E-06	5.20E-05	4.06E-06	-5.00E-05
0.04836	-3.21E-06	2.95E-05	3.79E-06	-4.48E-05	1.67E-06	5.15E-05	3.97E-06	-4.95E-05
0.04898	-4.05E-06	2.95E-05	3.09E-06	-4.47E-05	1.94E-06	5.18E-05	3.98E-06	-4.95E-05
0.0496	-4.12E-06	2.97E-05	2.91E-06	-4.41E-05	1.62E-06	5.17E-05	4.41E-06	-4.98E-05
0.05022	-3.81E-06	2.95E-05	3.02E-06	-4.47E-05	2.33E-06	5.19E-05	4.76E-06	-4.96E-05
0.05084	-3.42E-06	2.96E-05	2.59E-06	-4.47E-05	1.53E-06	5.14E-05	4.45E-06	-4.98E-05
0.05146	-4.02E-06	3.01E-05	2.88E-06	-4.47E-05	2.06E-06	5.14E-05	4.35E-06	-4.95E-05
0.05208	-3.99E-06	2.94E-05	2.88E-06	-4.46E-05	1.81E-06	5.20E-05	4.42E-06	-4.97E-05
0.0527	-3.65E-06	3.00E-05	2.95E-06	-4.39E-05	1.58E-06	5.17E-05	3.75E-06	-4.96E-05
0.05332	-3.56E-06	2.98E-05	2.89E-06	-4.49E-05	2.14E-06	5.10E-05	3.97E-06	-4.99E-05
0.05394	-3.71E-06	3.01E-05	3.17E-06	-4.46E-05	1.61E-06	5.19E-05	4.16E-06	-4.94E-05
0.05456	-3.77E-06	2.95E-05	3.17E-06	-4.47E-05	1.58E-06	5.14E-05	4.15E-06	-5.01E-05
0.05518	-3.66E-06	2.98E-05	3.58E-06	-4.44E-05	1.62E-06	5.15E-05	4.60E-06	-4.95E-05
0.0558	-3.42E-06	3.01E-05	3.44E-06	-4.40E-05	1.97E-06	5.15E-05	4.32E-06	-4.97E-05
0.05642	-4.09E-06	3.03E-05	3.38E-06	-4.49E-05	1.78E-06	5.20E-05	4.08E-06	-4.95E-05
0.05704	-4.19E-06	3.00E-05	3.18E-06	-4.45E-05	1.74E-06	5.15E-05	4.03E-06	-4.98E-05
0.05766	-4.27E-06	2.92E-05	3.75E-06	-4.49E-05	1.59E-06	5.17E-05	3.77E-06	-4.95E-05
0.05828	-4.07E-06	2.95E-05	2.60E-06	-4.49E-05	1.66E-06	5.22E-05	4.22E-06	-4.94E-05
0.0589	-3.78E-06	3.01E-05	3.52E-06	-4.46E-05	1.83E-06	5.17E-05	4.41E-06	-4.98E-05
0.05952	-3.91E-06	2.99E-05	2.92E-06	-4.48E-05	2.06E-06	5.19E-05	4.05E-06	-4.94E-05
0.06014	-3.93E-06	3.00E-05	3.65E-06	-4.47E-05	1.45E-06	5.14E-05	3.85E-06	-4.97E-05
0.06076	-3.74E-06	2.99E-05	3.23E-06	-4.49E-05	1.45E-06	5.17E-05	4.55E-06	-4.95E-05
0.06138	-3.88E-06	2.98E-05	3.30E-06	-4.50E-05	1.85E-06	5.16E-05	3.92E-06	-4.94E-05
	-3.86E-06	2.99E-05	3.08E-06	-4.46E-05	1.76419E-06	5.15574E-05	4.25784E-06	-4.96E-05

APPENDIX C

	Load at Beam 20 with 600 kg				Load at Beam 20 with 700 kg			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	1.72E-06	6.17E-05	4.39E-06	-5.92E-05	1.78E-06	6.70E-05	4.18E-06	-6.84E-05
0.00062	1.66E-06	6.23E-05	4.44E-06	-5.94E-05	1.64E-06	6.75E-05	4.41E-06	-6.83E-05
0.00124	1.79E-06	6.18E-05	4.47E-06	-5.93E-05	1.49E-06	6.71E-05	3.42E-06	-6.82E-05
0.00186	1.22E-06	6.22E-05	4.31E-06	-5.90E-05	1.51E-06	6.73E-05	4.53E-06	-6.82E-05
0.00248	1.76E-06	6.19E-05	4.44E-06	-5.93E-05	1.59E-06	6.76E-05	3.68E-06	-6.87E-05
0.0031	1.53E-06	6.23E-05	4.84E-06	-5.92E-05	1.12E-06	6.72E-05	4.05E-06	-6.81E-05
0.00372	1.74E-06	6.17E-05	4.47E-06	-5.95E-05	2.35E-06	6.71E-05	4.30E-06	-6.79E-05
0.00434	1.72E-06	6.20E-05	5.00E-06	-5.94E-05	1.40E-06	6.72E-05	4.53E-06	-6.84E-05
0.00496	1.71E-06	6.18E-05	4.36E-06	-5.90E-05	1.27E-06	6.75E-05	4.04E-06	-6.86E-05
0.00558	1.34E-06	6.22E-05	4.13E-06	-5.95E-05	1.42E-06	6.70E-05	4.42E-06	-6.85E-05
0.0062	1.52E-06	6.22E-05	4.28E-06	-5.95E-05	1.95E-06	6.72E-05	4.53E-06	-6.79E-05
0.00682	2.03E-06	6.20E-05	4.71E-06	-5.96E-05	1.67E-06	6.73E-05	4.61E-06	-6.84E-05
0.00744	1.77E-06	6.20E-05	4.40E-06	-5.95E-05	1.70E-06	6.74E-05	4.61E-06	-6.84E-05
0.00806	1.41E-06	6.22E-05	4.31E-06	-5.99E-05	2.17E-06	6.72E-05	4.32E-06	-6.82E-05
0.00868	1.65E-06	6.23E-05	4.42E-06	-5.95E-05	1.77E-06	6.75E-05	4.30E-06	-6.80E-05
0.0093	1.94E-06	6.19E-05	4.01E-06	-5.93E-05	1.33E-06	6.73E-05	4.51E-06	-6.79E-05
0.00992	1.97E-06	6.19E-05	4.41E-06	-5.92E-05	1.12E-06	6.73E-05	4.32E-06	-6.81E-05
0.01054	2.27E-06	6.20E-05	4.29E-06	-5.89E-05	1.26E-06	6.77E-05	3.99E-06	-6.82E-05
0.01116	1.83E-06	6.23E-05	4.24E-06	-5.90E-05	1.75E-06	6.77E-05	4.58E-06	-6.82E-05
0.01178	1.78E-06	6.23E-05	4.03E-06	-5.94E-05	1.54E-06	6.71E-05	4.16E-06	-6.86E-05
0.0124	1.70E-06	6.19E-05	4.53E-06	-5.97E-05	1.36E-06	6.71E-05	4.30E-06	-6.85E-05
0.01302	1.84E-06	6.19E-05	4.71E-06	-5.89E-05	1.61E-06	6.79E-05	4.31E-06	-6.84E-05
0.01364	1.53E-06	6.19E-05	4.73E-06	-5.91E-05	1.71E-06	6.73E-05	4.21E-06	-6.83E-05
0.01426	1.54E-06	6.18E-05	4.47E-06	-5.91E-05	1.46E-06	6.76E-05	4.32E-06	-6.85E-05
0.01488	1.54E-06	6.19E-05	4.15E-06	-5.94E-05	1.69E-06	6.76E-05	4.33E-06	-6.80E-05
0.0155	1.11E-06	6.19E-05	5.21E-06	-5.91E-05	1.23E-06	6.75E-05	4.42E-06	-6.86E-05
0.01612	1.79E-06	6.22E-05	4.49E-06	-5.88E-05	1.98E-06	6.73E-05	4.60E-06	-6.82E-05
0.01674	1.65E-06	6.21E-05	4.53E-06	-5.87E-05	1.69E-06	6.74E-05	4.91E-06	-6.84E-05
0.01736	1.61E-06	6.19E-05	3.69E-06	-5.95E-05	1.05E-06	6.73E-05	4.90E-06	-6.86E-05
0.01798	1.56E-06	6.19E-05	4.36E-06	-5.91E-05	1.56E-06	6.74E-05	4.67E-06	-6.84E-05
0.0186	1.70E-06	6.19E-05	4.64E-06	-5.95E-05	1.17E-06	6.75E-05	4.21E-06	-6.83E-05
0.01922	1.96E-06	6.18E-05	4.36E-06	-5.91E-05	1.35E-06	6.77E-05	4.51E-06	-6.80E-05
0.01984	1.35E-06	6.20E-05	4.65E-06	-5.90E-05	1.26E-06	6.75E-05	4.20E-06	-6.81E-05
0.02046	1.64E-06	6.21E-05	4.60E-06	-5.92E-05	1.31E-06	6.71E-05	4.61E-06	-6.82E-05
0.02108	1.88E-06	6.20E-05	4.79E-06	-5.91E-05	1.40E-06	6.75E-05	4.35E-06	-6.85E-05
0.0217	1.37E-06	6.17E-05	4.47E-06	-5.90E-05	1.10E-06	6.72E-05	4.83E-06	-6.86E-05
0.02232	1.41E-06	6.18E-05	4.89E-06	-5.92E-05	1.20E-06	6.72E-05	4.46E-06	-6.83E-05
0.02294	1.34E-06	6.20E-05	4.55E-06	-5.91E-05	1.31E-06	6.77E-05	4.64E-06	-6.82E-05
0.02356	1.64E-06	6.22E-05	4.84E-06	-5.91E-05	1.66E-06	6.75E-05	4.32E-06	-6.79E-05
0.02418	1.44E-06	6.18E-05	4.46E-06	-5.90E-05	1.56E-06	6.70E-05	3.87E-06	-6.79E-05
0.0248	1.58E-06	6.20E-05	4.30E-06	-5.87E-05	1.12E-06	6.71E-05	4.74E-06	-6.83E-05
0.02542	1.64E-06	6.21E-05	4.28E-06	-5.89E-05	1.34E-06	6.75E-05	4.43E-06	-6.82E-05
0.02604	1.56E-06	6.20E-05	4.46E-06	-5.94E-05	1.12E-06	6.69E-05	4.39E-06	-6.84E-05
0.02666	1.96E-06	6.24E-05	4.54E-06	-5.93E-05	1.33E-06	6.76E-05	4.61E-06	-6.82E-05
0.02728	1.54E-06	6.22E-05	4.77E-06	-5.91E-05	1.27E-06	6.69E-05	4.49E-06	-6.84E-05
0.0279	1.63E-06	6.19E-05	4.30E-06	-5.89E-05	1.40E-06	6.71E-05	4.27E-06	-6.79E-05
0.02852	1.05E-06	6.19E-05	4.26E-06	-5.92E-05	1.46E-06	6.72E-05	3.75E-06	-6.82E-05
0.02914	1.63E-06	6.17E-05	4.66E-06	-5.88E-05	1.68E-06	6.74E-05	4.65E-06	-6.80E-05
0.02976	1.56E-06	6.22E-05	4.62E-06	-5.91E-05	1.55E-06	6.73E-05	4.52E-06	-6.85E-05
0.03038	1.84E-06	6.22E-05	3.90E-06	-5.93E-05	1.74E-06	6.74E-05	4.07E-06	-6.84E-05
0.031	1.55E-06	6.17E-05	4.64E-06	-5.95E-05	9.33E-07	6.71E-05	4.55E-06	-6.81E-05
0.03162	1.50E-06	6.23E-05	5.06E-06	-5.96E-05	1.58E-06	6.71E-05	4.33E-06	-6.85E-05
0.03224	2.18E-06	6.18E-05	3.75E-06	-5.91E-05	1.67E-06	6.72E-05	4.53E-06	-6.84E-05
0.03286	1.43E-06	6.20E-05	4.60E-06	-5.88E-05	1.56E-06	6.71E-05	4.36E-06	-6.79E-05
0.03348	1.59E-06	6.23E-05	4.51E-06	-5.90E-05	1.63E-06	6.77E-05	4.66E-06	-6.83E-05
0.0341	1.55E-06	6.23E-05	4.52E-06	-5.89E-05	1.11E-06	6.73E-05	4.37E-06	-6.82E-05
0.03472	1.35E-06	6.17E-05	4.12E-06	-5.93E-05	1.23E-06	6.75E-05	4.71E-06	-6.80E-05
0.03534	1.77E-06	6.21E-05	5.03E-06	-5.94E-05	1.08E-06	6.71E-05	4.30E-06	-6.80E-05
0.03596	1.46E-06	6.23E-05	4.46E-06	-5.91E-05	1.23E-06	6.76E-05	4.77E-06	-6.80E-05
0.03658	1.65E-06	6.16E-05	4.33E-06	-5.95E-05	1.25E-06	6.71E-05	4.77E-06	-6.82E-05
0.0372	1.43E-06	6.22E-05	4.77E-06	-5.90E-05	1.16E-06	6.68E-05	4.03E-06	-6.81E-05
0.03782	1.42E-06	6.20E-05	4.51E-06	-5.91E-05	1.61E-06	6.72E-05	4.27E-06	-6.81E-05
0.03844	1.71E-06	6.24E-05	4.72E-06	-5.89E-05	1.30E-06	6.73E-05	4.61E-06	-6.86E-05
0.03906	1.20E-06	6.18E-05	4.43E-06	-5.87E-05	1.69E-06	6.70E-05	3.86E-06	-6.81E-05
0.03968	1.72E-06	6.22E-05	5.01E-06	-5.91E-05	1.46E-06	6.73E-05	4.56E-06	-6.82E-05
0.0403	1.65E-06	6.22E-05	4.83E-06	-5.97E-05	1.64E-06	6.73E-05	4.50E-06	-6.77E-05
0.04092	1.97E-06	6.23E-05	3.93E-06	-5.94E-05	9.51E-07	6.72E-05	4.39E-06	-6.83E-05
0.04154	1.91E-06	6.18E-05	4.55E-06	-5.89E-05	1.32E-06	6.67E-05	4.55E-06	-6.92E-05
0.04216	1.86E-06	6.23E-05	5.08E-06	-5.93E-05	1.31E-06	6.74E-05	4.50E-06	-6.80E-05
0.04278	1.84E-06	6.20E-05	4.30E-06	-5.91E-05	1.69E-06	6.73E-05	4.15E-06	-6.88E-05
0.0434	1.75E-06	6.20E-05	4.58E-06	-5.95E-05	1.64E-06	6.74E-05	4.41E-06	-6.80E-05
0.04402	1.98E-06	6.25E-05	4.25E-06	-5.90E-05	1.79E-06	6.74E-05	4.62E-06	-6.80E-05
0.04464	2.04E-06	6.23E-05	4.69E-06	-5.90E-05	1.77E-06	6.76E-05	4.05E-06	-6.82E-05
0.04526	1.75E-06	6.23E-05	4.32E-06	-5.99E-05	1.43E-06	6.71E-05	3.81E-06	-6.84E-05
0.04588	1.52E-06	6.21E-05	3.78E-06	-5.89E-05	1.53E-06	6.73E-05	4.65E-06	-6.83E-05
0.0465	1.63E-06	6.15E-05	4.11E-06	-5.94E-05	1.20E-06	6.71E-05	4.98E-06	-6.80E-05
0.04712	1.73E-06	6.19E-05	4.06E-06	-5.91E-05	1.65E-06	6.73E-05	4.23E-06	-6.81E-05
0.04774	1.29E-06	6.22E-05	4.28E-06	-5.85E-05	1.40E-06	6.71E-05	4.45E-06	-6.83E-05
0.04836	2.16E-06	6.19E-05	4.57E-06	-5.98E-05	1.64E-06	6.73E-05	4.71E-06	-6.83E-05
0.04898	1.95E-06	6.21E-05	4.73E-06	-5.92E-05	1.36E-06	6.73E-05	4.15E-06	-6.80E-05
0.0496	1.58E-06	6.21E-05	4.36E-06	-5.91E-05	1.12E-06	6.72E-05	4.36E-06	-6.88E-05
0.05022	1.47E-06	6.23E-05	4.25E-06	-5.95E-05	1.41E-06	6.74E-05	4.35E-06	-6.78E-05
0.05084	1.53E-06	6.25E-05	4.60E-06	-5.93E-05	1.38E-06	6.69E-05	4.27E-06	-6.83E-05
0.05146	1.72E-06	6.20E-05	4.59E-06	-5.93E-05	1.30E-06	6.80E-05	4.23E-06	-6.82E-05
0.05208	2.01E-06	6.21E-05	4.54E-06	-5.95E-05	1.68E-06	6.75E-05	4.45E-06	-6.82E-05
0.0527	1.70E-06	6.23E-05	4.81E-06	-5.93E-05	1.60E-06	6.74E-05	4.66E-06	-6.85E-05
0.05332	1.77E-06	6.19E-05	4.56E-06	-5.92E-05	1.19E-06	6.73E-05	4.16E-06	-6.86E-05
0.05394	1.69E-06	6.20E-05	4.64E-06	-5.87E-05	1.23E-06	6.71E-05	3.94E-06	-6.80E-05
0.05456	1.92E-06	6.21E-05	3.90E-06	-5.91E-05	1.70E-06	6.73E-05	4.35E-06	-6.85E-05
0.05518	2.07E-06	6.20E-05	4.47E-06	-5.95E-05	1.22E-06	6.73E-05	5.14E-06	-6.86E-05
0.0558	1.78E-06	6.21E-05	4.48E-06	-5.93E-05	1.69E-06	6.72E-05	4.02E-06	-6.84E-05
0.05642	1.87E-06	6.19E-05	4.24E-06	-5.90E-05	1.12E-06	6.72E-05	4.43E-06	-6.82E-05
0.05704	1.72E-06	6.15E-05	4.36E-06	-5.91E-05	1.58E-06	6.72E-05	4.54E-06	-6.78E-05
0.05766	2.02E-06	6.20E-05	4.72E-06	-5.91E-05	1.32E-06	6.71E-05	3.99E-06	-6.80E-05
0.05828	1.85E-06	6.21E-05	4.37E-06	-5.92E-05	1.32E-06	6.76E-05	4.48E-06	-6.85E-05
0.0589	1.92E-06	6.24E-05	4.59E-06	-5.89E-05	1.47E-06	6.72E-05	4.39E-06	-6.81E-05
0.05952	1.67E-06	6.19E-05	4.15E-06	-5.86E-05	1.50E-06	6.71E-05	4.52E-06	-6.83E-05
0.06014	1.82E-06	6.19E-05	4.49E-06	-5.93E-05	1.90E-06	6.73E-05	4.43E-06	-6.78E-05
0.06076	1.98E-06	6.21E-05	5.05E-06	-5.93E-05	1.52E-06	6.70E-05	4.51E-06	-6.82E-05
0.06138	1.57E-06	6.19E-05	4.61E-06	-5.92E-05	1.35E-06	6.68E-05	4.66E-06	-6.75E-05
	1.68E-06	6.20E-05	4.47E-06	-5.92E-05	1.46E-06	6.73E-05	4.39E-06	-6.82E-05

APPENDIX C

	Load at Beam 20 with 380 kg (Decreasing Order)				Load at Beam 20 with 500 kg (Decreasing Order)			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	-3.77E-06	3.00E-05	3.13E-06	-4.44E-05	-5.11E-07	5.19E-05	3.87E-06	-4.99E-05
0.00062	-3.77E-06	3.02E-05	3.20E-06	-4.49E-05	-2.25E-07	5.18E-05	4.41E-06	-4.92E-05
0.00124	-4.18E-06	2.99E-05	3.37E-06	-4.50E-05	-5.44E-07	5.16E-05	4.33E-06	-4.91E-05
0.00186	-4.17E-06	3.02E-05	3.19E-06	-4.43E-05	-3.56E-07	5.19E-05	3.62E-06	-4.91E-05
0.00248	-4.29E-06	2.97E-05	2.95E-06	-4.42E-05	-2.82E-07	5.19E-05	4.18E-06	-4.94E-05
0.0031	-3.69E-06	3.00E-05	2.57E-06	-4.45E-05	-1.58E-08	5.19E-05	3.81E-06	-4.94E-05
0.00372	-3.89E-06	2.94E-05	2.77E-06	-4.48E-05	-2.56E-07	5.13E-05	4.09E-06	-4.89E-05
0.00434	-4.08E-06	2.98E-05	3.25E-06	-4.42E-05	-9.45E-08	5.15E-05	4.22E-06	-4.97E-05
0.00496	-3.56E-06	3.00E-05	2.92E-06	-4.45E-05	-6.44E-08	5.12E-05	4.15E-06	-4.95E-05
0.00558	-4.13E-06	2.98E-05	3.19E-06	-4.50E-05	1.76E-07	5.16E-05	3.96E-06	-4.96E-05
0.0062	-3.81E-06	2.99E-05	2.97E-06	-4.46E-05	-2.48E-07	5.19E-05	3.46E-06	-4.94E-05
0.00682	-3.57E-06	3.02E-05	3.42E-06	-4.45E-05	-2.40E-07	5.15E-05	4.30E-06	-4.94E-05
0.00744	-4.08E-06	3.01E-05	2.90E-06	-4.49E-05	-6.01E-08	5.17E-05	4.34E-06	-4.97E-05
0.00806	-3.69E-06	3.05E-05	3.13E-06	-4.47E-05	-1.47E-09	5.14E-05	3.77E-06	-4.96E-05
0.00868	-3.23E-06	2.98E-05	3.53E-06	-4.46E-05	-9.30E-08	5.18E-05	4.50E-06	-4.98E-05
0.0093	-3.84E-06	3.01E-05	2.95E-06	-4.50E-05	-4.01E-07	5.12E-05	3.59E-06	-4.96E-05
0.00992	-3.96E-06	3.01E-05	2.68E-06	-4.48E-05	-5.57E-07	5.16E-05	4.67E-06	-4.94E-05
0.01054	-3.86E-06	2.99E-05	2.76E-06	-4.43E-05	2.22E-07	5.15E-05	3.57E-06	-4.97E-05
0.01116	-4.35E-06	2.98E-05	3.01E-06	-4.53E-05	-2.45E-07	5.11E-05	4.10E-06	-4.96E-05
0.01178	-4.12E-06	2.99E-05	2.69E-06	-4.45E-05	-1.55E-07	5.20E-05	3.93E-06	-4.91E-05
0.0124	-4.19E-06	3.04E-05	2.61E-06	-4.46E-05	7.87E-08	5.19E-05	3.98E-06	-4.95E-05
0.01302	-3.63E-06	2.92E-05	2.51E-06	-4.43E-05	1.36E-07	5.20E-05	4.13E-06	-4.91E-05
0.01364	-3.94E-06	2.99E-05	3.05E-06	-4.46E-05	3.28E-07	5.17E-05	3.81E-06	-4.94E-05
0.01426	-3.39E-06	3.01E-05	3.33E-06	-4.46E-05	-2.23E-07	5.15E-05	3.60E-06	-4.98E-05
0.01488	-3.82E-06	3.04E-05	3.19E-06	-4.44E-05	-3.28E-07	5.17E-05	4.14E-06	-4.96E-05
0.0155	-4.07E-06	2.97E-05	3.78E-06	-4.44E-05	-1.89E-07	5.17E-05	4.26E-06	-4.95E-05
0.01612	-3.87E-06	3.03E-05	2.87E-06	-4.47E-05	1.29E-07	5.19E-05	4.43E-06	-4.94E-05
0.01674	-3.92E-06	2.95E-05	3.12E-06	-4.48E-05	-2.72E-08	5.17E-05	4.10E-06	-4.97E-05
0.01736	-3.67E-06	2.95E-05	3.23E-06	-4.46E-05	-5.58E-08	5.13E-05	3.96E-06	-4.94E-05
0.01798	-3.39E-06	3.02E-05	3.45E-06	-4.43E-05	2.57E-08	5.21E-05	4.30E-06	-4.98E-05
0.0186	-3.81E-06	2.98E-05	3.20E-06	-4.47E-05	-3.01E-08	5.17E-05	3.60E-06	-4.90E-05
0.01922	-3.88E-06	2.98E-05	2.93E-06	-4.46E-05	2.85E-07	5.18E-05	4.03E-06	-4.95E-05
0.01984	-4.03E-06	3.00E-05	3.19E-06	-4.49E-05	-4.35E-07	5.17E-05	4.38E-06	-4.94E-05
0.02046	-4.14E-06	2.94E-05	3.10E-06	-4.49E-05	2.86E-08	5.14E-05	4.19E-06	-4.93E-05
0.02108	-4.18E-06	2.98E-05	3.42E-06	-4.46E-05	-4.05E-07	5.20E-05	4.09E-06	-4.92E-05
0.0217	-4.03E-06	3.01E-05	2.84E-06	-4.44E-05	-5.80E-07	5.13E-05	4.01E-06	-4.97E-05
0.02232	-3.62E-06	2.96E-05	3.27E-06	-4.47E-05	-3.36E-07	5.15E-05	4.01E-06	-4.98E-05
0.02294	-3.90E-06	2.96E-05	3.24E-06	-4.46E-05	5.00E-08	5.20E-05	4.44E-06	-4.97E-05
0.02356	-3.85E-06	2.99E-05	2.96E-06	-4.49E-05	-2.83E-07	5.19E-05	4.13E-06	-4.94E-05
0.02418	-3.87E-06	2.96E-05	2.80E-06	-4.51E-05	-1.32E-07	5.14E-05	4.40E-06	-4.96E-05
0.0248	-3.52E-06	2.99E-05	3.51E-06	-4.48E-05	-2.83E-07	5.15E-05	4.04E-06	-4.93E-05
0.02542	-4.20E-06	3.01E-05	3.18E-06	-4.42E-05	1.20E-07	5.15E-05	3.51E-06	-4.96E-05
0.02604	-3.32E-06	2.95E-05	2.61E-06	-4.45E-05	-4.16E-07	5.14E-05	3.71E-06	-4.98E-05
0.02666	-3.78E-06	3.00E-05	3.23E-06	-4.46E-05	-3.63E-07	5.13E-05	3.67E-06	-4.95E-05
0.02728	-3.53E-06	2.98E-05	3.50E-06	-4.47E-05	-1.00E-07	5.17E-05	3.80E-06	-4.95E-05
0.0279	-3.78E-06	2.99E-05	3.36E-06	-4.44E-05	-3.59E-07	5.17E-05	3.60E-06	-4.94E-05
0.02852	-3.54E-06	2.98E-05	3.04E-06	-4.45E-05	-1.40E-07	5.15E-05	3.82E-06	-4.95E-05
0.02914	-3.69E-06	3.02E-05	3.35E-06	-4.45E-05	-4.51E-07	5.18E-05	4.65E-06	-4.95E-05
0.02976	-4.23E-06	2.96E-05	2.55E-06	-4.51E-05	-2.40E-07	5.17E-05	3.29E-06	-4.93E-05
0.03038	-4.23E-06	2.93E-05	2.49E-06	-4.44E-05	4.29E-08	5.22E-05	4.03E-06	-4.91E-05
0.031	-3.79E-06	3.02E-05	3.12E-06	-4.45E-05	-2.16E-07	5.13E-05	4.51E-06	-4.95E-05
0.03162	-4.09E-06	2.95E-05	3.13E-06	-4.48E-05	-1.04E-07	5.16E-05	4.38E-06	-4.94E-05
0.03224	-3.91E-06	3.02E-05	3.22E-06	-4.47E-05	-1.60E-07	5.18E-05	4.34E-06	-4.94E-05
0.03286	-3.97E-06	3.00E-05	3.35E-06	-4.49E-05	-1.00E-07	5.15E-05	3.70E-06	-4.96E-05
0.03348	-4.01E-06	2.97E-05	3.02E-06	-4.49E-05	-5.44E-08	5.16E-05	4.19E-06	-4.94E-05
0.0341	-3.82E-06	2.98E-05	2.95E-06	-4.46E-05	-1.35E-07	5.20E-05	3.95E-06	-4.95E-05
0.03472	-3.88E-06	3.00E-05	3.34E-06	-4.41E-05	3.72E-07	5.16E-05	4.71E-06	-4.94E-05
0.03534	-4.13E-06	3.00E-05	2.78E-06	-4.46E-05	-5.44E-08	5.16E-05	4.09E-06	-4.96E-05
0.03596	-3.53E-06	2.98E-05	3.03E-06	-4.44E-05	-3.26E-07	5.20E-05	4.19E-06	-4.98E-05
0.03658	-4.18E-06	2.97E-05	3.54E-06	-4.53E-05	1.43E-07	5.17E-05	3.96E-06	-4.98E-05
0.0372	-4.18E-06	3.02E-05	3.24E-06	-4.48E-05	-1.04E-07	5.15E-05	4.07E-06	-4.94E-05
0.03782	-4.01E-06	3.01E-05	2.93E-06	-4.46E-05	-4.32E-07	5.14E-05	4.37E-06	-4.92E-05
0.03844	-3.93E-06	3.03E-05	2.84E-06	-4.43E-05	4.72E-08	5.15E-05	3.99E-06	-4.97E-05
0.03906	-4.04E-06	3.00E-05	2.91E-06	-4.46E-05	-3.78E-07	5.20E-05	4.02E-06	-4.90E-05
0.03968	-3.60E-06	2.97E-05	3.47E-06	-4.41E-05	3.43E-08	5.17E-05	4.26E-06	-4.94E-05
0.0403	-3.93E-06	2.96E-05	2.90E-06	-4.47E-05	8.55E-09	5.17E-05	4.22E-06	-4.95E-05
0.04092	-3.66E-06	2.99E-05	2.73E-06	-4.44E-05	-3.29E-08	5.17E-05	4.25E-06	-4.94E-05
0.04154	-4.02E-06	2.94E-05	2.83E-06	-4.48E-05	-3.44E-08	5.15E-05	4.28E-06	-4.95E-05
0.04216	-3.45E-06	2.98E-05	3.15E-06	-4.44E-05	1.36E-07	5.13E-05	4.01E-06	-4.93E-05
0.04278	-3.35E-06	3.06E-05	3.36E-06	-4.46E-05	-1.43E-08	5.14E-05	3.96E-06	-4.95E-05
0.0434	-3.79E-06	3.00E-05	2.67E-06	-4.42E-05	-4.58E-08	5.20E-05	4.48E-06	-4.96E-05
0.04402	-3.58E-06	2.96E-05	3.06E-06	-4.47E-05	7.29E-08	5.16E-05	4.20E-06	-4.96E-05
0.04464	-3.77E-06	2.98E-05	3.03E-06	-4.46E-05	-1.32E-07	5.17E-05	3.67E-06	-4.94E-05
0.04526	-3.87E-06	2.99E-05	2.79E-06	-4.49E-05	-4.84E-07	5.18E-05	3.67E-06	-4.94E-05
0.04588	-4.14E-06	2.96E-05	3.22E-06	-4.48E-05	-1.42E-07	5.22E-05	4.39E-06	-4.91E-05
0.0465	-4.07E-06	2.96E-05	2.48E-06	-4.45E-05	-2.58E-07	5.14E-05	4.40E-06	-4.98E-05
0.04712	-3.93E-06	2.98E-05	2.62E-06	-4.48E-05	-8.45E-08	5.15E-05	4.57E-06	-4.93E-05
0.04774	-3.97E-06	2.95E-05	2.55E-06	-4.49E-05	-1.45E-07	5.19E-05	4.00E-06	-4.95E-05
0.04836	-3.21E-06	2.95E-05	3.79E-06	-4.48E-05	-3.65E-07	5.17E-05	4.35E-06	-4.94E-05
0.04898	-4.05E-06	2.95E-05	3.09E-06	-4.47E-05	-2.50E-07	5.15E-05	3.79E-06	-4.96E-05
0.0496	-4.12E-06	2.97E-05	2.91E-06	-4.41E-05	-1.43E-07	5.12E-05	4.10E-06	-4.95E-05
0.05022	-3.81E-06	2.95E-05	3.02E-06	-4.47E-05	1.02E-07	5.21E-05	3.87E-06	-4.92E-05
0.05084	-3.42E-06	2.96E-05	2.59E-06	-4.47E-05	-3.72E-07	5.16E-05	4.17E-06	-4.91E-05
0.05146	-4.02E-06	3.01E-05	2.88E-06	-4.47E-05	-1.90E-07	5.18E-05	4.02E-06	-4.93E-05
0.05208	-3.99E-06	2.94E-05	2.88E-06	-4.46E-05	-7.59E-08	5.15E-05	3.84E-06	-4.92E-05
0.0527	-3.65E-06	3.00E-05	2.95E-06	-4.39E-05	1.24E-07	5.22E-05	4.55E-06	-4.92E-05
0.05332	-3.56E-06	2.98E-05	2.89E-06	-4.49E-05	-3.63E-07	5.17E-05	3.63E-06	-4.97E-05
0.05394	-3.71E-06	3.01E-05	3.17E-06	-4.46E-05	3.57E-08	5.18E-05	4.19E-06	-4.93E-05
0.05456	-3.77E-06	2.95E-05	3.17E-06	-4.47E-05	8.87E-08	5.19E-05	4.20E-06	-4.98E-05
0.05518	-3.66E-06	2.98E-05	3.58E-06	-4.44E-05	-5.73E-08	5.15E-05	3.40E-06	-4.98E-05
0.0558	-3.42E-06	3.01E-05	3.44E-06	-4.40E-05	-2.89E-07	5.13E-05	4.44E-06	-4.94E-05
0.05642	-4.09E-06	3.03E-05	3.38E-06	-4.49E-05	5.00E-08	5.18E-05	4.13E-06	-4.98E-05
0.05704	-4.19E-06	3.00E-05	3.18E-06	-4.45E-05	-1.13E-07	5.15E-05	4.48E-06	-4.95E-05
0.05766	-4.27E-06	2.92E-05	3.75E-06	-4.49E-05	-3.41E-07	5.18E-05	3.78E-06	-4.96E-05
0.05828	-4.07E-06	2.95E-05	2.60E-06	-4.49E-05	6.86E-08	5.16E-05	4.12E-06	-4.95E-05
0.0589	-3.78E-06	3.01E-05	3.52E-06	-4.46E-05	-4.24E-07	5.15E-05	4.21E-06	-4.92E-05
0.05952	-3.91E-06	2.99E-05	2.92E-06	-4.48E-05	-3.59E-07	5.13E-05	4.74E-06	-4.94E-05
0.06014	-3.93E-06	3.00E-05	3.65E-06	-4.47E-05	-6.30E-08	5.14E-05	3.81E-06	-4.98E-05
0.06076	-3.74E-06	2.99E-05	3.23E-06	-4.49E-05	6.21E-07	5.19E-05	4.15E-06	-4.91E-05
0.06138	-3.88E-06	2.98E-05	3.30E-06	-4.50E-05	-3.66E-07	5.17E-05	3.56E-06	-4.99E-05
	-3.86E-06	2.99E-05	3.08E-06	-4.46E-05	-1.34E-07	5.17E-05	4.07E-06	-4.95E-05

APPENDIX C

	Load at Beam 20 with 600 kg (Decreasing Order)				Load at Beam 20 with 700 kg (Decreasing Order)			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	1.07E-06	6.25E-05	4.41E-06	-5.91E-05	1.78E-06	6.79E-05	4.18E-06	-6.84E-05
0.00062	3.66E-07	6.21E-05	4.27E-06	-5.92E-05	1.64E-06	6.84E-05	4.41E-06	-6.83E-05
0.00124	4.79E-07	6.21E-05	4.14E-06	-5.92E-05	1.49E-06	6.80E-05	3.42E-06	-6.82E-05
0.00186	2.40E-07	6.20E-05	4.46E-06	-5.89E-05	1.51E-06	6.82E-05	4.53E-06	-6.82E-05
0.00248	5.16E-07	6.25E-05	4.81E-06	-5.90E-05	1.59E-06	6.85E-05	3.68E-06	-6.87E-05
0.0031	5.91E-07	6.25E-05	4.59E-06	-5.92E-05	1.12E-06	6.81E-05	4.05E-06	-6.81E-05
0.00372	5.65E-07	6.19E-05	4.39E-06	-5.90E-05	2.35E-06	6.80E-05	4.30E-06	-6.79E-05
0.00434	2.25E-07	6.26E-05	4.40E-06	-5.90E-05	1.40E-06	6.81E-05	4.53E-06	-6.84E-05
0.00496	3.59E-07	6.21E-05	4.61E-06	-5.90E-05	1.27E-06	6.84E-05	4.04E-06	-6.86E-05
0.00558	7.84E-07	6.22E-05	4.32E-06	-5.93E-05	1.42E-06	6.79E-05	4.42E-06	-6.85E-05
0.0062	5.72E-07	6.24E-05	4.17E-06	-5.92E-05	1.95E-06	6.81E-05	4.53E-06	-6.79E-05
0.00682	4.32E-07	6.26E-05	4.90E-06	-5.92E-05	1.67E-06	6.82E-05	4.61E-06	-6.84E-05
0.00744	6.15E-07	6.25E-05	4.19E-06	-5.92E-05	1.70E-06	6.83E-05	4.61E-06	-6.84E-05
0.00806	5.87E-07	6.23E-05	4.21E-06	-5.89E-05	2.17E-06	6.81E-05	4.32E-06	-6.82E-05
0.00868	5.89E-07	6.24E-05	4.40E-06	-5.89E-05	1.77E-06	6.84E-05	4.30E-06	-6.80E-05
0.0093	5.71E-07	6.24E-05	4.68E-06	-5.94E-05	1.33E-06	6.82E-05	4.51E-06	-6.79E-05
0.00992	4.12E-07	6.20E-05	4.10E-06	-5.90E-05	1.12E-06	6.82E-05	4.32E-06	-6.81E-05
0.01054	4.19E-07	6.20E-05	4.18E-06	-5.91E-05	1.26E-06	6.86E-05	3.99E-06	-6.82E-05
0.01116	8.04E-07	6.21E-05	3.98E-06	-5.92E-05	1.75E-06	6.86E-05	4.58E-06	-6.82E-05
0.01178	4.38E-07	6.21E-05	4.13E-06	-5.90E-05	1.54E-06	6.80E-05	4.16E-06	-6.86E-05
0.0124	2.25E-07	6.22E-05	3.91E-06	-5.95E-05	1.36E-06	6.80E-05	4.30E-06	-6.85E-05
0.01302	9.15E-08	6.24E-05	3.78E-06	-5.89E-05	1.61E-06	6.88E-05	4.31E-06	-6.84E-05
0.01364	5.14E-07	6.16E-05	3.95E-06	-5.92E-05	1.71E-06	6.82E-05	4.21E-06	-6.83E-05
0.01426	3.66E-07	6.24E-05	4.83E-06	-5.93E-05	1.46E-06	6.85E-05	4.32E-06	-6.85E-05
0.01488	-2.44E-08	6.25E-05	4.61E-06	-5.93E-05	1.69E-06	6.85E-05	4.33E-06	-6.80E-05
0.0155	6.01E-07	6.20E-05	3.85E-06	-5.92E-05	1.23E-06	6.84E-05	4.42E-06	-6.86E-05
0.01612	6.18E-07	6.20E-05	3.65E-06	-5.87E-05	1.98E-06	6.82E-05	4.60E-06	-6.82E-05
0.01674	4.62E-07	6.20E-05	4.30E-06	-5.93E-05	1.69E-06	6.83E-05	4.91E-06	-6.84E-05
0.01736	5.38E-07	6.24E-05	4.19E-06	-5.92E-05	1.05E-06	6.82E-05	4.90E-06	-6.86E-05
0.01798	6.01E-07	6.27E-05	4.45E-06	-5.90E-05	1.56E-06	6.83E-05	4.67E-06	-6.84E-05
0.0186	8.40E-07	6.21E-05	4.36E-06	-5.88E-05	1.17E-06	6.84E-05	4.21E-06	-6.83E-05
0.01922	6.25E-07	6.24E-05	4.38E-06	-5.90E-05	1.35E-06	6.86E-05	4.51E-06	-6.80E-05
0.01984	6.17E-07	6.24E-05	4.45E-06	-5.89E-05	1.26E-06	6.84E-05	4.20E-06	-6.81E-05
0.02046	3.55E-07	6.19E-05	4.29E-06	-5.91E-05	1.31E-06	6.80E-05	4.61E-06	-6.82E-05
0.02108	4.84E-07	6.25E-05	4.18E-06	-5.93E-05	1.40E-06	6.84E-05	4.35E-06	-6.85E-05
0.0217	6.01E-07	6.20E-05	4.28E-06	-5.94E-05	1.10E-06	6.81E-05	4.83E-06	-6.86E-05
0.02232	3.53E-07	6.25E-05	4.47E-06	-5.90E-05	1.20E-06	6.81E-05	4.46E-06	-6.83E-05
0.02294	2.25E-07	6.23E-05	4.45E-06	-5.90E-05	1.31E-06	6.86E-05	4.64E-06	-6.82E-05
0.02356	4.19E-07	6.21E-05	3.96E-06	-5.89E-05	1.66E-06	6.84E-05	4.32E-06	-6.79E-05
0.02418	3.69E-07	6.18E-05	4.28E-06	-5.92E-05	1.56E-06	6.79E-05	3.87E-06	-6.79E-05
0.0248	2.19E-07	6.17E-05	4.18E-06	-5.94E-05	1.12E-06	6.80E-05	4.74E-06	-6.83E-05
0.02542	5.24E-07	6.20E-05	3.97E-06	-5.90E-05	1.34E-06	6.84E-05	4.43E-06	-6.82E-05
0.02604	5.14E-07	6.23E-05	4.36E-06	-5.94E-05	1.12E-06	6.78E-05	4.39E-06	-6.84E-05
0.02666	2.80E-07	6.24E-05	4.28E-06	-5.88E-05	1.33E-06	6.85E-05	4.61E-06	-6.82E-05
0.02728	3.83E-07	6.22E-05	4.04E-06	-5.91E-05	1.27E-06	6.78E-05	4.49E-06	-6.84E-05
0.0279	7.64E-07	6.22E-05	4.28E-06	-5.92E-05	1.40E-06	6.80E-05	4.27E-06	-6.79E-05
0.02852	8.96E-07	6.19E-05	4.59E-06	-5.90E-05	1.46E-06	6.81E-05	3.75E-06	-6.82E-05
0.02914	6.45E-07	6.21E-05	4.74E-06	-5.92E-05	1.68E-06	6.83E-05	4.65E-06	-6.80E-05
0.02976	5.26E-07	6.18E-05	4.18E-06	-5.92E-05	1.55E-06	6.82E-05	4.52E-06	-6.85E-05
0.03038	5.35E-07	6.28E-05	4.41E-06	-5.88E-05	1.74E-06	6.83E-05	4.07E-06	-6.84E-05
0.031	4.52E-07	6.25E-05	4.28E-06	-5.88E-05	9.33E-07	6.80E-05	4.55E-06	-6.81E-05
0.03162	6.94E-07	6.22E-05	4.42E-06	-5.84E-05	1.58E-06	6.80E-05	4.33E-06	-6.85E-05
0.03224	9.21E-07	6.23E-05	4.33E-06	-5.88E-05	1.67E-06	6.81E-05	4.53E-06	-6.84E-05
0.03286	4.15E-07	6.21E-05	4.27E-06	-5.94E-05	1.56E-06	6.80E-05	4.36E-06	-6.79E-05
0.03348	5.68E-07	6.21E-05	4.68E-06	-5.92E-05	1.63E-06	6.86E-05	4.66E-06	-6.83E-05
0.0341	3.12E-07	6.20E-05	4.41E-06	-5.92E-05	1.11E-06	6.82E-05	4.37E-06	-6.82E-05
0.03472	3.42E-07	6.25E-05	4.22E-06	-5.89E-05	1.23E-06	6.84E-05	4.71E-06	-6.80E-05
0.03534	4.89E-07	6.22E-05	4.60E-06	-5.92E-05	1.08E-06	6.80E-05	4.30E-06	-6.80E-05
0.03596	5.47E-07	6.26E-05	4.83E-06	-5.92E-05	1.23E-06	6.85E-05	4.77E-06	-6.80E-05
0.03658	5.04E-07	6.20E-05	4.94E-06	-5.91E-05	1.25E-06	6.80E-05	4.77E-06	-6.82E-05
0.0372	2.98E-07	6.23E-05	4.35E-06	-5.92E-05	1.16E-06	6.77E-05	4.03E-06	-6.81E-05
0.03782	5.38E-07	6.24E-05	4.78E-06	-5.92E-05	1.61E-06	6.81E-05	4.27E-06	-6.81E-05
0.03844	4.29E-08	6.23E-05	4.54E-06	-5.96E-05	1.30E-06	6.82E-05	4.61E-06	-6.86E-05
0.03906	7.48E-07	6.20E-05	4.12E-06	-5.92E-05	1.69E-06	6.79E-05	3.86E-06	-6.81E-05
0.03968	5.84E-07	6.19E-05	3.94E-06	-5.90E-05	1.46E-06	6.82E-05	4.56E-06	-6.82E-05
0.0403	8.18E-07	6.18E-05	4.20E-06	-5.92E-05	1.64E-06	6.82E-05	4.50E-06	-6.77E-05
0.04092	4.48E-07	6.24E-05	4.23E-06	-5.91E-05	9.51E-07	6.81E-05	4.39E-06	-6.83E-05
0.04154	4.36E-07	6.21E-05	3.93E-06	-5.92E-05	1.32E-06	6.76E-05	4.55E-06	-6.92E-05
0.04216	6.80E-07	6.22E-05	4.56E-06	-5.89E-05	1.31E-06	6.83E-05	4.50E-06	-6.80E-05
0.04278	4.51E-07	6.22E-05	4.07E-06	-5.93E-05	1.69E-06	6.82E-05	4.15E-06	-6.88E-05
0.0434	1.03E-06	6.23E-05	4.58E-06	-5.90E-05	1.64E-06	6.83E-05	4.41E-06	-6.80E-05
0.04402	2.37E-07	6.24E-05	4.15E-06	-5.92E-05	1.79E-06	6.83E-05	4.62E-06	-6.80E-05
0.04464	6.70E-07	6.21E-05	4.25E-06	-5.87E-05	1.77E-06	6.85E-05	4.05E-06	-6.82E-05
0.04526	2.39E-07	6.24E-05	4.40E-06	-5.88E-05	1.43E-06	6.80E-05	3.81E-06	-6.84E-05
0.04588	5.99E-07	6.23E-05	4.25E-06	-5.93E-05	1.53E-06	6.82E-05	4.65E-06	-6.83E-05
0.0465	4.62E-07	6.22E-05	4.46E-06	-5.93E-05	1.20E-06	6.80E-05	4.98E-06	-6.80E-05
0.04712	7.37E-07	6.22E-05	3.87E-06	-5.90E-05	1.65E-06	6.82E-05	4.23E-06	-6.81E-05
0.04774	6.09E-07	6.20E-05	4.14E-06	-5.85E-05	1.40E-06	6.80E-05	4.45E-06	-6.83E-05
0.04836	5.15E-07	6.23E-05	3.93E-06	-5.92E-05	1.64E-06	6.82E-05	4.71E-06	-6.83E-05
0.04898	4.33E-07	6.23E-05	4.37E-06	-5.94E-05	1.36E-06	6.82E-05	4.15E-06	-6.80E-05
0.0496	5.35E-07	6.24E-05	4.22E-06	-5.90E-05	1.12E-06	6.81E-05	4.36E-06	-6.88E-05
0.05022	3.73E-07	6.27E-05	4.22E-06	-5.94E-05	1.41E-06	6.83E-05	4.35E-06	-6.78E-05
0.05084	2.45E-07	6.20E-05	4.38E-06	-5.87E-05	1.38E-06	6.78E-05	4.27E-06	-6.83E-05
0.05146	4.86E-08	6.25E-05	4.71E-06	-5.92E-05	1.30E-06	6.89E-05	4.23E-06	-6.82E-05
0.05208	4.11E-07	6.22E-05	4.15E-06	-5.96E-05	1.68E-06	6.84E-05	4.45E-06	-6.82E-05
0.0527	5.58E-07	6.19E-05	4.09E-06	-5.94E-05	1.60E-06	6.83E-05	4.66E-06	-6.85E-05
0.05332	6.50E-07	6.19E-05	4.42E-06	-5.88E-05	1.19E-06	6.82E-05	4.16E-06	-6.86E-05
0.05394	6.35E-07	6.19E-05	4.27E-06	-5.90E-05	1.23E-06	6.80E-05	3.94E-06	-6.80E-05
0.05456	5.21E-07	6.27E-05	4.15E-06	-5.93E-05	1.70E-06	6.82E-05	4.35E-06	-6.85E-05
0.05518	8.26E-07	6.19E-05	4.58E-06	-5.90E-05	1.22E-06	6.82E-05	5.14E-06	-6.86E-05
0.0558	7.22E-07	6.21E-05	3.95E-06	-5.89E-05	1.69E-06	6.81E-05	4.02E-06	-6.84E-05
0.05642	8.36E-07	6.17E-05	4.33E-06	-5.95E-05	1.12E-06	6.81E-05	4.43E-06	-6.82E-05
0.05704	2.98E-07	6.18E-05	4.45E-06	-5.91E-05	1.58E-06	6.81E-05	4.54E-06	-6.78E-05
0.05766	9.81E-07	6.22E-05	3.83E-06	-5.88E-05	1.32E-06	6.80E-05	3.99E-06	-6.80E-05
0.05828	5.84E-07	6.24E-05	5.02E-06	-5.83E-05	1.32E-06	6.85E-05	4.48E-06	-6.85E-05
0.0589	4.39E-07	6.23E-05	4.45E-06	-5.95E-05	1.47E-06	6.81E-05	4.39E-06	-6.81E-05
0.05952	3.72E-07	6.24E-05	3.96E-06	-5.90E-05	1.50E-06	6.80E-05	4.52E-06	-6.83E-05
0.06014	6.04E-07	6.23E-05	4.74E-06	-5.95E-05	1.90E-06	6.82E-05	4.43E-06	-6.78E-05
0.06076	4.05E-07	6.23E-05	4.53E-06	-5.86E-05	1.52E-06	6.79E-05	4.51E-06	-6.82E-05
0.06138	4.43E-08	6.24E-05	4.10E-06	-5.89E-05	1.35E-06	6.77E-05	4.66E-06	-6.75E-05
	5.07069E-07	6.22E-05	4.3164E-06	-5.91E-05	1.46E-06	6.82E-05	4.39E-06	-6.82E-05

APPENDIX C

	Load at Beam 21 with 380 kg				Load at Beam 21 with 500 kg			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	-3.85E-05	-2.19E-05	3.42E-05	-1.21E-05	-5.05E-05	1.26E-05	4.86E-05	-5.25E-06
0.00062	-3.87E-05	-2.17E-05	3.50E-05	-1.26E-05	-5.13E-05	1.31E-05	4.94E-05	-4.82E-06
0.00124	-3.82E-05	-2.18E-05	3.48E-05	-1.24E-05	-5.08E-05	1.37E-05	4.86E-05	-5.68E-06
0.00186	-3.82E-05	-2.21E-05	3.44E-05	-1.23E-05	-5.09E-05	1.30E-05	4.92E-05	-5.55E-06
0.00248	-3.86E-05	-2.15E-05	3.48E-05	-1.29E-05	-5.13E-05	1.31E-05	4.85E-05	-5.80E-06
0.0031	-3.86E-05	-2.17E-05	3.53E-05	-1.26E-05	-5.05E-05	1.30E-05	4.92E-05	-5.33E-06
0.00372	-3.87E-05	-2.22E-05	3.50E-05	-1.21E-05	-5.12E-05	1.27E-05	4.86E-05	-5.19E-06
0.00434	-3.82E-05	-2.19E-05	3.53E-05	-1.24E-05	-5.09E-05	1.29E-05	4.87E-05	-5.80E-06
0.00496	-3.82E-05	-2.20E-05	3.47E-05	-1.26E-05	-5.10E-05	1.30E-05	4.86E-05	-5.49E-06
0.00558	-3.87E-05	-2.20E-05	3.47E-05	-1.19E-05	-5.10E-05	1.32E-05	4.85E-05	-6.11E-06
0.0062	-3.85E-05	-2.16E-05	3.51E-05	-1.26E-05	-5.11E-05	1.31E-05	4.91E-05	-5.72E-06
0.00682	-3.84E-05	-2.13E-05	3.47E-05	-1.25E-05	-5.14E-05	1.29E-05	4.86E-05	-5.51E-06
0.00744	-3.84E-05	-2.24E-05	3.45E-05	-1.19E-05	-5.07E-05	1.29E-05	4.95E-05	-5.26E-06
0.00806	-3.86E-05	-2.20E-05	3.47E-05	-1.23E-05	-5.09E-05	1.32E-05	4.88E-05	-5.29E-06
0.00868	-3.84E-05	-2.20E-05	3.52E-05	-1.24E-05	-5.09E-05	1.30E-05	4.91E-05	-5.53E-06
0.0093	-3.81E-05	-2.21E-05	3.46E-05	-1.23E-05	-5.09E-05	1.36E-05	4.90E-05	-5.51E-06
0.00992	-3.86E-05	-2.23E-05	3.48E-05	-1.21E-05	-5.07E-05	1.31E-05	4.84E-05	-5.65E-06
0.01054	-3.87E-05	-2.13E-05	3.48E-05	-1.22E-05	-5.12E-05	1.33E-05	4.90E-05	-5.38E-06
0.01116	-3.86E-05	-2.20E-05	3.46E-05	-1.24E-05	-5.08E-05	1.29E-05	4.91E-05	-5.28E-06
0.01178	-3.85E-05	-2.19E-05	3.49E-05	-1.25E-05	-5.12E-05	1.37E-05	4.87E-05	-5.25E-06
0.0124	-3.82E-05	-2.18E-05	3.50E-05	-1.22E-05	-5.08E-05	1.31E-05	4.88E-05	-5.49E-06
0.01302	-3.87E-05	-2.16E-05	3.43E-05	-1.22E-05	-5.09E-05	1.33E-05	4.89E-05	-5.30E-06
0.01364	-3.85E-05	-2.21E-05	3.41E-05	-1.18E-05	-5.08E-05	1.37E-05	4.92E-05	-5.50E-06
0.01426	-3.84E-05	-2.19E-05	3.46E-05	-1.26E-05	-5.11E-05	1.27E-05	4.86E-05	-5.94E-06
0.01488	-3.83E-05	-2.19E-05	3.48E-05	-1.24E-05	-5.14E-05	1.28E-05	4.89E-05	-5.49E-06
0.0155	-3.87E-05	-2.22E-05	3.44E-05	-1.24E-05	-5.11E-05	1.33E-05	4.85E-05	-5.50E-06
0.01612	-3.84E-05	-2.20E-05	3.50E-05	-1.26E-05	-5.10E-05	1.34E-05	4.90E-05	-5.18E-06
0.01674	-3.85E-05	-2.20E-05	3.42E-05	-1.25E-05	-5.08E-05	1.32E-05	4.91E-05	-5.19E-06
0.01736	-3.83E-05	-2.18E-05	3.44E-05	-1.23E-05	-5.07E-05	1.28E-05	4.84E-05	-5.31E-06
0.01798	-3.87E-05	-2.18E-05	3.50E-05	-1.27E-05	-5.08E-05	1.33E-05	4.88E-05	-5.24E-06
0.0186	-3.80E-05	-2.20E-05	3.45E-05	-1.22E-05	-5.06E-05	1.30E-05	4.89E-05	-4.96E-06
0.01922	-3.85E-05	-2.17E-05	3.53E-05	-1.26E-05	-5.07E-05	1.32E-05	4.86E-05	-6.21E-06
0.01984	-3.89E-05	-2.14E-05	3.47E-05	-1.24E-05	-5.08E-05	1.31E-05	4.87E-05	-4.79E-06
0.02046	-3.83E-05	-2.22E-05	3.44E-05	-1.23E-05	-5.13E-05	1.33E-05	4.93E-05	-5.60E-06
0.02108	-3.82E-05	-2.18E-05	3.45E-05	-1.24E-05	-5.09E-05	1.33E-05	4.93E-05	-5.34E-06
0.0217	-3.82E-05	-2.14E-05	3.48E-05	-1.22E-05	-5.07E-05	1.31E-05	4.86E-05	-5.84E-06
0.02232	-3.85E-05	-2.18E-05	3.44E-05	-1.24E-05	-5.08E-05	1.32E-05	4.88E-05	-5.68E-06
0.02294	-3.83E-05	-2.23E-05	3.52E-05	-1.22E-05	-5.07E-05	1.28E-05	4.88E-05	-5.21E-06
0.02356	-3.82E-05	-2.23E-05	3.49E-05	-1.20E-05	-5.02E-05	1.33E-05	4.91E-05	-5.58E-06
0.02418	-3.86E-05	-2.19E-05	3.45E-05	-1.19E-05	-5.09E-05	1.33E-05	4.90E-05	-4.95E-06
0.0248	-3.82E-05	-2.20E-05	3.45E-05	-1.23E-05	-5.08E-05	1.33E-05	4.87E-05	-5.76E-06
0.02542	-3.82E-05	-2.21E-05	3.56E-05	-1.20E-05	-5.09E-05	1.31E-05	4.87E-05	-5.62E-06
0.02604	-3.85E-05	-2.20E-05	3.43E-05	-1.23E-05	-5.06E-05	1.31E-05	4.89E-05	-6.15E-06
0.02666	-3.82E-05	-2.21E-05	3.47E-05	-1.19E-05	-5.05E-05	1.33E-05	4.88E-05	-5.06E-06
0.02728	-3.86E-05	-2.19E-05	3.45E-05	-1.18E-05	-5.13E-05	1.28E-05	4.85E-05	-5.20E-06
0.0279	-3.82E-05	-2.18E-05	3.46E-05	-1.21E-05	-5.10E-05	1.32E-05	4.95E-05	-5.34E-06
0.02852	-3.83E-05	-2.22E-05	3.48E-05	-1.22E-05	-5.11E-05	1.35E-05	4.96E-05	-5.48E-06
0.02914	-3.86E-05	-2.21E-05	3.48E-05	-1.25E-05	-5.11E-05	1.30E-05	4.91E-05	-5.39E-06
0.02976	-3.79E-05	-2.19E-05	3.45E-05	-1.22E-05	-5.07E-05	1.30E-05	4.92E-05	-5.15E-06
0.03038	-3.90E-05	-2.19E-05	3.44E-05	-1.26E-05	-5.16E-05	1.33E-05	4.88E-05	-5.83E-06
0.031	-3.84E-05	-2.23E-05	3.45E-05	-1.16E-05	-5.07E-05	1.32E-05	4.90E-05	-5.89E-06
0.03162	-3.84E-05	-2.23E-05	3.48E-05	-1.23E-05	-5.07E-05	1.35E-05	4.89E-05	-5.54E-06
0.03224	-3.84E-05	-2.19E-05	3.50E-05	-1.21E-05	-5.13E-05	1.32E-05	4.90E-05	-5.38E-06
0.03286	-3.85E-05	-2.21E-05	3.51E-05	-1.23E-05	-5.09E-05	1.29E-05	4.91E-05	-5.67E-06
0.03348	-3.81E-05	-2.23E-05	3.42E-05	-1.23E-05	-5.06E-05	1.27E-05	4.88E-05	-5.18E-06
0.0341	-3.80E-05	-2.22E-05	3.49E-05	-1.22E-05	-5.09E-05	1.30E-05	4.96E-05	-5.76E-06
0.03472	-3.81E-05	-2.19E-05	3.46E-05	-1.24E-05	-5.06E-05	1.28E-05	4.86E-05	-5.55E-06
0.03534	-3.82E-05	-2.18E-05	3.46E-05	-1.23E-05	-5.12E-05	1.30E-05	4.91E-05	-5.04E-06
0.03596	-3.86E-05	-2.19E-05	3.47E-05	-1.21E-05	-5.06E-05	1.32E-05	4.93E-05	-5.74E-06
0.03658	-3.83E-05	-2.16E-05	3.48E-05	-1.19E-05	-5.09E-05	1.28E-05	4.89E-05	-5.22E-06
0.0372	-3.85E-05	-2.18E-05	3.51E-05	-1.23E-05	-5.10E-05	1.28E-05	4.89E-05	-5.71E-06
0.03782	-3.85E-05	-2.21E-05	3.53E-05	-1.21E-05	-5.09E-05	1.35E-05	4.92E-05	-5.58E-06
0.03844	-3.82E-05	-2.20E-05	3.49E-05	-1.23E-05	-5.08E-05	1.33E-05	4.91E-05	-5.24E-06
0.03906	-3.82E-05	-2.17E-05	3.45E-05	-1.23E-05	-5.12E-05	1.35E-05	4.92E-05	-5.40E-06
0.03968	-3.86E-05	-2.27E-05	3.48E-05	-1.23E-05	-5.07E-05	1.23E-05	4.96E-05	-6.02E-06
0.0403	-3.81E-05	-2.20E-05	3.45E-05	-1.22E-05	-5.09E-05	1.32E-05	4.89E-05	-5.17E-06
0.04092	-3.84E-05	-2.22E-05	3.49E-05	-1.24E-05	-5.10E-05	1.32E-05	4.90E-05	-5.22E-06
0.04154	-3.82E-05	-2.17E-05	3.47E-05	-1.18E-05	-5.07E-05	1.33E-05	4.88E-05	-5.49E-06
0.04216	-3.81E-05	-2.18E-05	3.43E-05	-1.21E-05	-5.11E-05	1.33E-05	4.88E-05	-5.95E-06
0.04278	-3.81E-05	-2.18E-05	3.51E-05	-1.21E-05	-5.13E-05	1.27E-05	4.90E-05	-5.46E-06
0.0434	-3.88E-05	-2.16E-05	3.52E-05	-1.25E-05	-5.12E-05	1.28E-05	4.88E-05	-5.51E-06
0.04402	-3.85E-05	-2.20E-05	3.50E-05	-1.24E-05	-5.08E-05	1.26E-05	4.87E-05	-5.26E-06
0.04464	-3.85E-05	-2.19E-05	3.46E-05	-1.26E-05	-5.08E-05	1.33E-05	4.92E-05	-4.85E-06
0.04526	-3.85E-05	-2.21E-05	3.47E-05	-1.20E-05	-5.09E-05	1.30E-05	4.92E-05	-5.65E-06
0.04588	-3.82E-05	-2.23E-05	3.44E-05	-1.19E-05	-5.10E-05	1.29E-05	4.94E-05	-5.61E-06
0.0465	-3.83E-05	-2.14E-05	3.49E-05	-1.23E-05	-5.11E-05	1.34E-05	4.90E-05	-5.16E-06
0.04712	-3.84E-05	-2.20E-05	3.42E-05	-1.25E-05	-5.11E-05	1.35E-05	4.92E-05	-5.13E-06
0.04774	-3.85E-05	-2.22E-05	3.47E-05	-1.23E-05	-5.05E-05	1.30E-05	4.89E-05	-5.97E-06
0.04836	-3.85E-05	-2.19E-05	3.44E-05	-1.25E-05	-5.08E-05	1.35E-05	4.91E-05	-5.47E-06
0.04898	-3.83E-05	-2.21E-05	3.44E-05	-1.26E-05	-5.10E-05	1.32E-05	4.91E-05	-5.09E-06
0.0496	-3.82E-05	-2.21E-05	3.49E-05	-1.21E-05	-5.10E-05	1.34E-05	4 94E-05	-5.46E-06
0.05022	-3.79E-05	-2.17E-05	3.45E-05	-1.25E-05	-5.10E-05	1.30E-05	4.87E-05	-5.26E-06
0.05084	-3.85E-05	-2.20E-05	3.44E-05	-1.20E-05	-5.11E-05	1.32E-05	4.91E-05	-5.78E-06
0.05146	-3.81E-05	-2.18E-05	3.49E-05	-1.25E-05	-5.09E-05	1.26E-05	4.94E-05	-5.78E-06
0.05208	-3.81E-05	-2.17E-05	3.49E-05	-1.20E-05	-5.10E-05	1.31E-05	4.91E-05	-5.57E-06
0.0527	-3.83E-05	-2.19E-05	3.47E-05	-1.22E-05	-5.09E-05	1.33E-05	4.94E-05	-5.16E-06
0.05332	-3.85E-05	-2.14E-05	3.46E-05	-1.24E-05	-5.10E-05	1.31E-05	4.93E-05	-5.35E-06
0.05394	-3.82E-05	-2.23E-05	3.52E-05	-1.25E-05	-5.08E-05	1.37E-05	4.94E-05	-5.34E-06
0.05456	-3.81E-05	-2.21E-05	3.54E-05	-1.26E-05	-5.04E-05	1.30E-05	4.88E-05	-5.34E-06
0.05518	-3.89E-05	-2.18E-05	3.48E-05	-1.22E-05	-5.08E-05	1.28E-05	4.91E-05	-4.94E-06
0.0558	-3.79E-05	-2.17E-05	3.46E-05	-1.24E-05	-5.08E-05	1.29E-05	4.91E-05	-5.23E-06
0.05642	-3.80E-05	-2.15E-05	3.52E-05	-1.19E-05	-5.15E-05	1.26E-05	4.91E-05	-5.79E-06
0.05704	-3.82E-05	-2.16E-05	3.42E-05	-1.22E-05	-5.08E-05	1.32E-05	4.88E-05	-5.84E-06
0.05766	-3.88E-05	-2.18E-05	3.49E-05	-1.21E-05	-5.09E-05	1.32E-05	4.87E-05	-5.98E-06
0.05828	-3.84E-05	-2.19E-05	3.47E-05	-1.22E-05	-5.12E-05	1.33E-05	4.90E-05	-5.84E-06
0.0589	-3.85E-05	-2.17E-05	3.47E-05	-1.22E-05	-5.07E-05	1.33E-05	4.91E-05	-5.28E-06
0.05952	-3.84E-05	-2.16E-05	3.44E-05	-1.22E-05	-5.07E-05	1.32E-05	4.91E-05	-5.66E-06
0.06014	-3.79E-05	-2.21E-05	3.52E-05	-1.23E-05	-5.08E-05	1.33E-05	4.89E-05	-5.62E-06
0.06076	-3.86E-05	-2.19E-05	3.43E-05	-1.19E-05	-5.07E-05	1.33E-05	4.89E-05	-5.44E-06
0.06138	-3.82E-05	-2.24E-05	3.50E-05	-1.24E-05	-5.10E-05	1.33E-05	4.89E-05	-5.24E-06
	-3.84E-05	-2.19E-05	3.47E-05	-1.23E-05	-5.09E-05	1.31E-05	4.90E-05	-5.46E-06

APPENDIX C

	Load at Beam 21 with 600 kg				Load at Beam 21 with 700 kg			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	-6.12E-05	1.15E-05	6.08E-05	-3.25E-05	-7.02E-05	1.02E-05	6.96E-05	-1.89E-05
0.00062	-6.04E-05	1.17E-05	6.04E-05	-3.36E-05	-7.03E-05	1.01E-05	6.99E-05	-1.89E-05
0.00124	-6.11E-05	1.14E-05	6.06E-05	-3.31E-05	-7.04E-05	9.98E-06	7.02E-05	-1.89E-05
0.00186	-6.08E-05	1.21E-05	6.07E-05	-3.37E-05	-7.04E-05	1.02E-05	6.97E-05	-1.92E-05
0.00248	-6.04E-05	1.17E-05	6.04E-05	-3.32E-05	-7.05E-05	1.04E-05	7.00E-05	-1.90E-05
0.0031	-6.06E-05	1.16E-05	6.05E-05	-3.41E-05	-7.08E-05	1.04E-05	7.01E-05	-1.91E-05
0.00372	-6.04E-05	1.17E-05	6.08E-05	-3.35E-05	-7.02E-05	1.01E-05	7.01E-05	-1.93E-05
0.00434	-6.09E-05	1.19E-05	6.08E-05	-3.37E-05	-7.06E-05	1.02E-05	6.97E-05	-1.92E-05
0.00496	-6.07E-05	1.17E-05	6.06E-05	-3.34E-05	-7.03E-05	1.01E-05	7.01E-05	-1.94E-05
0.00558	-6.03E-05	1.14E-05	6.05E-05	-3.31E-05	-7.06E-05	1.05E-05	6.98E-05	-1.91E-05
0.0062	-6.06E-05	1.15E-05	6.07E-05	-3.38E-05	-7.01E-05	1.05E-05	6.97E-05	-1.90E-05
0.00682	-6.09E-05	1.25E-05	6.04E-05	-3.34E-05	-7.03E-05	1.06E-05	7.01E-05	-1.90E-05
0.00744	-6.06E-05	1.21E-05	6.10E-05	-3.33E-05	-7.04E-05	1.05E-05	6.94E-05	-1.84E-05
0.00806	-6.03E-05	1.15E-05	6.05E-05	-3.34E-05	-7.04E-05	1.01E-05	6.98E-05	-1.89E-05
0.00868	-6.08E-05	1.11E-05	6.06E-05	-3.35E-05	-7.06E-05	1.01E-05	6.97E-05	-1.87E-05
0.0093	-6.05E-05	1.19E-05	6.01E-05	-3.34E-05	-7.01E-05	1.03E-05	6.98E-05	-1.87E-05
0.00992	-6.08E-05	1.14E-05	6.06E-05	-3.35E-05	-7.05E-05	9.93E-06	6.97E-05	-1.89E-05
0.01054	-6.09E-05	1.18E-05	6.06E-05	-3.36E-05	-7.05E-05	9.95E-06	6.99E-05	-1.85E-05
0.01116	-6.04E-05	1.19E-05	6.03E-05	-3.33E-05	-7.07E-05	1.00E-05	6.98E-05	-1.88E-05
0.01178	-6.10E-05	1.13E-05	6.07E-05	-3.36E-05	-7.04E-05	1.00E-05	6.97E-05	-1.86E-05
0.0124	-6.08E-05	1.19E-05	6.05E-05	-3.34E-05	-7.01E-05	1.00E-05	6.98E-05	-1.95E-05
0.01302	-6.09E-05	1.17E-05	6.01E-05	-3.36E-05	-7.08E-05	1.04E-05	6.96E-05	-1.89E-05
0.01364	-6.03E-05	1.19E-05	6.01E-05	-3.39E-05	-7.08E-05	1.01E-05	6.99E-05	-1.91E-05
0.01426	-6.03E-05	1.19E-05	6.08E-05	-3.32E-05	-7.03E-05	1.01E-05	6.93E-05	-1.90E-05
0.01488	-6.08E-05	1.19E-05	6.07E-05	-3.31E-05	-7.07E-05	9.87E-06	6.99E-05	-1.83E-05
0.0155	-6.10E-05	1.18E-05	6.10E-05	-3.35E-05	-7.04E-05	1.05E-05	6.95E-05	-1.90E-05
0.01612	-6.09E-05	1.19E-05	6.09E-05	-3.36E-05	-7.03E-05	1.03E-05	7.06E-05	-1.87E-05
0.01674	-6.09E-05	1.13E-05	6.08E-05	-3.34E-05	-7.07E-05	1.03E-05	6.96E-05	-1.87E-05
0.01736	-6.07E-05	1.17E-05	6.06E-05	-3.37E-05	-7.05E-05	1.02E-05	7.00E-05	-1.87E-05
0.01798	-6.10E-05	1.18E-05	6.10E-05	-3.34E-05	-7.06E-05	1.01E-05	6.95E-05	-1.87E-05
0.0186	-6.08E-05	1.18E-05	6.05E-05	-3.37E-05	-7.05E-05	1.04E-05	7.04E-05	-1.88E-05
0.01922	-6.07E-05	1.18E-05	6.06E-05	-3.30E-05	-7.06E-05	9.89E-06	6.90E-05	-1.90E-05
0.01984	-6.08E-05	1.12E-05	6.05E-05	-3.34E-05	-7.02E-05	1.08E-05	6.98E-05	-1.91E-05
0.02046	-6.06E-05	1.21E-05	6.07E-05	-3.34E-05	-7.04E-05	1.03E-05	7.00E-05	-1.93E-05
0.02108	-6.05E-05	1.15E-05	6.00E-05	-3.34E-05	-7.05E-05	1.01E-05	6.91E-05	-1.88E-05
0.0217	-6.07E-05	1.15E-05	6.08E-05	-3.37E-05	-7.03E-05	1.02E-05	6.96E-05	-1.89E-05
0.02232	-6.08E-05	1.15E-05	6.01E-05	-3.39E-05	-7.01E-05	1.01E-05	6.98E-05	-1.91E-05
0.02294	-6.12E-05	1.16E-05	6.02E-05	-3.41E-05	-7.09E-05	1.02E-05	6.98E-05	-1.90E-05
0.02356	-6.10E-05	1.18E-05	6.10E-05	-3.37E-05	-7.06E-05	1.02E-05	6.95E-05	-1.86E-05
0.02418	-6.07E-05	1.19E-05	6.05E-05	-3.34E-05	-7.08E-05	1.05E-05	7.00E-05	-1.90E-05
0.0248	-6.03E-05	1.20E-05	6.04E-05	-3.34E-05	-7.08E-05	9.94E-06	6.99E-05	-1.86E-05
0.02542	-6.06E-05	1.14E-05	6.02E-05	-3.35E-05	-7.05E-05	1.02E-05	6.97E-05	-1.87E-05
0.02604	-6.06E-05	1.19E-05	6.04E-05	-3.30E-05	-7.07E-05	1.01E-05	6.99E-05	-1.89E-05
0.02666	-6.07E-05	1.18E-05	6.03E-05	-3.36E-05	-7.04E-05	9.94E-06	6.95E-05	-1.88E-05
0.02728	-6.07E-05	1.14E-05	6.05E-05	-3.39E-05	-7.03E-05	1.01E-05	6.96E-05	-1.86E-05
0.0279	-6.06E-05	1.15E-05	6.04E-05	-3.30E-05	-7.05E-05	1.01E-05	7.02E-05	-1.93E-05
0.02852	-6.10E-05	1.13E-05	6.03E-05	-3.35E-05	-7.05E-05	9.98E-06	6.98E-05	-1.87E-05
0.02914	-6.07E-05	1.19E-05	6.09E-05	-3.35E-05	-7.05E-05	1.04E-05	7.03E-05	-1.90E-05
0.02976	-6.08E-05	1.16E-05	6.02E-05	-3.38E-05	-7.04E-05	1.01E-05	6.98E-05	-1.90E-05
0.03038	-6.09E-05	1.15E-05	6.05E-05	-3.34E-05	-7.03E-05	1.03E-05	6.97E-05	-1.86E-05
0.031	-6.10E-05	1.19E-05	6.04E-05	-3.39E-05	-7.04E-05	1.04E-05	6.95E-05	-1.91E-05
0.03162	-6.06E-05	1.20E-05	6.09E-05	-3.30E-05	-7.05E-05	1.04E-05	6.97E-05	-1.90E-05
0.03224	-6.06E-05	1.21E-05	6.04E-05	-3.35E-05	-7.02E-05	1.06E-05	7.00E-05	-1.87E-05
0.03286	-6.10E-05	1.16E-05	6.05E-05	-3.35E-05	-7.04E-05	1.03E-05	7.00E-05	-1.89E-05
0.03348	-6.08E-05	1.16E-05	6.09E-05	-3.38E-05	-7.04E-05	1.00E-05	6.97E-05	-1.87E-05
0.0341	-6.08E-05	1.19E-05	6.02E-05	-3.35E-05	-7.04E-05	1.05E-05	7.04E-05	-1.91E-05
0.03472	-6.12E-05	1.16E-05	6.05E-05	-3.32E-05	-7.04E-05	1.04E-05	7.02E-05	-1.87E-05
0.03534	-6.07E-05	1.10E-05	6.07E-05	-3.34E-05	-7.08E-05	9.67E-06	6.98E-05	-1.91E-05
0.03596	-6.04E-05	1.24E-05	6.07E-05	-3.36E-05	-7.04E-05	1.02E-05	6.99E-05	-1.84E-05
0.03658	-6.04E-05	1.19E-05	6.06E-05	-3.30E-05	-7.04E-05	9.90E-06	7.01E-05	-1.92E-05
0.0372	-6.10E-05	1.16E-05	6.04E-05	-3.41E-05	-7.03E-05	1.05E-05	6.98E-05	-1.92E-05
0.03782	-6.06E-05	1.17E-05	6.07E-05	-3.36E-05	-7.03E-05	9.77E-06	7.03E-05	-1.89E-05
0.03844	-6.06E-05	1.14E-05	6.06E-05	-3.35E-05	-7.07E-05	1.02E-05	6.96E-05	-1.87E-05
0.03906	-6.06E-05	1.17E-05	6.07E-05	-3.32E-05	-7.04E-05	1.02E-05	6.96E-05	-1.88E-05
0.03968	-6.05E-05	1.19E-05	6.04E-05	-3.35E-05	-7.06E-05	1.05E-05	6.96E-05	-1.89E-05
0.0403	-6.09E-05	1.12E-05	6.07E-05	-3.34E-05	-7.01E-05	1.03E-05	6.97E-05	-1.87E-05
0.04092	-6.12E-05	1.17E-05	6.04E-05	-3.34E-05	-7.03E-05	1.08E-05	6.96E-05	-1.89E-05
0.04154	-6.07E-05	1.15E-05	6.06E-05	-3.35E-05	-7.05E-05	1.02E-05	6.99E-05	-1.89E-05
0.04216	-6.07E-05	1.18E-05	6.07E-05	-3.34E-05	-7.06E-05	1.01E-05	6.94E-05	-1.87E-05
0.04278	-6.10E-05	1.21E-05	6.07E-05	-3.37E-05	-7.05E-05	1.00E-05	6.97E-05	-1.91E-05
0.0434	-6.09E-05	1.17E-05	6.09E-05	-3.32E-05	-7.06E-05	1.03E-05	7.00E-05	-1.92E-05
0.04402	-6.06E-05	1.18E-05	6.09E-05	-3.38E-05	-7.04E-05	1.08E-05	6.97E-05	-1.88E-05
0.04464	-6.08E-05	1.17E-05	6.07E-05	-3.31E-05	-7.03E-05	1.04E-05	6.94E-05	-1.95E-05
0.04526	-6.08E-05	1.19E-05	6.09E-05	-3.37E-05	-7.06E-05	1.01E-05	6.99E-05	-1.87E-05
0.04588	-6.06E-05	1.18E-05	6.07E-05	-3.41E-05	-7.05E-05	1.01E-05	7.02E-05	-1.89E-05
0.0465	-6.06E-05	1.23E-05	6.10E-05	-3.33E-05	-7.06E-05	9.98E-06	7.00E-05	-1.86E-05
0.04712	-6.05E-05	1.17E-05	6.10E-05	-3.34E-05	-7.01E-05	9.81E-06	6.98E-05	-1.88E-05
0.04774	-6.06E-05	1.18E-05	6.05E-05	-3.36E-05	-7.05E-05	1.04E-05	6.97E-05	-1.87E-05
0.04836	-6.09E-05	1.18E-05	6.06E-05	-3.35E-05	-7.01E-05	1.02E-05	6.97E-05	-1.86E-05
0.04898	-6.08E-05	1.11E-05	6.07E-05	-3.37E-05	-7.03E-05	1.06E-05	6.93E-05	-1.91E-05
0.0496	-6.05E-05	1.16E-05	6.05E-05	-3.30E-05	-7.05E-05	1.00E-05	6.99E-05	-1.87E-05
0.05022	-6.05E-05	1.20E-05	6.12E-05	-3.29E-05	-7.07E-05	1.01E-05	6.95E-05	-1.85E-05
0.05084	-6.06E-05	1.18E-05	6.06E-05	-3.35E-05	-7.07E-05	1.01E-05	6.95E-05	-1.90E-05
0.05146	-6.04E-05	1.19E-05	6.04E-05	-3.34E-05	-7.07E-05	1.05E-05	6.98E-05	-1.86E-05
0.05208	-6.12E-05	1.16E-05	6.06E-05	-3.33E-05	-7.05E-05	1.05E-05	6.92E-05	-1.90E-05
0.0527	-6.09E-05	1.16E-05	6.13E-05	-3.37E-05	-7.03E-05	1.02E-05	7.00E-05	-1.87E-05
0.05332	-6.10E-05	1.14E-05	6.08E-05	-3.31E-05	-7.00E-05	1.03E-05	6.98E-05	-1.85E-05
0.05394	-6.09E-05	1.17E-05	6.02E-05	-3.36E-05	-7.05E-05	9.97E-06	7.03E-05	-1.84E-05
0.05456	-6.03E-05	1.18E-05	6.05E-05	-3.35E-05	-7.05E-05	1.05E-05	6.96E-05	-1.89E-05
0.05518	-6.13E-05	1.17E-05	6.08E-05	-3.34E-05	-7.02E-05	9.99E-06	6.96E-05	-1.94E-05
0.0558	-6.04E-05	1.17E-05	6.06E-05	-3.35E-05	-7.01E-05	1.01E-05	6.95E-05	-1.84E-05
0.05642	-6.13E-05	1.17E-05	6.03E-05	-3.33E-05	-7.08E-05	1.04E-05	6.96E-05	-1.89E-05
0.05704	-6.09E-05	1.16E-05	6.09E-05	-3.36E-05	-7.04E-05	1.08E-05	6.97E-05	-1.92E-05
0.05766	-6.04E-05	1.17E-05	6.13E-05	-3.34E-05	-7.08E-05	1.03E-05	7.04E-05	-1.88E-05
0.05828	-6.09E-05	1.15E-05	6.09E-05	-3.34E-05	-7.06E-05	1.01E-05	6.98E-05	-1.92E-05
0.0589	-6.01E-05	1.17E-05	6.09E-05	-3.37E-05	-7.06E-05	1.00E-05	6.95E-05	-1.88E-05
0.05952	-6.05E-05	1.23E-05	6.11E-05	-3.32E-05	-7.06E-05	1.03E-05	6.98E-05	-1.88E-05
0.06014	-6.11E-05	1.22E-05	6.03E-05	-3.33E-05	-7.06E-05	1.05E-05	7.00E-05	-1.90E-05
0.06076	-6.09E-05	1.15E-05	6.08E-05	-3.36E-05	-7.03E-05	9.67E-06	6.96E-05	-1.92E-05
0.06138	-6.08E-05	1.19E-05	6.05E-05	-3.38E-05	-7.08E-05	1.06E-05	6.95E-05	-1.88E-05
	-6.07E-05	1.17E-05	6.06E-05	-3.35E-05	-7.05E-05	1.02211E-05	6.97856E-05	-1.89E-05

APPENDIX C

	Load at Beam 21 with 380 kg (Decreasing Order)				Load at Beam 21 with 500 kg (Decreasing Order)			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	-3.85E-05	-2.19E-05	3.42E-05	-1.21E-05	-5.00E-05	1.22E-05	4.96E-05	-2.42E-05
0.00062	-3.87E-05	-2.17E-05	3.50E-05	-1.26E-05	-4.92E-05	1.21E-05	4.96E-05	-2.47E-05
0.00124	-3.82E-05	-2.18E-05	3.48E-05	-1.24E-05	-4.94E-05	1.19E-05	4.91E-05	-2.47E-05
0.00186	-3.82E-05	-2.21E-05	3.44E-05	-1.23E-05	-4.95E-05	1.17E-05	4.92E-05	-2.47E-05
0.00248	-3.86E-05	-2.15E-05	3.48E-05	-1.29E-05	-4.96E-05	1.21E-05	4.95E-05	-2.48E-05
0.0031	-3.86E-05	-2.17E-05	3.53E-05	-1.26E-05	-4.94E-05	1.23E-05	4.93E-05	-2.43E-05
0.00372	-3.87E-05	-2.22E-05	3.50E-05	-1.21E-05	-4.97E-05	1.21E-05	4.93E-05	-2.48E-05
0.00434	-3.82E-05	-2.19E-05	3.53E-05	-1.24E-05	-4.95E-05	1.20E-05	4.99E-05	-2.45E-05
0.00496	-3.82E-05	-2.20E-05	3.47E-05	-1.26E-05	-4.97E-05	1.20E-05	4.93E-05	-2.43E-05
0.00558	-3.87E-05	-2.20E-05	3.47E-05	-1.19E-05	-4.93E-05	1.24E-05	4.98E-05	-2.44E-05
0.0062	-3.85E-05	-2.16E-05	3.51E-05	-1.26E-05	-4.96E-05	1.21E-05	4.95E-05	-2.43E-05
0.00682	-3.84E-05	-2.13E-05	3.47E-05	-1.25E-05	-4.98E-05	1.24E-05	4.91E-05	-2.53E-05
0.00744	-3.84E-05	-2.24E-05	3.45E-05	-1.19E-05	-4.94E-05	1.21E-05	4.91E-05	-2.48E-05
0.00806	-3.86E-05	-2.20E-05	3.47E-05	-1.23E-05	-4.94E-05	1.25E-05	4.90E-05	-2.41E-05
0.00868	-3.84E-05	-2.20E-05	3.52E-05	-1.24E-05	-4.95E-05	1.20E-05	4.90E-05	-2.45E-05
0.0093	-3.81E-05	-2.21E-05	3.46E-05	-1.23E-05	-4.94E-05	1.15E-05	4.95E-05	-2.49E-05
0.00992	-3.86E-05	-2.23E-05	3.48E-05	-1.21E-05	-4.98E-05	1.21E-05	4.98E-05	-2.49E-05
0.01054	-3.87E-05	-2.13E-05	3.48E-05	-1.22E-05	-4.95E-05	1.21E-05	4.92E-05	-2.45E-05
0.01116	-3.86E-05	-2.20E-05	3.46E-05	-1.24E-05	-4.91E-05	1.24E-05	4.94E-05	-2.48E-05
0.01178	-3.85E-05	-2.19E-05	3.49E-05	-1.25E-05	-4.96E-05	1.22E-05	4.93E-05	-2.46E-05
0.0124	-3.82E-05	-2.18E-05	3.50E-05	-1.22E-05	-4.98E-05	1.20E-05	4.89E-05	-2.48E-05
0.01302	-3.87E-05	-2.16E-05	3.43E-05	-1.22E-05	-4.97E-05	1.19E-05	4.96E-05	-2.44E-05
0.01364	-3.85E-05	-2.21E-05	3.41E-05	-1.18E-05	-4.92E-05	1.23E-05	4.96E-05	-2.48E-05
0.01426	-3.84E-05	-2.19E-05	3.46E-05	-1.26E-05	-4.97E-05	1.20E-05	4.92E-05	-2.48E-05
0.01488	-3.83E-05	-2.19E-05	3.48E-05	-1.24E-05	-4.96E-05	1.20E-05	4.97E-05	-2.49E-05
0.0155	-3.87E-05	-2.22E-05	3.44E-05	-1.24E-05	-4.95E-05	1.18E-05	4.85E-05	-2.45E-05
0.01612	-3.84E-05	-2.20E-05	3.50E-05	-1.26E-05	-4.95E-05	1.23E-05	4.95E-05	-2.46E-05
0.01674	-3.85E-05	-2.20E-05	3.42E-05	-1.25E-05	-4.92E-05	1.23E-05	4.97E-05	-2.49E-05
0.01736	-3.83E-05	-2.18E-05	3.44E-05	-1.23E-05	-4.96E-05	1.21E-05	4.89E-05	-2.42E-05
0.01798	-3.87E-05	-2.18E-05	3.50E-05	-1.27E-05	-4.93E-05	1.23E-05	4.93E-05	-2.44E-05
0.0186	-3.80E-05	-2.20E-05	3.45E-05	-1.22E-05	-4.97E-05	1.16E-05	4.93E-05	-2.46E-05
0.01922	-3.85E-05	-2.17E-05	3.53E-05	-1.26E-05	-4.96E-05	1.23E-05	5.00E-05	-2.45E-05
0.01984	-3.89E-05	-2.14E-05	3.47E-05	-1.24E-05	-4.94E-05	1.22E-05	4.94E-05	-2.47E-05
0.02046	-3.83E-05	-2.22E-05	3.44E-05	-1.23E-05	-4.93E-05	1.16E-05	4.93E-05	-2.49E-05
0.02108	-3.82E-05	-2.18E-05	3.45E-05	-1.24E-05	-5.00E-05	1.22E-05	4.90E-05	-2.46E-05
0.0217	-3.82E-05	-2.14E-05	3.48E-05	-1.22E-05	-4.92E-05	1.23E-05	4.94E-05	-2.45E-05
0.02232	-3.85E-05	-2.18E-05	3.44E-05	-1.24E-05	-4.99E-05	1.23E-05	4.94E-05	-2.43E-05
0.02294	-3.83E-05	-2.23E-05	3.52E-05	-1.22E-05	-4.94E-05	1.20E-05	4.91E-05	-2.44E-05
0.02356	-3.82E-05	-2.23E-05	3.49E-05	-1.20E-05	-4.96E-05	1.15E-05	4.95E-05	-2.43E-05
0.02418	-3.86E-05	-2.19E-05	3.45E-05	-1.19E-05	-4.96E-05	1.20E-05	4.94E-05	-2.46E-05
0.0248	-3.82E-05	-2.20E-05	3.45E-05	-1.23E-05	-4.93E-05	1.18E-05	4.95E-05	-2.45E-05
0.02542	-3.82E-05	-2.21E-05	3.56E-05	-1.20E-05	-4.94E-05	1.27E-05	4.97E-05	-2.45E-05
0.02604	-3.85E-05	-2.20E-05	3.43E-05	-1.23E-05	-4.94E-05	1.24E-05	4.98E-05	-2.43E-05
0.02666	-3.82E-05	-2.21E-05	3.47E-05	-1.19E-05	-4.95E-05	1.19E-05	4.94E-05	-2.44E-05
0.02728	-3.86E-05	-2.19E-05	3.45E-05	-1.18E-05	-4.95E-05	1.23E-05	4.89E-05	-2.47E-05
0.0279	-3.82E-05	-2.18E-05	3.46E-05	-1.21E-05	-5.02E-05	1.21E-05	4.95E-05	-2.47E-05
0.02852	-3.83E-05	-2.22E-05	3.48E-05	-1.22E-05	-4.98E-05	1.21E-05	4.92E-05	-2.47E-05
0.02914	-3.86E-05	-2.21E-05	3.48E-05	-1.25E-05	-4.96E-05	1.15E-05	4.94E-05	-2.47E-05
0.02976	-3.79E-05	-2.19E-05	3.45E-05	-1.22E-05	-4.99E-05	1.19E-05	4.95E-05	-2.47E-05
0.03038	-3.90E-05	-2.19E-05	3.44E-05	-1.26E-05	-4.98E-05	1.22E-05	4.93E-05	-2.45E-05
0.031	-3.84E-05	-2.23E-05	3.45E-05	-1.16E-05	-4.99E-05	1.22E-05	4.93E-05	-2.48E-05
0.03162	-3.84E-05	-2.23E-05	3.48E-05	-1.23E-05	-4.94E-05	1.17E-05	4.96E-05	-2.43E-05
0.03224	-3.84E-05	-2.19E-05	3.50E-05	-1.21E-05	-4.97E-05	1.18E-05	4.94E-05	-2.48E-05
0.03286	-3.85E-05	-2.21E-05	3.51E-05	-1.23E-05	-4.91E-05	1.28E-05	4.92E-05	-2.45E-05
0.03348	-3.81E-05	-2.23E-05	3.42E-05	-1.23E-05	-4.93E-05	1.20E-05	4.94E-05	-2.48E-05
0.0341	-3.80E-05	-2.22E-05	3.49E-05	-1.22E-05	-4.95E-05	1.20E-05	4.92E-05	-2.47E-05
0.03472	-3.81E-05	-2.19E-05	3.46E-05	-1.24E-05	-4.97E-05	1.18E-05	4.94E-05	-2.50E-05
0.03534	-3.82E-05	-2.18E-05	3.46E-05	-1.23E-05	-4.94E-05	1.21E-05	4.93E-05	-2.48E-05
0.03596	-3.86E-05	-2.19E-05	3.47E-05	-1.21E-05	-4.98E-05	1.19E-05	4.94E-05	-2.47E-05
0.03658	-3.83E-05	-2.16E-05	3.48E-05	-1.19E-05	-4.97E-05	1.20E-05	4.96E-05	-2.45E-05
0.0372	-3.85E-05	-2.18E-05	3.51E-05	-1.23E-05	-5.00E-05	1.21E-05	4.92E-05	-2.48E-05
0.03782	-3.85E-05	-2.21E-05	3.53E-05	-1.21E-05	-4.99E-05	1.17E-05	4.90E-05	-2.42E-05
0.03844	-3.82E-05	-2.20E-05	3.49E-05	-1.23E-05	-4.94E-05	1.22E-05	4.95E-05	-2.45E-05
0.03906	-3.82E-05	-2.17E-05	3.45E-05	-1.23E-05	-4.94E-05	1.18E-05	4.96E-05	-2.48E-05
0.03968	-3.86E-05	-2.27E-05	3.48E-05	-1.23E-05	-4.95E-05	1.24E-05	4.94E-05	-2.46E-05
0.0403	-3.81E-05	-2.20E-05	3.45E-05	-1.22E-05	-5.00E-05	1.22E-05	4.97E-05	-2.48E-05
0.04092	-3.84E-05	-2.22E-05	3.49E-05	-1.24E-05	-4.98E-05	1.20E-05	4.99E-05	-2.45E-05
0.04154	-3.82E-05	-2.17E-05	3.47E-05	-1.18E-05	-4.92E-05	1.21E-05	4.91E-05	-2.51E-05
0.04216	-3.81E-05	-2.18E-05	3.43E-05	-1.21E-05	-4.96E-05	1.20E-05	4.96E-05	-2.45E-05
0.04278	-3.81E-05	-2.18E-05	3.51E-05	-1.21E-05	-4.96E-05	1.27E-05	4.96E-05	-2.50E-05
0.0434	-3.88E-05	-2.16E-05	3.52E-05	-1.25E-05	-4.97E-05	1.24E-05	4.94E-05	-2.45E-05
0.04402	-3.85E-05	-2.20E-05	3.50E-05	-1.24E-05	-4.93E-05	1.28E-05	4.97E-05	-2.46E-05
0.04464	-3.85E-05	-2.19E-05	3.46E-05	-1.26E-05	-4.98E-05	1.24E-05	4.96E-05	-2.42E-05
0.04526	-3.85E-05	-2.21E-05	3.47E-05	-1.20E-05	-4.95E-05	1.17E-05	4.93E-05	-2.44E-05
0.04588	-3.82E-05	-2.23E-05	3.44E-05	-1.19E-05	-4.95E-05	1.24E-05	4.95E-05	-2.50E-05
0.0465	-3.83E-05	-2.14E-05	3.49E-05	-1.23E-05	-4.95E-05	1.18E-05	4.88E-05	-2.49E-05
0.04712	-3.84E-05	-2.20E-05	3.42E-05	-1.25E-05	-4.96E-05	1.24E-05	4.95E-05	-2.50E-05
0.04774	-3.85E-05	-2.22E-05	3.47E-05	-1.23E-05	-4.91E-05	1.21E-05	4.97E-05	-2.45E-05
0.04836	-3.85E-05	-2.19E-05	3.44E-05	-1.25E-05	-4.96E-05	1.21E-05	4.87E-05	-2.47E-05
0.04898	-3.83E-05	-2.21E-05	3.44E-05	-1.26E-05	-4.97E-05	1.25E-05	4.91E-05	-2.44E-05
0.0496	-3.82E-05	-2.21E-05	3.49E-05	-1.21E-05	-4.96E-05	1.18E-05	4.96E-05	-2.46E-05
0.05022	-3.79E-05	-2.17E-05	3.45E-05	-1.25E-05	-4.97E-05	1.19E-05	4.93E-05	-2.41E-05
0.05084	-3.85E-05	-2.20E-05	3.44E-05	-1.20E-05	-4.94E-05	1.18E-05	4.95E-05	-2.50E-05
0.05146	-3.81E-05	-2.18E-05	3.49E-05	-1.25E-05	-4.96E-05	1.24E-05	4.96E-05	-2.41E-05
0.05208	-3.81E-05	-2.17E-05	3.49E-05	-1.20E-05	-4.97E-05	1.21E-05	4.91E-05	-2.48E-05
0.0527	-3.83E-05	-2.19E-05	3.47E-05	-1.22E-05	-4.94E-05	1.19E-05	4.98E-05	-2.44E-05
0.05332	-3.85E-05	-2.14E-05	3.46E-05	-1.24E-05	-4.95E-05	1.24E-05	4.96E-05	-2.41E-05
0.05394	-3.82E-05	-2.23E-05	3.52E-05	-1.25E-05	-4.92E-05	1.19E-05	4.87E-05	-2.45E-05
0.05456	-3.81E-05	-2.21E-05	3.54E-05	-1.26E-05	-4.98E-05	1.19E-05	4.94E-05	-2.49E-05
0.05518	-3.89E-05	-2.18E-05	3.48E-05	-1.22E-05	-4.94E-05	1.23E-05	4.92E-05	-2.50E-05
0.0558	-3.79E-05	-2.17E-05	3.46E-05	-1.24E-05	-4.97E-05	1.19E-05	4.96E-05	-2.45E-05
0.05642	-3.80E-05	-2.15E-05	3.52E-05	-1.19E-05	-4.98E-05	1.17E-05	4.92E-05	-2.52E-05
0.05704	-3.82E-05	-2.16E-05	3.42E-05	-1.22E-05	-4.93E-05	1.22E-05	4.92E-05	-2.49E-05
0.05766	-3.88E-05	-2.18E-05	3.49E-05	-1.21E-05	-4.97E-05	1.20E-05	5.00E-05	-2.45E-05
0.05828	-3.84E-05	-2.19E-05	3.47E-05	-1.22E-05	-4.93E-05	1.22E-05	4.92E-05	-2.48E-05
0.0589	-3.85E-05	-2.17E-05	3.47E-05	-1.22E-05	-4.95E-05	1.20E-05	4.93E-05	-2.45E-05
0.05952	-3.84E-05	-2.16E-05	3.44E-05	-1.22E-05	-4.92E-05	1.21E-05	4.90E-05	-2.45E-05
0.06014	-3.79E-05	-2.21E-05	3.52E-05	-1.23E-05	-4.96E-05	1.20E-05	4.92E-05	-2.45E-05
0.06076	-3.86E-05	-2.19E-05	3.43E-05	-1.19E-05	-4.98E-05	1.20E-05	4.92E-05	-2.50E-05
0.06138	-3.82E-05	-2.24E-05	3.50E-05	-1.24E-05	-4.94E-05	1.20E-05	4.91E-05	-2.47E-05
	-3.84E-05	-2.19E-05	3.47E-05	-1.23E-05	-4.96E-05	1.21E-05	4.94E-05	-2.46E-05

APPENDIX C

	Load at Beam 21 with 600 kg (Decreasing Order)				Load at Beam 21 with 700 kg (Decreasing Order)			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	-5.98E-05	1.10E-05	5.94E-05	4.28E-05	-6.89E-05	1.03E-05	6.94E-05	5.22E-05
0.00062	-5.95E-05	1.07E-05	5.95E-05	4.30E-05	-6.93E-05	1.04E-05	6.97E-05	5.18E-05
0.00124	-5.99E-05	1.12E-05	5.94E-05	4.21E-05	-6.95E-05	1.08E-05	6.91E-05	5.19E-05
0.00186	-6.00E-05	1.08E-05	5.90E-05	4.21E-05	-6.95E-05	1.04E-05	6.92E-05	5.18E-05
0.00248	-5.99E-05	1.12E-05	5.97E-05	4.23E-05	-6.92E-05	1.08E-05	6.95E-05	5.20E-05
0.0031	-5.99E-05	1.12E-05	5.87E-05	4.22E-05	-6.86E-05	1.05E-05	6.96E-05	5.21E-05
0.00372	-5.93E-05	1.09E-05	5.95E-05	4.26E-05	-6.88E-05	1.09E-05	6.95E-05	5.22E-05
0.00434	-6.00E-05	1.11E-05	5.98E-05	4.25E-05	-6.87E-05	1.04E-05	6.96E-05	5.20E-05
0.00496	-5.97E-05	1.15E-05	5.93E-05	4.19E-05	-6.88E-05	1.04E-05	6.89E-05	5.16E-05
0.00558	-5.95E-05	1.08E-05	5.95E-05	4.25E-05	-6.90E-05	1.07E-05	6.94E-05	5.20E-05
0.0062	-5.94E-05	1.07E-05	5.92E-05	4.26E-05	-6.90E-05	1.06E-05	6.96E-05	5.16E-05
0.00682	-5.96E-05	1.13E-05	5.88E-05	4.23E-05	-6.90E-05	1.05E-05	6.90E-05	5.19E-05
0.00744	-6.00E-05	1.10E-05	5.98E-05	4.24E-05	-6.93E-05	1.03E-05	6.95E-05	5.18E-05
0.00806	-6.00E-05	1.13E-05	5.90E-05	4.26E-05	-6.90E-05	1.05E-05	6.94E-05	5.16E-05
0.00868	-6.00E-05	1.09E-05	5.90E-05	4.20E-05	-6.87E-05	1.04E-05	6.93E-05	5.18E-05
0.0093	-5.98E-05	1.08E-05	5.93E-05	4.21E-05	-6.90E-05	1.04E-05	6.93E-05	5.16E-05
0.00992	-5.99E-05	1.10E-05	5.95E-05	4.28E-05	-6.92E-05	1.02E-05	6.93E-05	5.23E-05
0.01054	-5.97E-05	1.10E-05	5.95E-05	4.22E-05	-6.91E-05	1.00E-05	6.94E-05	5.15E-05
0.01116	-5.98E-05	1.10E-05	5.95E-05	4.21E-05	-6.89E-05	1.03E-05	6.91E-05	5.19E-05
0.01178	-5.99E-05	1.14E-05	5.97E-05	4.23E-05	-6.90E-05	1.06E-05	6.94E-05	5.17E-05
0.0124	-5.98E-05	1.14E-05	5.94E-05	4.19E-05	-6.93E-05	1.04E-05	6.98E-05	5.15E-05
0.01302	-5.92E-05	1.11E-05	5.96E-05	4.23E-05	-6.95E-05	1.06E-05	6.95E-05	5.18E-05
0.01364	-6.00E-05	1.12E-05	5.91E-05	4.22E-05	-6.93E-05	1.06E-05	6.94E-05	5.21E-05
0.01426	-5.91E-05	1.09E-05	5.95E-05	4.26E-05	-6.93E-05	1.01E-05	6.88E-05	5.17E-05
0.01488	-5.95E-05	1.08E-05	5.91E-05	4.21E-05	-6.91E-05	1.03E-05	6.94E-05	5.18E-05
0.0155	-6.00E-05	1.12E-05	5.94E-05	4.23E-05	-6.94E-05	1.02E-05	6.97E-05	5.18E-05
0.01612	-5.98E-05	1.12E-05	5.88E-05	4.19E-05	-6.95E-05	1.05E-05	6.98E-05	5.22E-05
0.01674	-5.97E-05	1.12E-05	5.88E-05	4.22E-05	-6.89E-05	1.10E-05	6.97E-05	5.21E-05
0.01736	-6.00E-05	1.06E-05	5.89E-05	4.22E-05	-6.90E-05	1.00E-05	6.93E-05	5.16E-05
0.01798	-5.98E-05	1.10E-05	5.91E-05	4.20E-05	-6.94E-05	1.02E-05	6.97E-05	5.18E-05
0.0186	-5.94E-05	1.14E-05	5.89E-05	4.20E-05	-6.96E-05	1.04E-05	6.93E-05	5.19E-05
0.01922	-5.98E-05	1.12E-05	5.94E-05	4.19E-05	-6.93E-05	1.10E-05	6.94E-05	5.21E-05
0.01984	-5.96E-05	1.06E-05	5.90E-05	4.27E-05	-6.91E-05	1.04E-05	6.90E-05	5.21E-05
0.02046	-5.96E-05	1.07E-05	5.91E-05	4.20E-05	-6.90E-05	1.04E-05	6.92E-05	5.18E-05
0.02108	-5.97E-05	1.08E-05	5.92E-05	4.23E-05	-6.91E-05	1.05E-05	7.00E-05	5.21E-05
0.0217	-5.97E-05	1.06E-05	5.90E-05	4.26E-05	-6.86E-05	1.06E-05	6.92E-05	5.19E-05
0.02232	-5.96E-05	1.07E-05	5.96E-05	4.20E-05	-6.94E-05	1.03E-05	6.97E-05	5.20E-05
0.02294	-5.95E-05	1.09E-05	5.90E-05	4.20E-05	-6.94E-05	1.03E-05	6.89E-05	5.16E-05
0.02356	-5.98E-05	1.07E-05	5.92E-05	4.20E-05	-6.97E-05	1.06E-05	6.96E-05	5.19E-05
0.02418	-5.98E-05	1.07E-05	6.03E-05	4.21E-05	-6.92E-05	1.05E-05	6.95E-05	5.19E-05
0.0248	-6.01E-05	1.08E-05	5.90E-05	4.22E-05	-6.93E-05	1.02E-05	6.98E-05	5.19E-05
0.02542	-6.00E-05	1.11E-05	5.92E-05	4.24E-05	-6.89E-05	1.04E-05	6.97E-05	5.25E-05
0.02604	-5.97E-05	1.12E-05	5.94E-05	4.22E-05	-6.90E-05	1.04E-05	6.89E-05	5.17E-05
0.02666	-5.96E-05	1.04E-05	5.97E-05	4.20E-05	-6.92E-05	1.11E-05	6.94E-05	5.20E-05
0.02728	-5.97E-05	1.10E-05	5.96E-05	4.23E-05	-6.89E-05	1.02E-05	6.92E-05	5.16E-05
0.0279	-5.97E-05	1.10E-05	5.92E-05	4.21E-05	-6.94E-05	9.77E-06	6.91E-05	5.21E-05
0.02852	-5.98E-05	1.14E-05	5.94E-05	4.19E-05	-6.94E-05	1.03E-05	6.97E-05	5.17E-05
0.02914	-5.96E-05	1.10E-05	5.93E-05	4.22E-05	-6.90E-05	1.05E-05	6.95E-05	5.17E-05
0.02976	-5.97E-05	1.09E-05	5.91E-05	4.19E-05	-6.92E-05	1.07E-05	6.97E-05	5.17E-05
0.03038	-5.94E-05	1.13E-05	5.90E-05	4.23E-05	-6.93E-05	1.06E-05	6.95E-05	5.21E-05
0.031	-6.00E-05	1.07E-05	5.95E-05	4.23E-05	-6.91E-05	1.08E-05	7.00E-05	5.20E-05
0.03162	-5.96E-05	1.14E-05	5.93E-05	4.18E-05	-6.93E-05	1.07E-05	6.96E-05	5.16E-05
0.03224	-5.94E-05	1.09E-05	5.96E-05	4.21E-05	-6.91E-05	1.10E-05	6.98E-05	5.22E-05
0.03286	-5.97E-05	1.07E-05	5.91E-05	4.19E-05	-6.90E-05	1.03E-05	6.96E-05	5.21E-05
0.03348	-5.98E-05	1.09E-05	5.88E-05	4.23E-05	-6.87E-05	1.04E-05	6.93E-05	5.20E-05
0.0341	-5.96E-05	1.16E-05	5.95E-05	4.19E-05	-6.93E-05	1.07E-05	6.92E-05	5.18E-05
0.03472	-5.97E-05	1.08E-05	5.93E-05	4.22E-05	-6.92E-05	1.02E-05	6.89E-05	5.18E-05
0.03534	-5.96E-05	1.08E-05	5.93E-05	4.27E-05	-6.96E-05	1.05E-05	6.97E-05	5.18E-05
0.03596	-5.94E-05	1.16E-05	5.93E-05	4.20E-05	-6.91E-05	1.07E-05	6.94E-05	5.18E-05
0.03658	-5.97E-05	1.08E-05	5.95E-05	4.18E-05	-6.94E-05	1.03E-05	6.92E-05	5.17E-05
0.0372	-5.98E-05	1.18E-05	5.98E-05	4.22E-05	-6.94E-05	1.04E-05	6.97E-05	5.19E-05
0.03782	-6.01E-05	1.09E-05	5.89E-05	4.20E-05	-6.92E-05	1.04E-05	6.93E-05	5.13E-05
0.03844	-5.98E-05	1.08E-05	5.96E-05	4.25E-05	-6.88E-05	1.04E-05	6.92E-05	5.16E-05
0.03906	-5.97E-05	1.07E-05	5.95E-05	4.25E-05	-6.88E-05	1.08E-05	6.95E-05	5.22E-05
0.03968	-5.94E-05	1.08E-05	5.92E-05	4.27E-05	-6.94E-05	1.04E-05	6.92E-05	5.16E-05
0.0403	-5.93E-05	1.14E-05	5.93E-05	4.24E-05	-6.92E-05	1.03E-05	6.93E-05	5.17E-05
0.04092	-6.00E-05	1.10E-05	5.91E-05	4.20E-05	-6.90E-05	1.01E-05	6.94E-05	5.14E-05
0.04154	-5.95E-05	1.13E-05	5.93E-05	4.25E-05	-6.90E-05	1.07E-05	6.92E-05	5.20E-05
0.04216	-5.97E-05	1.10E-05	5.95E-05	4.26E-05	-6.91E-05	1.05E-05	6.98E-05	5.17E-05
0.04278	-6.02E-05	1.11E-05	5.93E-05	4.23E-05	-6.94E-05	1.02E-05	6.98E-05	5.22E-05
0.0434	-5.96E-05	1.08E-05	5.90E-05	4.22E-05	-6.95E-05	1.03E-05	6.98E-05	5.17E-05
0.04402	-5.96E-05	1.08E-05	5.97E-05	4.22E-05	-6.88E-05	1.03E-05	6.95E-05	5.24E-05
0.04464	-6.02E-05	1.12E-05	5.97E-05	4.19E-05	-6.91E-05	1.05E-05	6.95E-05	5.14E-05
0.04526	-5.96E-05	1.12E-05	5.97E-05	4.21E-05	-6.98E-05	1.03E-05	6.95E-05	5.15E-05
0.04588	-5.98E-05	1.09E-05	5.86E-05	4.26E-05	-6.93E-05	1.10E-05	6.97E-05	5.12E-05
0.0465	-6.01E-05	1.09E-05	5.94E-05	4.17E-05	-6.92E-05	1.02E-05	6.94E-05	5.22E-05
0.04712	-5.93E-05	1.05E-05	5.91E-05	4.22E-05	-6.94E-05	1.04E-05	6.94E-05	5.22E-05
0.04774	-5.99E-05	1.11E-05	5.89E-05	4.26E-05	-6.89E-05	1.07E-05	6.90E-05	5.16E-05
0.04836	-5.95E-05	1.10E-05	5.94E-05	4.19E-05	-6.92E-05	1.06E-05	6.94E-05	5.17E-05
0.04898	-5.94E-05	1.12E-05	5.96E-05	4.23E-05	-6.91E-05	1.03E-05	6.97E-05	5.19E-05
0.0496	-5.99E-05	1.14E-05	5.91E-05	4.25E-05	-6.87E-05	1.07E-05	6.96E-05	5.21E-05
0.05022	-6.00E-05	1.13E-05	5.86E-05	4.25E-05	-6.87E-05	1.03E-05	6.96E-05	5.15E-05
0.05084	-5.99E-05	1.13E-05	5.91E-05	4.21E-05	-6.92E-05	1.02E-05	6.90E-05	5.16E-05
0.05146	-5.96E-05	1.12E-05	5.92E-05	4.19E-05	-6.95E-05	1.07E-05	7.01E-05	5.18E-05
0.05208	-5.91E-05	1.10E-05	5.95E-05	4.17E-05	-6.88E-05	1.05E-05	6.91E-05	5.19E-05
0.0527	-5.98E-05	1.08E-05	5.92E-05	4.21E-05	-6.92E-05	1.04E-05	6.97E-05	5.17E-05
0.05332	-5.98E-05	1.09E-05	5.90E-05	4.20E-05	-6.92E-05	1.03E-05	6.93E-05	5.16E-05
0.05394	-5.95E-05	1.12E-05	5.89E-05	4.22E-05	-6.92E-05	1.10E-05	6.94E-05	5.18E-05
0.05456	-5.96E-05	1.10E-05	5.89E-05	4.24E-05	-6.94E-05	1.03E-05	6.93E-05	5.20E-05
0.05518	-5.96E-05	1.11E-05	5.91E-05	4.20E-05	-6.92E-05	1.02E-05	6.92E-05	5.22E-05
0.0558	-5.99E-05	1.11E-05	5.97E-05	4.24E-05	-6.91E-05	1.12E-05	6.94E-05	5.20E-05
0.05642	-5.95E-05	1.05E-05	5.93E-05	4.27E-05	-6.93E-05	1.05E-05	6.95E-05	5.23E-05
0.05704	-5.93E-05	1.12E-05	5.89E-05	4.23E-05	-6.91E-05	1.06E-05	6.95E-05	5.19E-05
0.05766	-5.93E-05	1.07E-05	5.93E-05	4.25E-05	-6.91E-05	1.03E-05	6.94E-05	5.19E-05
0.05828	-5.92E-05	1.12E-05	5.92E-05	4.19E-05	-6.92E-05	1.07E-05	6.97E-05	5.19E-05
0.0589	-5.96E-05	1.10E-05	5.95E-05	4.23E-05	-6.92E-05	1.04E-05	7.01E-05	5.12E-05
0.05952	-6.00E-05	1.09E-05	5.98E-05	4.24E-05	-6.91E-05	1.05E-05	6.95E-05	5.22E-05
0.06014	-6.01E-05	1.09E-05	5.99E-05	4.26E-05	-6.92E-05	1.02E-05	6.94E-05	5.16E-05
0.06076	-5.96E-05	1.10E-05	5.93E-05	4.23E-05	-6.91E-05	1.03E-05	6.94E-05	5.17E-05
0.06138	-5.99E-05	1.11E-05	5.90E-05	4.23E-05	-6.94E-05	1.04E-05	6.92E-05	5.21E-05
	-5.97E-05	1.10E-05	5.93E-05	4.22E-05	-6.92E-05	1.05E-05	6.94E-05	5.19E-05

APPENDIX C

	Load at Beam 22 with 380 kg				Load at Beam 22 with 500 kg			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	-3.25E-06	-3.71E-05	-1.90E-07	3.73E-05	-1.30E-07	-4.96E-05	1.44E-06	4.80E-05
0.00062	-3.88E-06	-3.70E-05	3.64E-07	3.74E-05	-5.34E-07	-4.95E-05	1.12E-06	4.74E-05
0.00124	-3.35E-06	-3.74E-05	-8.27E-08	3.66E-05	-5.95E-07	-4.91E-05	1.59E-06	4.75E-05
0.00186	-3.15E-06	-3.71E-05	-2.75E-07	3.74E-05	1.09E-07	-4.91E-05	1.56E-06	4.69E-05
0.00248	-3.52E-06	-3.66E-05	-4.54E-07	3.78E-05	-8.03E-07	-4.95E-05	9.35E-07	4.69E-05
0.0031	-3.63E-06	-3.74E-05	-3.91E-07	3.73E-05	6.43E-08	-4.94E-05	9.20E-07	4.74E-05
0.00372	-3.21E-06	-3.72E-05	3.29E-09	3.71E-05	-5.01E-07	-4.89E-05	1.25E-06	4.75E-05
0.00434	-3.48E-06	-3.69E-05	-5.05E-07	3.74E-05	-4.44E-07	-4.95E-05	1.05E-06	4.69E-05
0.00496	-3.20E-06	-3.73E-05	-3.95E-07	3.79E-05	-3.33E-07	-4.91E-05	9.76E-07	4.72E-05
0.00558	-2.89E-06	-3.72E-05	-1.01E-09	3.77E-05	1.39E-07	-4.95E-05	1.07E-06	4.72E-05
0.0062	-3.27E-06	-3.72E-05	2.21E-07	3.74E-05	-4.49E-07	-4.89E-05	1.53E-06	4.73E-05
0.00682	-3.41E-06	-3.72E-05	2.28E-07	3.78E-05	-4.88E-07	-4.91E-05	8.10E-07	4.73E-05
0.00744	-3.37E-06	-3.76E-05	1.34E-07	3.74E-05	-5.29E-07	-4.91E-05	1.51E-06	4.72E-05
0.00806	-2.88E-06	-3.74E-05	2.94E-07	3.78E-05	-3.23E-07	-4.92E-05	1.98E-06	4.71E-05
0.00868	-3.33E-06	-3.68E-05	-1.39E-08	3.78E-05	-3.71E-07	-4.91E-05	1.41E-06	4.72E-05
0.0093	-3.00E-06	-3.70E-05	-1.18E-07	3.76E-05	-6.01E-08	-4.87E-05	9.33E-07	4.72E-05
0.00992	-3.15E-06	-3.72E-05	-1.79E-07	3.78E-05	-1.39E-07	-4.93E-05	8.80E-07	4.69E-05
0.01054	-3.76E-06	-3.71E-05	-5.83E-08	3.82E-05	-1.10E-07	-4.94E-05	9.67E-07	4.71E-05
0.01116	-3.38E-06	-3.67E-05	1.62E-08	3.78E-05	-4.88E-07	-4.95E-05	1.62E-06	4.69E-05
0.01178	-3.21E-06	-3.72E-05	3.17E-07	3.84E-05	-2.83E-07	-4.94E-05	8.74E-07	4.72E-05
0.0124	-3.42E-06	-3.75E-05	-2.66E-07	3.77E-05	-2.30E-07	-4.93E-05	9.06E-07	4.70E-05
0.01302	-3.66E-06	-3.73E-05	2.44E-07	3.72E-05	-4.71E-07	-4.91E-05	1.09E-06	4.71E-05
0.01364	-3.61E-06	-3.68E-05	-4.88E-07	3.75E-05	-4.26E-07	-4.93E-05	1.39E-06	4.74E-05
0.01426	-3.22E-06	-3.75E-05	-4.34E-07	3.76E-05	-5.73E-08	-4.96E-05	1.85E-06	4.66E-05
0.01488	-3.64E-06	-3.72E-05	-6.74E-09	3.78E-05	-6.84E-07	-4.90E-05	1.33E-06	4.74E-05
0.0155	-3.47E-06	-3.70E-05	2.37E-07	3.76E-05	-6.97E-07	-4.91E-05	1.10E-06	4.72E-05
0.01612	-3.28E-06	-3.71E-05	9.93E-08	3.72E-05	-4.78E-07	-4.91E-05	1.44E-06	4.74E-05
0.01674	-3.51E-06	-3.72E-05	-8.12E-07	3.78E-05	-2.30E-07	-4.92E-05	8.90E-07	4.73E-05
0.01736	-3.80E-06	-3.72E-05	-1.59E-07	3.78E-05	-2.20E-07	-4.96E-05	1.62E-06	4.73E-05
0.01798	-3.39E-06	-3.70E-05	-3.85E-07	3.75E-05	-5.29E-07	-4.91E-05	1.36E-06	4.75E-05
0.0186	-3.73E-06	-3.74E-05	2.08E-07	3.72E-05	-1.87E-07	-4.93E-05	1.41E-06	4.72E-05
0.01922	-3.18E-06	-3.75E-05	-3.49E-07	3.75E-05	-2.80E-07	-4.90E-05	1.40E-06	4.69E-05
0.01984	-3.28E-06	-3.70E-05	-9.61E-09	3.84E-05	-2.79E-07	-4.89E-05	1.61E-06	4.70E-05
0.02046	-3.49E-06	-3.80E-05	-2.96E-07	3.78E-05	-6.91E-07	-4.90E-05	1.51E-06	4.76E-05
0.02108	-3.65E-06	-3.74E-05	-3.91E-07	3.80E-05	-5.01E-07	-4.93E-05	1.12E-06	4.69E-05
0.0217	-3.89E-06	-3.71E-05	3.04E-07	3.72E-05	-4.33E-09	-4.90E-05	8.82E-07	4.68E-05
0.02232	-3.22E-06	-3.77E-05	4.32E-07	3.79E-05	-2.32E-07	-4.91E-05	1.36E-06	4.73E-05
0.02294	-3.54E-06	-3.72E-05	-2.47E-07	3.77E-05	-5.19E-07	-4.91E-05	1.47E-06	4.73E-05
0.02356	-3.51E-06	-3.71E-05	-6.80E-07	3.74E-05	-2.95E-07	-4.89E-05	1.57E-06	4.66E-05
0.02418	-3.63E-06	-3.72E-05	-1.74E-07	3.76E-05	-3.92E-07	-4.97E-05	1.47E-06	4.72E-05
0.0248	-3.55E-06	-3.72E-05	1.35E-07	3.76E-05	-1.35E-07	-4.88E-05	1.63E-06	4.73E-05
0.02542	-3.43E-06	-3.71E-05	-5.60E-07	3.70E-05	-2.53E-07	-4.92E-05	1.88E-06	4.76E-05
0.02604	-3.63E-06	-3.74E-05	-3.18E-07	3.77E-05	5.58E-08	-4.93E-05	6.88E-07	4.70E-05
0.02666	-3.35E-06	-3.73E-05	5.49E-08	3.79E-05	-5.17E-07	-4.87E-05	1.81E-06	4.74E-05
0.02728	-3.28E-06	-3.75E-05	-1.79E-07	3.75E-05	-5.17E-07	-4.93E-05	1.36E-06	4.69E-05
0.0279	-3.38E-06	-3.75E-05	-1.99E-07	3.73E-05	-5.47E-07	-4.91E-05	1.31E-06	4.67E-05
0.02852	-3.59E-06	-3.69E-05	-4.97E-07	3.80E-05	-5.61E-07	-4.90E-05	1.00E-06	4.72E-05
0.02914	-3.64E-06	-3.76E-05	3.19E-08	3.77E-05	-4.81E-07	-4.93E-05	1.11E-06	4.74E-05
0.02976	-3.28E-06	-3.71E-05	-5.86E-07	3.71E-05	1.30E-07	-4.89E-05	1.31E-06	4.72E-05
0.03038	-3.12E-06	-3.70E-05	-3.18E-07	3.78E-05	-2.13E-07	-4.93E-05	1.24E-06	4.70E-05
0.031	-3.84E-06	-3.73E-05	-2.75E-07	3.78E-05	1.43E-07	-4.95E-05	9.96E-07	4.74E-05
0.03162	-2.82E-06	-3.69E-05	5.92E-08	3.76E-05	-4.21E-07	-4.95E-05	1.36E-06	4.72E-05
0.03224	-3.48E-06	-3.73E-05	-5.07E-07	3.77E-05	-2.30E-07	-4.91E-05	1.17E-06	4.73E-05
0.03286	-3.58E-06	-3.72E-05	1.85E-07	3.73E-05	-2.60E-07	-4.95E-05	1.19E-06	4.69E-05
0.03348	-3.14E-06	-3.73E-05	8.21E-08	3.78E-05	-3.91E-07	-4.95E-05	1.35E-06	4.70E-05
0.0341	-3.47E-06	-3.72E-05	-1.04E-07	3.70E-05	-3.68E-07	-4.89E-05	1.40E-06	4.69E-05
0.03472	-3.34E-06	-3.72E-05	-8.12E-08	3.72E-05	-7.05E-07	-4.92E-05	1.50E-06	4.73E-05
0.03534	-3.72E-06	-3.73E-05	-3.25E-07	3.76E-05	-6.88E-07	-4.92E-05	1.54E-06	4.73E-05
0.03596	-3.37E-06	-3.72E-05	-6.40E-08	3.78E-05	-7.50E-07	-4.91E-05	1.09E-06	4.69E-05
0.03658	-3.79E-06	-3.74E-05	-3.42E-07	3.77E-05	-5.35E-07	-4.88E-05	9.27E-07	4.76E-05
0.0372	-3.57E-06	-3.72E-05	-9.61E-09	3.78E-05	8.15E-08	-4.84E-05	1.30E-06	4.70E-05
0.03782	-3.52E-06	-3.70E-05	-5.86E-07	3.77E-05	-3.18E-07	-4.91E-05	9.96E-07	4.74E-05
0.03844	-3.49E-06	-3.69E-05	-8.46E-07	3.73E-05	-3.66E-07	-4.96E-05	1.63E-06	4.69E-05
0.03906	-3.48E-06	-3.69E-05	6.35E-08	3.79E-05	-5.29E-07	-4.95E-05	1.24E-06	4.72E-05
0.03968	-3.29E-06	-3.79E-05	-5.08E-07	3.76E-05	-3.96E-07	-4.96E-05	1.51E-06	4.72E-05
0.0403	-3.49E-06	-3.70E-05	-1.50E-07	3.81E-05	-2.56E-07	-4.92E-05	1.53E-06	4.73E-05
0.04092	-3.35E-06	-3.72E-05	-3.09E-07	3.77E-05	-1.10E-07	-4.94E-05	1.05E-06	4.75E-05
0.04154	-3.30E-06	-3.73E-05	-1.60E-07	3.77E-05	-4.01E-07	-4.87E-05	1.24E-06	4.72E-05
0.04216	-3.60E-06	-3.74E-05	-2.12E-07	3.77E-05	-1.99E-07	-4.89E-05	1.88E-06	4.73E-05
0.04278	-3.37E-06	-3.72E-05	-1.40E-07	3.77E-05	-5.80E-07	-4.93E-05	1.04E-06	4.67E-05
0.0434	-3.58E-06	-3.74E-05	-3.40E-08	3.74E-05	-4.31E-07	-4.85E-05	1.42E-06	4.73E-05
0.04402	-3.50E-06	-3.71E-05	2.20E-07	3.74E-05	-1.23E-07	-4.89E-05	1.83E-06	4.73E-05
0.04464	-3.57E-06	-3.70E-05	-2.88E-07	3.74E-05	-8.30E-08	-4.88E-05	6.59E-07	4.69E-05
0.04526	-3.75E-06	-3.72E-05	-8.98E-08	3.77E-05	-5.29E-07	-5.00E-05	1.20E-06	4.74E-05
0.04588	-3.54E-06	-3.73E-05	-4.38E-07	3.73E-05	-8.30E-08	-4.86E-05	1.17E-06	4.71E-05
0.0465	-3.13E-06	-3.71E-05	-2.96E-07	3.79E-05	-6.57E-07	-4.89E-05	1.65E-06	4.71E-05
0.04712	-3.22E-06	-3.70E-05	-2.82E-07	3.77E-05	-2.42E-07	-4.91E-05	1.02E-06	4.76E-05
0.04774	-3.01E-06	-3.69E-05	-4.42E-07	3.81E-05	-2.60E-07	-4.87E-05	1.19E-06	4.68E-05
0.04836	-3.51E-06	-3.76E-05	-4.27E-07	3.76E-05	3.57E-08	-4.92E-05	1.15E-06	4.69E-05
0.04898	-3.68E-06	-3.73E-05	-1.29E-07	3.77E-05	-2.12E-07	-4.93E-05	8.04E-07	4.76E-05
0.0496	-3.54E-06	-3.73E-05	-3.18E-07	3.77E-05	-5.39E-07	-4.96E-05	1.62E-06	4.73E-05
0.05022	-3.83E-06	-3.76E-05	-2.75E-07	3.74E-05	-3.99E-07	-4.88E-05	1.66E-06	4.73E-05
0.05084	-3.39E-06	-3.71E-05	-6.44E-07	3.80E-05	-2.63E-07	-4.89E-05	1.90E-06	4.78E-05
0.05146	-3.16E-06	-3.66E-05	-3.09E-07	3.73E-05	-5.77E-07	-4.93E-05	1.10E-06	4.73E-05
0.05208	-3.55E-06	-3.70E-05	-1.43E-07	3.77E-05	-6.18E-07	-4.94E-05	1.08E-06	4.70E-05
0.0527	-3.81E-06	-3.70E-05	-2.40E-07	3.82E-05	-2.03E-07	-4.89E-05	9.53E-07	4.72E-05
0.05332	-3.24E-06	-3.67E-05	-7.12E-08	3.77E-05	-5.72E-07	-4.89E-05	1.15E-06	4.76E-05
0.05394	-3.53E-06	-3.75E-05	-3.11E-08	3.77E-05	2.65E-07	-4.87E-05	1.26E-06	4.71E-05
0.05456	-3.48E-06	-3.75E-05	1.14E-07	3.82E-05	-2.65E-07	-4.92E-05	1.19E-06	4.70E-05
0.05518	-2.92E-06	-3.74E-05	3.06E-07	3.75E-05	-4.99E-07	-4.90E-05	8.37E-07	4.69E-05
0.0558	-3.33E-06	-3.70E-05	-6.26E-08	3.76E-05	3.29E-08	-4.93E-05	1.32E-06	4.72E-05
0.05642	-3.63E-06	-3.71E-05	4.72E-09	3.76E-05	-1.12E-07	-4.92E-05	1.02E-06	4.69E-05
0.05704	-3.43E-06	-3.72E-05	3.24E-07	3.77E-05	-9.02E-08	-4.88E-05	1.18E-06	4.70E-05
0.05766	-3.22E-06	-3.72E-05	-3.74E-07	3.76E-05	-9.23E-07	-4.93E-05	1.03E-06	4.68E-05
0.05828	-3.19E-06	-3.66E-05	-1.39E-08	3.79E-05	-1.99E-07	-4.90E-05	1.20E-06	4.68E-05
0.0589	-3.40E-06	-3.71E-05	-6.26E-08	3.79E-05	-1.09E-07	-4.91E-05	1.44E-06	4.73E-05
0.05952	-3.44E-06	-3.73E-05	-4.15E-07	3.75E-05	-5.51E-07	-4.94E-05	1.58E-06	4.72E-05
0.06014	-3.58E-06	-3.74E-05	-2.07E-07	3.75E-05	-2.43E-07	-4.87E-05	1.43E-06	4.74E-05
0.06076	-3.64E-06	-3.74E-05	-1.01E-07	3.78E-05	-1.86E-07	-4.95E-05	1.78E-06	4.73E-05
0.06138	-3.67E-06	-3.74E-05	-2.82E-07	3.79E-05	-4.18E-07	-4.89E-05	1.26E-06	4.73E-05
	-3.43E-06	-3.72E-05	-1.59E-07	3.76E-05	-3.30E-07	-4.92E-05	1.29E-06	4.72E-05

APPENDIX C

	Load at Beam 22 with 600 kg				Load at Beam 22 with 700 kg			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	2.30E-07	-5.96E-05	-6.69E-07	5.72E-05	9.90E-07	-6.91E-05	-9.35E-07	6.68E-05
0.00062	3.43E-07	-5.92E-05	1.76E-08	5.68E-05	8.23E-07	-6.94E-05	-9.32E-07	6.69E-05
0.00124	-7.73E-08	-5.90E-05	-6.11E-07	5.69E-05	8.30E-07	-6.92E-05	-8.19E-07	6.71E-05
0.00186	3.14E-08	-5.91E-05	-3.82E-07	5.64E-05	9.66E-07	-6.90E-05	-1.27E-06	6.76E-05
0.00248	4.84E-07	-5.96E-05	2.53E-07	5.67E-05	5.91E-07	-6.95E-05	-1.34E-06	6.71E-05
0.0031	1.40E-07	-5.96E-05	-2.90E-07	5.67E-05	1.10E-06	-6.90E-05	-7.32E-07	6.74E-05
0.00372	4.00E-08	-5.94E-05	-5.74E-07	5.75E-05	4.42E-07	-6.93E-05	-5.80E-07	6.71E-05
0.00434	8.58E-08	-5.91E-05	-2.95E-07	5.69E-05	9.03E-07	-6.93E-05	-8.25E-07	6.71E-05
0.00496	-4.58E-08	-5.92E-05	-7.72E-07	5.67E-05	8.31E-07	-6.93E-05	-1.10E-06	6.70E-05
0.00558	1.32E-07	-5.93E-05	-1.13E-07	5.67E-05	7.44E-07	-6.91E-05	-1.17E-06	6.76E-05
0.0062	-3.39E-07	-5.91E-05	-4.77E-07	5.66E-05	6.42E-07	-6.92E-05	-1.32E-06	6.74E-05
0.00682	2.45E-07	-5.89E-05	-4.25E-07	5.68E-05	4.56E-07	-6.93E-05	-1.50E-06	6.76E-05
0.00744	2.03E-07	-5.93E-05	2.44E-07	5.66E-05	9.01E-07	-6.95E-05	-1.27E-06	6.67E-05
0.00806	3.22E-07	-5.92E-05	-4.72E-07	5.71E-05	5.61E-07	-6.92E-05	-1.19E-06	6.75E-05
0.00868	5.26E-07	-5.91E-05	-3.91E-07	5.69E-05	9.03E-07	-6.92E-05	-5.58E-07	6.74E-05
0.0093	5.00E-08	-5.95E-05	-2.65E-07	5.68E-05	7.01E-07	-6.93E-05	-7.96E-07	6.72E-05
0.00992	5.32E-07	-5.95E-05	-7.32E-07	5.70E-05	6.64E-07	-6.92E-05	-1.04E-06	6.78E-05
0.01054	2.16E-07	-5.95E-05	-6.06E-07	5.67E-05	1.16E-06	-6.91E-05	-1.46E-06	6.74E-05
0.01116	-1.85E-07	-5.90E-05	2.10E-07	5.67E-05	4.12E-07	-6.96E-05	-1.43E-06	6.70E-05
0.01178	5.31E-07	-5.88E-05	-6.90E-07	5.64E-05	9.01E-07	-6.90E-05	-1.19E-06	6.69E-05
0.0124	2.79E-07	-5.97E-05	-6.34E-07	5.65E-05	8.28E-07	-6.97E-05	-9.42E-07	6.73E-05
0.01302	1.60E-07	-5.93E-05	-3.06E-07	5.76E-05	8.78E-07	-6.98E-05	-1.01E-06	6.72E-05
0.01364	4.23E-07	-5.94E-05	-6.92E-07	5.63E-05	9.41E-07	-6.96E-05	-1.21E-06	6.72E-05
0.01426	3.06E-07	-5.92E-05	-5.57E-07	5.68E-05	1.19E-07	-6.92E-05	-1.20E-06	6.71E-05
0.01488	9.39E-07	-5.90E-05	-4.52E-07	5.69E-05	7.25E-07	-6.92E-05	-1.16E-06	6.72E-05
0.0155	1.07E-07	-5.96E-05	-3.36E-07	5.69E-05	7.37E-07	-6.95E-05	-8.58E-07	6.73E-05
0.01612	2.03E-07	-5.95E-05	-5.45E-07	5.72E-05	8.36E-07	-6.95E-05	-1.12E-06	6.73E-05
0.01674	8.58E-08	-5.93E-05	1.90E-08	5.69E-05	8.31E-07	-6.92E-05	-8.72E-07	6.76E-05
0.01736	-2.55E-07	-5.91E-05	-2.40E-07	5.62E-05	5.47E-07	-6.91E-05	-7.59E-07	6.70E-05
0.01798	3.28E-07	-5.96E-05	-1.09E-06	5.68E-05	8.68E-07	-6.95E-05	-1.26E-06	6.70E-05
0.0186	9.01E-08	-5.93E-05	-1.80E-07	5.64E-05	9.31E-07	-6.95E-05	-1.30E-06	6.72E-05
0.01922	3.59E-07	-5.99E-05	-6.19E-07	5.70E-05	8.88E-07	-6.97E-05	-1.17E-06	6.72E-05
0.01984	1.85E-07	-5.92E-05	-6.72E-07	5.71E-05	6.08E-07	-6.97E-05	-9.19E-07	6.70E-05
0.02046	2.36E-07	-5.93E-05	-1.23E-07	5.69E-05	1.17E-06	-6.93E-05	-7.02E-07	6.70E-05
0.02108	-1.02E-07	-5.98E-05	-3.91E-07	5.67E-05	7.04E-07	-6.92E-05	-1.23E-06	6.74E-05
0.0217	5.31E-07	-5.94E-05	8.92E-08	5.66E-05	4.78E-07	-6.94E-05	-6.59E-07	6.69E-05
0.02232	2.53E-07	-5.91E-05	-3.28E-07	5.69E-05	6.37E-07	-6.96E-05	-8.71E-07	6.68E-05
0.02294	1.47E-07	-5.95E-05	-5.08E-07	5.71E-05	9.87E-07	-6.96E-05	-1.18E-06	6.76E-05
0.02356	1.69E-07	-5.92E-05	-6.41E-07	5.69E-05	1.09E-06	-6.91E-05	-1.14E-06	6.74E-05
0.02418	8.15E-08	-5.90E-05	-7.10E-07	5.69E-05	9.77E-07	-6.92E-05	-7.35E-07	6.72E-05
0.0248	2.96E-07	-5.93E-05	-7.66E-07	5.74E-05	1.02E-06	-6.96E-05	-1.73E-06	6.71E-05
0.02542	2.98E-07	-5.90E-05	-3.98E-07	5.63E-05	9.60E-07	-6.95E-05	-8.69E-07	6.71E-05
0.02604	2.72E-07	-5.95E-05	4.48E-08	5.70E-05	9.56E-07	-6.97E-05	-7.85E-07	6.69E-05
0.02666	4.25E-07	-5.92E-05	-4.06E-07	5.70E-05	4.91E-07	-6.95E-05	-5.08E-07	6.71E-05
0.02728	4.71E-07	-5.91E-05	-4.71E-07	5.69E-05	8.07E-07	-6.95E-05	-1.30E-06	6.73E-05
0.0279	2.05E-07	-5.92E-05	-5.73E-07	5.70E-05	5.94E-07	-6.92E-05	-4.16E-07	6.70E-05
0.02852	-8.73E-08	-5.95E-05	-6.63E-07	5.73E-05	5.62E-07	-6.93E-05	-7.09E-07	6.71E-05
0.02914	2.20E-07	-5.95E-05	-2.75E-07	5.66E-05	9.99E-07	-6.90E-05	-1.31E-06	6.74E-05
0.02976	-5.76E-09	-5.93E-05	-8.23E-07	5.71E-05	9.11E-07	-6.95E-05	-1.42E-06	6.69E-05
0.03038	1.22E-07	-5.92E-05	4.72E-09	5.70E-05	1.27E-06	-6.95E-05	-8.56E-07	6.71E-05
0.031	2.00E-08	-5.94E-05	-5.11E-07	5.65E-05	4.01E-07	-6.93E-05	-1.21E-06	6.72E-05
0.03162	2.82E-07	-5.92E-05	-3.95E-07	5.66E-05	9.03E-07	-6.92E-05	-1.25E-06	6.69E-05
0.03224	4.26E-07	-5.94E-05	-3.26E-07	5.70E-05	5.49E-07	-6.96E-05	-1.03E-06	6.73E-05
0.03286	2.29E-08	-5.90E-05	-4.06E-07	5.71E-05	7.33E-07	-6.92E-05	-1.23E-06	6.73E-05
0.03348	2.56E-07	-5.93E-05	-7.72E-07	5.70E-05	5.61E-07	-6.93E-05	-1.09E-06	6.74E-05
0.0341	2.25E-07	-5.89E-05	-5.15E-07	5.70E-05	1.31E-06	-6.94E-05	-7.80E-07	6.69E-05
0.03472	2.90E-07	-5.88E-05	-6.69E-08	5.69E-05	1.08E-06	-6.95E-05	-1.06E-06	6.70E-05
0.03534	2.23E-07	-5.96E-05	-4.47E-07	5.68E-05	1.13E-06	-6.96E-05	-1.08E-06	6.74E-05
0.03596	1.57E-08	-5.92E-05	-6.27E-07	5.64E-05	6.74E-07	-6.91E-05	-1.14E-06	6.70E-05
0.03658	2.19E-07	-5.92E-05	-3.71E-07	5.71E-05	3.48E-07	-6.93E-05	-1.54E-06	6.74E-05
0.0372	3.35E-07	-5.91E-05	-5.73E-07	5.66E-05	3.75E-07	-6.92E-05	-9.27E-07	6.70E-05
0.03782	3.65E-07	-5.87E-05	-8.98E-08	5.65E-05	6.18E-07	-6.95E-05	-1.46E-06	6.68E-05
0.03844	3.68E-07	-5.92E-05	-9.02E-07	5.69E-05	9.73E-07	-6.93E-05	-1.44E-06	6.70E-05
0.03906	5.05E-07	-5.90E-05	-4.05E-07	5.69E-05	2.98E-07	-6.94E-05	-9.57E-07	6.70E-05
0.03968	2.10E-07	-5.90E-05	-4.94E-07	5.70E-05	8.64E-07	-6.95E-05	-1.60E-06	6.76E-05
0.0403	-3.29E-08	-5.91E-05	-3.05E-07	5.67E-05	1.03E-06	-6.95E-05	-1.65E-06	6.72E-05
0.04092	-3.26E-07	-5.93E-05	-1.09E-06	5.65E-05	1.03E-06	-6.91E-05	-9.74E-07	6.74E-05
0.04154	1.60E-07	-5.94E-05	-8.41E-08	5.68E-05	6.62E-07	-6.97E-05	-1.32E-06	6.76E-05
0.04216	6.25E-07	-5.92E-05	-5.00E-07	5.67E-05	1.23E-06	-6.93E-05	-1.25E-06	6.74E-05
0.04278	-8.02E-08	-5.96E-05	-4.44E-07	5.72E-05	8.46E-07	-6.92E-05	-1.53E-06	6.71E-05
0.0434	2.07E-07	-5.94E-05	-6.90E-07	5.67E-05	7.20E-07	-6.90E-05	-9.58E-07	6.72E-05
0.04402	5.22E-07	-5.91E-05	-7.03E-07	5.67E-05	9.61E-07	-6.96E-05	-9.70E-07	6.72E-05
0.04464	3.66E-07	-5.92E-05	-2.67E-07	5.73E-05	9.59E-07	-6.93E-05	-1.02E-06	6.73E-05
0.04526	-1.04E-07	-5.91E-05	-3.32E-07	5.68E-05	4.72E-07	-6.92E-05	-9.11E-07	6.74E-05
0.04588	3.79E-07	-5.89E-05	-4.74E-07	5.65E-05	1.04E-06	-6.95E-05	-1.05E-06	6.73E-05
0.0465	-2.16E-07	-5.93E-05	-3.55E-07	5.64E-05	7.05E-07	-6.94E-05	-9.34E-07	6.71E-05
0.04712	-8.59E-08	-5.94E-05	-1.57E-07	5.70E-05	6.81E-07	-6.97E-05	-1.31E-06	6.74E-05
0.04774	4.48E-07	-5.95E-05	-3.13E-07	5.66E-05	7.37E-07	-6.92E-05	-9.94E-07	6.71E-05
0.04836	5.00E-08	-5.90E-05	-1.64E-07	5.66E-05	1.08E-06	-6.96E-05	-1.37E-06	6.72E-05
0.04898	-9.30E-08	-5.90E-05	-1.54E-07	5.64E-05	8.73E-07	-6.98E-05	-7.56E-07	6.72E-05
0.0496	3.49E-07	-5.94E-05	-2.79E-07	5.65E-05	8.74E-07	-6.99E-05	-7.98E-07	6.68E-05
0.05022	-1.72E-08	-5.93E-05	-3.10E-07	5.71E-05	9.79E-07	-6.96E-05	-1.27E-06	6.76E-05
0.05084	5.11E-07	-5.94E-05	-5.15E-07	5.68E-05	8.60E-07	-6.92E-05	-1.49E-06	6.70E-05
0.05146	2.69E-07	-5.92E-05	-2.32E-07	5.65E-05	1.46E-06	-6.94E-05	-8.36E-07	6.72E-05
0.05208	-6.59E-08	-5.97E-05	-3.89E-07	5.73E-05	1.14E-06	-6.93E-05	-6.87E-07	6.69E-05
0.0527	-5.78E-07	-5.91E-05	-4.55E-07	5.67E-05	6.48E-07	-6.99E-05	-1.32E-06	6.71E-05
0.05332	1.85E-07	-5.91E-05	-1.01E-06	5.65E-05	4.72E-07	-6.95E-05	-1.21E-06	6.71E-05
0.05394	-1.99E-07	-5.94E-05	-5.21E-07	5.67E-05	1.40E-06	-6.91E-05	-5.54E-07	6.73E-05
0.05456	1.44E-07	-5.88E-05	-3.71E-07	5.69E-05	3.91E-07	-6.96E-05	-1.35E-06	6.72E-05
0.05518	-1.93E-07	-5.96E-05	-6.89E-07	5.67E-05	8.34E-07	-6.94E-05	-1.17E-06	6.72E-05
0.0558	2.96E-07	-5.93E-05	-2.00E-07	5.65E-05	6.57E-07	-6.97E-05	-1.74E-06	6.71E-05
0.05642	-4.33E-09	-5.93E-05	-5.02E-07	5.71E-05	6.35E-07	-6.93E-05	-1.63E-06	6.74E-05
0.05704	1.79E-07	-5.89E-05	-7.30E-07	5.67E-05	9.49E-07	-6.97E-05	-1.23E-06	6.72E-05
0.05766	1.28E-08	-5.94E-05	3.62E-08	5.71E-05	9.57E-07	-6.88E-05	-1.00E-06	6.66E-05
0.05828	-5.73E-08	-5.94E-05	-2.79E-07	5.68E-05	1.02E-06	-6.93E-05	-9.87E-07	6.68E-05
0.0589	6.64E-07	-5.91E-05	-9.56E-08	5.67E-05	9.16E-07	-6.90E-05	-1.06E-06	6.73E-05
0.05952	7.07E-07	-5.93E-05	-3.16E-07	5.69E-05	8.34E-07	-6.90E-05	-1.28E-06	6.71E-05
0.06014	-1.69E-07	-5.91E-05	-5.71E-07	5.70E-05	8.47E-07	-6.97E-05	-1.13E-06	6.73E-05
0.06076	-3.01E-08	-5.90E-05	-5.81E-07	5.70E-05	1.21E-06	-6.94E-05	-9.47E-07	6.71E-05
0.06138	3.95E-07	-5.92E-05	-6.60E-07	5.67E-05	9.36E-07	-6.92E-05	-1.52E-06	6.72E-05
	1.82E-07	-5.92E-05	-4.19E-07	5.68E-05	8.17E-07	-6.94E-05	-1.10E-06	6.72E-05

APPENDIX C

	Load at Beam 22 with 380 kg (Decreasing Order)				Load at Beam 22 with 500 kg (Decreasing Order)			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	-3.25E-06	-3.94E-05	-1.90E-07	3.47E-05	1.18E-06	-4.89E-05	-1.16E-06	4.74E-05
0.00062	-3.88E-06	-3.93E-05	3.64E-07	3.48E-05	8.38E-07	-4.91E-05	-6.87E-07	4.73E-05
0.00124	-3.35E-06	-3.97E-05	-8.27E-08	3.40E-05	1.41E-06	-4.89E-05	-1.28E-06	4.74E-05
0.00186	-3.15E-06	-3.94E-05	-2.75E-07	3.48E-05	1.36E-06	-4.93E-05	-8.22E-07	4.70E-05
0.00248	-3.52E-06	-3.89E-05	-4.54E-07	3.52E-05	1.64E-06	-4.87E-05	-1.33E-06	4.73E-05
0.0031	-3.63E-06	-3.97E-05	-3.91E-07	3.47E-05	1.00E-06	-4.94E-05	-9.35E-07	4.72E-05
0.00372	-3.21E-06	-3.95E-05	3.29E-09	3.45E-05	1.29E-06	-4.92E-05	-9.67E-07	4.73E-05
0.00434	-3.48E-06	-3.92E-05	-5.05E-07	3.48E-05	1.39E-06	-4.89E-05	-4.91E-07	4.75E-05
0.00496	-3.20E-06	-3.96E-05	-3.95E-07	3.53E-05	1.23E-06	-4.91E-05	-1.28E-06	4.71E-05
0.00558	-2.89E-06	-3.95E-05	-1.01E-09	3.51E-05	1.36E-06	-4.92E-05	-1.32E-06	4.75E-05
0.0062	-3.27E-06	-3.95E-05	2.21E-07	3.48E-05	1.77E-06	-4.87E-05	-1.12E-06	4.74E-05
0.00682	-3.41E-06	-3.95E-05	2.28E-07	3.52E-05	1.22E-06	-4.92E-05	-1.11E-06	4.71E-05
0.00744	-3.37E-06	-3.99E-05	1.34E-07	3.48E-05	7.71E-07	-4.88E-05	-6.37E-07	4.69E-05
0.00806	-2.88E-06	-3.97E-05	2.94E-07	3.52E-05	1.45E-06	-4.88E-05	-1.39E-06	4.73E-05
0.00868	-3.33E-06	-3.91E-05	-1.39E-08	3.52E-05	9.23E-07	-4.88E-05	-7.76E-07	4.73E-05
0.0093	-3.00E-06	-3.93E-05	-1.18E-07	3.50E-05	1.69E-06	-4.91E-05	-1.25E-06	4.75E-05
0.00992	-3.15E-06	-3.95E-05	-1.79E-07	3.52E-05	1.66E-06	-4.86E-05	-6.64E-07	4.68E-05
0.01054	-3.76E-06	-3.94E-05	-5.83E-08	3.56E-05	1.69E-06	-4.90E-05	-9.04E-07	4.71E-05
0.01116	-3.38E-06	-3.90E-05	1.62E-08	3.52E-05	7.41E-07	-4.84E-05	-5.94E-07	4.69E-05
0.01178	-3.21E-06	-3.95E-05	3.17E-07	3.58E-05	5.52E-07	-4.90E-05	-1.31E-06	4.69E-05
0.0124	-3.42E-06	-3.98E-05	-2.66E-07	3.51E-05	9.66E-07	-4.87E-05	-1.25E-06	4.71E-05
0.01302	-3.66E-06	-3.96E-05	2.44E-07	3.46E-05	8.68E-07	-4.88E-05	-3.96E-07	4.73E-05
0.01364	-3.61E-06	-3.91E-05	-4.88E-07	3.49E-05	1.37E-06	-4.91E-05	-8.91E-07	4.69E-05
0.01426	-3.22E-06	-3.98E-05	-4.34E-07	3.50E-05	1.19E-06	-4.91E-05	-6.94E-07	4.70E-05
0.01488	-3.64E-06	-3.95E-05	-6.74E-09	3.52E-05	1.34E-06	-4.92E-05	-3.89E-07	4.71E-05
0.0155	-3.47E-06	-3.93E-05	2.37E-07	3.50E-05	1.65E-06	-4.85E-05	-1.05E-06	4.75E-05
0.01612	-3.28E-06	-3.94E-05	9.93E-08	3.46E-05	1.71E-06	-4.93E-05	-6.89E-07	4.76E-05
0.01674	-3.51E-06	-3.95E-05	-8.12E-07	3.52E-05	1.12E-06	-4.84E-05	-1.40E-06	4.69E-05
0.01736	-3.80E-06	-3.95E-05	-1.59E-07	3.52E-05	9.57E-07	-4.89E-05	-1.11E-06	4.68E-05
0.01798	-3.39E-06	-3.93E-05	-3.85E-07	3.49E-05	1.03E-06	-4.92E-05	-8.05E-07	4.69E-05
0.0186	-3.73E-06	-3.97E-05	2.08E-07	3.46E-05	1.15E-06	-4.88E-05	-9.72E-07	4.70E-05
0.01922	-3.18E-06	-3.98E-05	-3.49E-07	3.49E-05	1.44E-06	-4.91E-05	-1.43E-06	4.72E-05
0.01984	-3.28E-06	-3.93E-05	-9.61E-09	3.58E-05	1.54E-06	-4.91E-05	-1.12E-06	4.73E-05
0.02046	-3.49E-06	-4.03E-05	-2.96E-07	3.52E-05	1.28E-06	-4.94E-05	-9.61E-07	4.68E-05
0.02108	-3.65E-06	-3.97E-05	-3.91E-07	3.54E-05	1.38E-06	-4.90E-05	-9.39E-07	4.75E-05
0.0217	-3.89E-06	-3.94E-05	3.04E-07	3.46E-05	1.62E-06	-4.92E-05	-9.19E-07	4.68E-05
0.02232	-3.22E-06	-4.00E-05	4.32E-07	3.53E-05	1.38E-06	-4.92E-05	-1.00E-06	4.67E-05
0.02294	-3.54E-06	-3.95E-05	-2.47E-07	3.51E-05	1.26E-06	-4.90E-05	-8.63E-07	4.70E-05
0.02356	-3.51E-06	-3.94E-05	-6.80E-07	3.48E-05	1.29E-06	-4.94E-05	-1.26E-06	4.72E-05
0.02418	-3.63E-06	-3.95E-05	-1.74E-07	3.50E-05	1.22E-06	-4.91E-05	-2.47E-07	4.69E-05
0.0248	-3.55E-06	-3.95E-05	1.35E-07	3.50E-05	1.23E-06	-4.88E-05	-1.31E-06	4.70E-05
0.02542	-3.43E-06	-3.94E-05	-5.60E-07	3.44E-05	1.16E-06	-4.92E-05	-1.38E-06	4.68E-05
0.02604	-3.63E-06	-3.97E-05	-3.18E-07	3.51E-05	1.12E-06	-4.92E-05	-9.06E-07	4.71E-05
0.02666	-3.35E-06	-3.96E-05	5.49E-08	3.53E-05	1.21E-06	-4.86E-05	-4.91E-07	4.70E-05
0.02728	-3.28E-06	-3.98E-05	-1.79E-07	3.49E-05	8.20E-07	-4.92E-05	-1.32E-06	4.74E-05
0.0279	-3.38E-06	-3.98E-05	-1.99E-07	3.47E-05	1.04E-06	-4.92E-05	-1.22E-06	4.74E-05
0.02852	-3.59E-06	-3.92E-05	-4.97E-07	3.54E-05	9.77E-07	-4.94E-05	-1.27E-06	4.69E-05
0.02914	-3.64E-06	-3.99E-05	3.19E-08	3.51E-05	1.26E-06	-4.87E-05	-9.28E-07	4.71E-05
0.02976	-3.28E-06	-3.94E-05	-5.86E-07	3.45E-05	1.06E-06	-4.93E-05	-1.37E-06	4.73E-05
0.03038	-3.12E-06	-3.93E-05	-3.18E-07	3.52E-05	1.37E-06	-4.92E-05	-1.12E-06	4.69E-05
0.031	-3.84E-06	-3.96E-05	-2.75E-07	3.52E-05	1.11E-06	-4.94E-05	-1.18E-06	4.70E-05
0.03162	-2.82E-06	-3.92E-05	5.92E-08	3.50E-05	1.03E-06	-4.91E-05	-9.94E-07	4.75E-05
0.03224	-3.48E-06	-3.96E-05	-5.07E-07	3.51E-05	1.45E-06	-4.90E-05	-1.02E-06	4.73E-05
0.03286	-3.58E-06	-3.95E-05	1.85E-07	3.47E-05	8.41E-07	-4.91E-05	-1.28E-06	4.71E-05
0.03348	-3.14E-06	-3.96E-05	8.21E-08	3.52E-05	1.99E-06	-4.93E-05	-6.26E-07	4.68E-05
0.0341	-3.47E-06	-3.95E-05	-1.04E-07	3.44E-05	1.31E-06	-4.94E-05	-4.90E-07	4.64E-05
0.03472	-3.34E-06	-3.95E-05	-8.12E-08	3.46E-05	1.49E-06	-4.89E-05	-4.51E-07	4.72E-05
0.03534	-3.72E-06	-3.96E-05	-3.25E-07	3.50E-05	1.27E-06	-4.91E-05	-1.07E-06	4.67E-05
0.03596	-3.37E-06	-3.95E-05	-6.40E-08	3.52E-05	1.45E-06	-4.97E-05	-1.22E-06	4.73E-05
0.03658	-3.79E-06	-3.97E-05	-3.42E-07	3.51E-05	1.40E-06	-4.91E-05	-7.69E-07	4.73E-05
0.0372	-3.57E-06	-3.95E-05	-9.61E-09	3.52E-05	1.47E-06	-4.90E-05	-5.57E-07	4.70E-05
0.03782	-3.52E-06	-3.93E-05	-5.86E-07	3.51E-05	6.27E-07	-4.88E-05	-8.63E-07	4.70E-05
0.03844	-3.49E-06	-3.92E-05	-8.46E-07	3.47E-05	6.25E-07	-4.92E-05	-1.36E-06	4.77E-05
0.03906	-3.48E-06	-3.92E-05	6.35E-08	3.53E-05	8.93E-07	-4.85E-05	-7.66E-07	4.68E-05
0.03968	-3.29E-06	-4.02E-05	-5.08E-07	3.50E-05	1.08E-06	-4.90E-05	-8.61E-07	4.68E-05
0.0403	-3.49E-06	-3.93E-05	-1.50E-07	3.55E-05	1.33E-06	-4.93E-05	-9.42E-07	4.78E-05
0.04092	-3.35E-06	-3.95E-05	-3.09E-07	3.51E-05	1.33E-06	-4.91E-05	-9.48E-07	4.74E-05
0.04154	-3.30E-06	-3.96E-05	-1.60E-07	3.51E-05	1.35E-06	-4.93E-05	-9.74E-07	4.73E-05
0.04216	-3.60E-06	-3.97E-05	-2.12E-07	3.51E-05	1.16E-06	-4.95E-05	-1.07E-06	4.69E-05
0.04278	-3.37E-06	-3.95E-05	-1.40E-07	3.51E-05	1.36E-06	-4.90E-05	-9.42E-07	4.67E-05
0.0434	-3.58E-06	-3.97E-05	-3.40E-08	3.48E-05	1.77E-06	-4.93E-05	-1.39E-06	4.73E-05
0.04402	-3.50E-06	-3.94E-05	2.20E-07	3.48E-05	1.39E-06	-4.94E-05	-1.21E-06	4.66E-05
0.04464	-3.57E-06	-3.93E-05	-2.88E-07	3.48E-05	1.16E-06	-4.89E-05	-1.33E-06	4.68E-05
0.04526	-3.75E-06	-3.95E-05	-8.98E-08	3.51E-05	1.24E-06	-4.88E-05	-1.15E-06	4.73E-05
0.04588	-3.54E-06	-3.96E-05	-4.38E-07	3.47E-05	1.74E-06	-4.89E-05	-1.10E-06	4.71E-05
0.0465	-3.13E-06	-3.94E-05	-2.96E-07	3.53E-05	1.27E-06	-4.87E-05	-9.57E-07	4.71E-05
0.04712	-3.22E-06	-3.93E-05	-2.82E-07	3.51E-05	1.45E-06	-4.90E-05	-1.32E-06	4.74E-05
0.04774	-3.01E-06	-3.92E-05	-4.42E-07	3.55E-05	1.37E-06	-4.90E-05	-6.54E-07	4.67E-05
0.04836	-3.51E-06	-3.99E-05	-4.27E-07	3.50E-05	1.08E-06	-4.91E-05	-9.06E-07	4.69E-05
0.04898	-3.68E-06	-3.96E-05	-1.29E-07	3.51E-05	1.34E-06	-4.90E-05	-5.55E-07	4.71E-05
0.0496	-3.54E-06	-3.96E-05	-3.18E-07	3.51E-05	1.16E-06	-4.91E-05	-1.22E-06	4.74E-05
0.05022	-3.83E-06	-3.99E-05	-2.75E-07	3.48E-05	9.91E-07	-4.92E-05	-1.23E-06	4.74E-05
0.05084	-3.39E-06	-3.94E-05	-6.44E-07	3.54E-05	1.29E-06	-4.91E-05	-9.78E-07	4.68E-05
0.05146	-3.16E-06	-3.89E-05	-3.09E-07	3.47E-05	1.61E-06	-4.92E-05	-9.77E-07	4.71E-05
0.05208	-3.55E-06	-3.93E-05	-1.43E-07	3.51E-05	1.26E-06	-4.88E-05	-9.05E-07	4.70E-05
0.0527	-3.81E-06	-3.93E-05	-2.40E-07	3.56E-05	1.37E-06	-4.93E-05	-1.41E-06	4.69E-05
0.05332	-3.24E-06	-3.90E-05	-7.12E-08	3.51E-05	1.30E-06	-4.92E-05	-7.70E-07	4.72E-05
0.05394	-3.53E-06	-3.98E-05	-3.11E-08	3.51E-05	1.26E-06	-4.90E-05	-1.34E-06	4.64E-05
0.05456	-3.48E-06	-3.98E-05	1.14E-07	3.56E-05	1.15E-06	-4.91E-05	-1.40E-06	4.69E-05
0.05518	-2.92E-06	-3.97E-05	3.06E-07	3.49E-05	1.20E-06	-4.90E-05	-9.72E-07	4.70E-05
0.0558	-3.33E-06	-3.93E-05	-6.26E-08	3.50E-05	1.37E-06	-4.94E-05	-8.39E-07	4.69E-05
0.05642	-3.63E-06	-3.94E-05	4.72E-09	3.50E-05	1.48E-06	-4.90E-05	-1.52E-06	4.74E-05
0.05704	-3.43E-06	-3.95E-05	3.24E-07	3.51E-05	1.02E-06	-4.95E-05	-7.90E-07	4.69E-05
0.05766	-3.22E-06	-3.95E-05	-3.74E-07	3.50E-05	1.15E-06	-4.94E-05	-7.25E-07	4.66E-05
0.05828	-3.19E-06	-3.89E-05	-1.39E-08	3.53E-05	1.45E-06	-4.86E-05	-5.78E-07	4.72E-05
0.0589	-3.40E-06	-3.94E-05	-6.26E-08	3.53E-05	9.36E-07	-4.91E-05	-8.89E-07	4.69E-05
0.05952	-3.44E-06	-3.96E-05	-4.15E-07	3.49E-05	1.24E-06	-4.95E-05	-1.52E-06	4.69E-05
0.06014	-3.58E-06	-3.97E-05	-2.07E-07	3.49E-05	1.37E-06	-4.95E-05	-8.33E-07	4.72E-05
0.06076	-3.64E-06	-3.97E-05	-1.01E-07	3.52E-05	1.17E-06	-4.91E-05	-7.83E-07	4.77E-05
0.06138	-3.67E-06	-3.97E-05	-2.82E-07	3.53E-05	1.30E-06	-4.89E-05	-1.06E-06	4.70E-05
	-3.43E-06	-3.95E-05	-1.59E-07	3.50E-05	1.26E-06	-4.91E-05	-9.94E-07	4.71E-05

APPENDIX C

	Load at Beam 22 with 600 kg (Decreasing Order)				Load at Beam 22 with 700 kg (Decreasing Order)			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	1.05E-06	-5.94E-05	-1.53E-06	5.65E-05	9.90E-07	-6.91E-05	-9.35E-07	6.85E-05
0.00062	1.20E-06	-5.89E-05	-1.05E-06	5.74E-05	8.23E-07	-6.94E-05	-9.32E-07	6.84E-05
0.00124	1.14E-06	-5.90E-05	-1.08E-06	5.66E-05	8.30E-07	-6.92E-05	-8.19E-07	6.82E-05
0.00186	1.47E-06	-5.89E-05	-9.88E-07	5.73E-05	9.66E-07	-6.90E-05	-1.27E-06	6.77E-05
0.00248	1.17E-06	-5.94E-05	-4.68E-07	5.70E-05	5.91E-07	-6.95E-05	-1.34E-06	6.82E-05
0.0031	1.29E-06	-5.92E-05	-4.09E-07	5.73E-05	1.10E-06	-6.90E-05	-7.32E-07	6.79E-05
0.00372	1.47E-06	-5.90E-05	-1.58E-06	5.69E-05	4.42E-07	-6.93E-05	-5.80E-07	6.82E-05
0.00434	1.04E-06	-5.87E-05	-1.14E-06	5.70E-05	9.03E-07	-6.93E-05	-8.25E-07	6.82E-05
0.00496	1.63E-06	-5.90E-05	-1.09E-06	5.69E-05	8.31E-07	-6.93E-05	-1.10E-06	6.83E-05
0.00558	1.12E-06	-5.92E-05	-1.33E-06	5.74E-05	7.44E-07	-6.91E-05	-1.17E-06	6.77E-05
0.0062	1.13E-06	-5.93E-05	-1.19E-06	5.71E-05	6.42E-07	-6.92E-05	-1.32E-06	6.79E-05
0.00682	1.24E-06	-5.88E-05	-7.09E-07	5.66E-05	4.56E-07	-6.93E-05	-1.50E-06	6.77E-05
0.00744	1.10E-06	-5.92E-05	-8.52E-07	5.65E-05	9.01E-07	-6.95E-05	-1.27E-06	6.86E-05
0.00806	9.57E-07	-5.88E-05	-7.69E-07	5.72E-05	5.61E-07	-6.92E-05	-1.19E-06	6.78E-05
0.00868	1.06E-06	-5.90E-05	-8.65E-07	5.74E-05	9.03E-07	-6.92E-05	-5.58E-07	6.79E-05
0.0093	1.42E-06	-5.95E-05	-1.11E-06	5.67E-05	7.01E-07	-6.93E-05	-7.96E-07	6.81E-05
0.00992	1.15E-06	-5.91E-05	-1.13E-06	5.72E-05	6.64E-07	-6.92E-05	-1.04E-06	6.75E-05
0.01054	8.47E-07	-5.91E-05	-1.33E-06	5.70E-05	1.16E-06	-6.91E-05	-1.46E-06	6.79E-05
0.01116	1.11E-06	-5.91E-05	-1.07E-06	5.71E-05	4.12E-07	-6.96E-05	-1.43E-06	6.83E-05
0.01178	1.24E-06	-5.90E-05	-1.14E-06	5.69E-05	9.01E-07	-6.90E-05	-1.19E-06	6.84E-05
0.0124	1.06E-06	-5.89E-05	-7.52E-07	5.72E-05	8.28E-07	-6.97E-05	-9.42E-07	6.80E-05
0.01302	1.07E-06	-5.95E-05	-8.82E-07	5.72E-05	8.78E-07	-6.98E-05	-1.01E-06	6.81E-05
0.01364	1.15E-06	-5.90E-05	-1.28E-06	5.72E-05	9.41E-07	-6.96E-05	-1.21E-06	6.81E-05
0.01426	1.48E-06	-5.90E-05	-1.30E-06	5.65E-05	1.19E-07	-6.92E-05	-1.20E-06	6.82E-05
0.01488	9.97E-07	-5.89E-05	-5.74E-07	5.68E-05	7.25E-07	-6.92E-05	-1.16E-06	6.81E-05
0.0155	1.47E-06	-5.90E-05	-1.91E-06	5.67E-05	7.37E-07	-6.95E-05	-8.58E-07	6.80E-05
0.01612	7.22E-07	-5.90E-05	-1.20E-06	5.70E-05	8.36E-07	-6.95E-05	-1.12E-06	6.80E-05
0.01674	1.02E-06	-5.91E-05	-1.28E-06	5.71E-05	8.31E-07	-6.92E-05	-8.72E-07	6.77E-05
0.01736	1.21E-06	-5.92E-05	-6.47E-07	5.69E-05	5.47E-07	-6.91E-05	-7.59E-07	6.83E-05
0.01798	1.36E-06	-5.92E-05	-1.00E-06	5.72E-05	8.68E-07	-6.95E-05	-1.26E-06	6.83E-05
0.0186	1.05E-06	-5.93E-05	-9.57E-07	5.66E-05	9.31E-07	-6.95E-05	-1.30E-06	6.81E-05
0.01922	1.13E-06	-5.89E-05	-6.80E-07	5.69E-05	8.88E-07	-6.97E-05	-1.17E-06	6.81E-05
0.01984	9.19E-07	-5.91E-05	-1.08E-06	5.68E-05	6.08E-07	-6.97E-05	-9.19E-07	6.83E-05
0.02046	1.29E-06	-5.93E-05	-7.88E-07	5.71E-05	1.17E-06	-6.93E-05	-7.02E-07	6.83E-05
0.02108	1.54E-06	-5.94E-05	-1.67E-06	5.75E-05	7.04E-07	-6.92E-05	-1.23E-06	6.79E-05
0.0217	1.18E-06	-5.92E-05	-1.41E-06	5.68E-05	4.78E-07	-6.94E-05	-6.59E-07	6.84E-05
0.02232	1.30E-06	-5.90E-05	-6.20E-07	5.70E-05	6.37E-07	-6.96E-05	-8.71E-07	6.85E-05
0.02294	1.04E-06	-5.91E-05	-1.43E-06	5.67E-05	9.87E-07	-6.96E-05	-1.18E-06	6.77E-05
0.02356	1.24E-06	-5.92E-05	-7.65E-07	5.70E-05	1.09E-06	-6.91E-05	-1.14E-06	6.79E-05
0.02418	1.20E-06	-5.90E-05	-1.69E-06	5.70E-05	9.77E-07	-6.92E-05	-7.35E-07	6.81E-05
0.0248	8.91E-07	-5.88E-05	-5.68E-07	5.71E-05	1.02E-06	-6.96E-05	-1.73E-06	6.82E-05
0.02542	1.07E-06	-5.93E-05	-5.27E-07	5.71E-05	9.60E-07	-6.95E-05	-8.69E-07	6.82E-05
0.02604	1.34E-06	-5.91E-05	-1.54E-06	5.72E-05	9.56E-07	-6.97E-05	-7.85E-07	6.84E-05
0.02666	7.85E-07	-5.95E-05	-6.46E-07	5.68E-05	4.91E-07	-6.95E-05	-5.08E-07	6.82E-05
0.02728	1.34E-06	-5.93E-05	-1.32E-06	5.67E-05	8.07E-07	-6.95E-05	-1.30E-06	6.80E-05
0.0279	1.10E-06	-5.93E-05	-8.03E-07	5.71E-05	5.94E-07	-6.92E-05	-4.16E-07	6.83E-05
0.02852	1.20E-06	-5.97E-05	-1.09E-06	5.73E-05	5.62E-07	-6.93E-05	-7.09E-07	6.82E-05
0.02914	1.12E-06	-5.96E-05	-1.25E-06	5.68E-05	9.99E-07	-6.90E-05	-1.31E-06	6.79E-05
0.02976	9.43E-07	-5.92E-05	-9.72E-07	5.68E-05	9.11E-07	-6.95E-05	-1.42E-06	6.84E-05
0.03038	7.73E-07	-5.92E-05	-1.65E-06	5.71E-05	1.27E-06	-6.95E-05	-8.56E-07	6.82E-05
0.031	6.74E-07	-5.89E-05	-1.15E-06	5.71E-05	4.01E-07	-6.93E-05	-1.21E-06	6.81E-05
0.03162	1.04E-06	-5.92E-05	-6.08E-07	5.70E-05	9.03E-07	-6.92E-05	-1.25E-06	6.84E-05
0.03224	1.32E-06	-5.90E-05	-5.63E-07	5.69E-05	5.49E-07	-6.96E-05	-1.03E-06	6.80E-05
0.03286	9.20E-07	-5.87E-05	-1.16E-06	5.73E-05	7.33E-07	-6.92E-05	-1.23E-06	6.80E-05
0.03348	9.60E-07	-5.91E-05	-9.87E-07	5.69E-05	5.61E-07	-6.93E-05	-1.09E-06	6.79E-05
0.0341	9.71E-07	-5.94E-05	-9.02E-07	5.73E-05	1.31E-06	-6.94E-05	-7.80E-07	6.84E-05
0.03472	9.51E-07	-5.90E-05	-1.06E-06	5.67E-05	1.08E-06	-6.95E-05	-1.06E-06	6.83E-05
0.03534	9.84E-07	-5.93E-05	-1.28E-06	5.66E-05	1.13E-06	-6.96E-05	-1.08E-06	6.79E-05
0.03596	9.34E-07	-5.91E-05	-9.35E-07	5.64E-05	6.74E-07	-6.91E-05	-1.14E-06	6.83E-05
0.03658	1.28E-06	-5.87E-05	-1.04E-06	5.69E-05	3.48E-07	-6.93E-05	-1.54E-06	6.79E-05
0.0372	1.78E-06	-5.89E-05	-7.88E-07	5.70E-05	3.75E-07	-6.92E-05	-9.27E-07	6.83E-05
0.03782	1.38E-06	-5.87E-05	-1.03E-06	5.71E-05	6.18E-07	-6.95E-05	-1.46E-06	6.85E-05
0.03844	9.26E-07	-5.91E-05	-9.77E-07	5.68E-05	9.73E-07	-6.93E-05	-1.44E-06	6.83E-05
0.03906	8.93E-07	-5.91E-05	-1.13E-06	5.75E-05	2.98E-07	-6.94E-05	-9.57E-07	6.83E-05
0.03968	8.66E-07	-5.91E-05	-1.20E-06	5.70E-05	8.64E-07	-6.95E-05	-1.60E-06	6.77E-05
0.0403	1.47E-06	-5.92E-05	-1.27E-06	5.71E-05	1.03E-06	-6.95E-05	-1.65E-06	6.81E-05
0.04092	1.32E-06	-5.93E-05	-9.51E-07	5.70E-05	1.03E-06	-6.91E-05	-9.74E-07	6.79E-05
0.04154	1.04E-06	-5.87E-05	-1.81E-06	5.77E-05	6.62E-07	-6.97E-05	-1.32E-06	6.77E-05
0.04216	1.33E-06	-5.87E-05	-1.30E-06	5.65E-05	1.23E-06	-6.93E-05	-1.25E-06	6.79E-05
0.04278	1.36E-06	-5.92E-05	-1.37E-06	5.66E-05	8.46E-07	-6.92E-05	-1.53E-06	6.82E-05
0.0434	1.05E-06	-5.93E-05	-8.74E-07	5.69E-05	7.20E-07	-6.90E-05	-9.58E-07	6.81E-05
0.04402	1.14E-06	-5.90E-05	-7.89E-07	5.68E-05	9.61E-07	-6.96E-05	-9.70E-07	6.81E-05
0.04464	1.15E-06	-5.88E-05	-7.02E-07	5.70E-05	9.59E-07	-6.93E-05	-1.02E-06	6.80E-05
0.04526	8.63E-07	-5.91E-05	-1.03E-06	5.71E-05	4.72E-07	-6.92E-05	-9.11E-07	6.79E-05
0.04588	1.89E-06	-5.90E-05	-1.14E-06	5.70E-05	1.04E-06	-6.95E-05	-1.05E-06	6.80E-05
0.0465	1.20E-06	-5.90E-05	-1.06E-06	5.67E-05	7.05E-07	-6.94E-05	-9.34E-07	6.82E-05
0.04712	1.34E-06	-5.90E-05	-6.36E-07	5.71E-05	6.81E-07	-6.97E-05	-1.31E-06	6.79E-05
0.04774	8.73E-07	-5.85E-05	-1.19E-06	5.73E-05	7.37E-07	-6.92E-05	-9.94E-07	6.82E-05
0.04836	1.00E-06	-5.94E-05	-1.04E-06	5.70E-05	1.08E-06	-6.96E-05	-1.37E-06	6.81E-05
0.04898	9.84E-07	-5.90E-05	-9.42E-07	5.71E-05	8.73E-07	-6.98E-05	-7.56E-07	6.81E-05
0.0496	1.25E-06	-5.89E-05	-1.20E-06	5.69E-05	8.74E-07	-6.99E-05	-7.98E-07	6.85E-05
0.05022	1.41E-06	-5.92E-05	-1.31E-06	5.70E-05	9.79E-07	-6.96E-05	-1.27E-06	6.77E-05
0.05084	9.29E-07	-5.93E-05	-9.68E-07	5.68E-05	8.60E-07	-6.92E-05	-1.49E-06	6.83E-05
0.05146	1.11E-06	-5.89E-05	-1.07E-06	5.74E-05	1.46E-06	-6.94E-05	-8.36E-07	6.81E-05
0.05208	1.07E-06	-5.92E-05	-1.10E-06	5.71E-05	1.14E-06	-6.93E-05	-6.87E-07	6.84E-05
0.0527	1.19E-06	-5.90E-05	-9.81E-07	5.62E-05	6.48E-07	-6.99E-05	-1.32E-06	6.82E-05
0.05332	1.34E-06	-5.93E-05	-9.12E-07	5.74E-05	4.72E-07	-6.95E-05	-1.21E-06	6.82E-05
0.05394	1.13E-06	-5.91E-05	-1.19E-06	5.73E-05	1.40E-06	-6.91E-05	-5.54E-07	6.80E-05
0.05456	1.55E-06	-5.90E-05	-6.46E-07	5.72E-05	3.91E-07	-6.96E-05	-1.35E-06	6.81E-05
0.05518	1.17E-06	-5.92E-05	-9.77E-07	5.69E-05	8.34E-07	-6.94E-05	-1.17E-06	6.81E-05
0.0558	1.07E-06	-5.88E-05	-6.73E-07	5.66E-05	6.57E-07	-6.97E-05	-1.74E-06	6.82E-05
0.05642	1.17E-06	-5.93E-05	-1.40E-06	5.73E-05	6.35E-07	-6.93E-05	-1.63E-06	6.79E-05
0.05704	1.33E-06	-5.93E-05	-5.96E-07	5.72E-05	9.49E-07	-6.97E-05	-1.23E-06	6.81E-05
0.05766	9.13E-07	-5.95E-05	-1.32E-06	5.70E-05	9.57E-07	-6.88E-05	-1.00E-06	6.87E-05
0.05828	1.33E-06	-5.87E-05	-9.54E-07	5.73E-05	1.02E-06	-6.93E-05	-9.87E-07	6.85E-05
0.0589	1.46E-06	-5.93E-05	-7.19E-07	5.70E-05	9.16E-07	-6.90E-05	-1.06E-06	6.80E-05
0.05952	1.21E-06	-5.94E-05	-1.19E-06	5.76E-05	8.34E-07	-6.90E-05	-1.28E-06	6.82E-05
0.06014	1.20E-06	-5.89E-05	-9.51E-07	5.70E-05	8.47E-07	-6.97E-05	-1.13E-06	6.80E-05
0.06076	1.32E-06	-5.94E-05	-1.29E-06	5.68E-05	1.21E-06	-6.94E-05	-9.47E-07	6.82E-05
0.06138	1.18E-06	-5.91E-05	-1.34E-06	5.73E-05	9.36E-07	-6.92E-05	-1.52E-06	6.81E-05
	1.16E-06	-5.91E-05	-1.05E-06	5.70E-05	8.17E-07	-6.94E-05	-1.10E-06	6.81E-05

APPENDIX C

	Load at Beam 23 with 380 kg				Load at Beam 23 with 500 kg			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	3.09E-05	-9.20E-06	-4.60E-05	1.88E-05	4.86E-05	2.26E-05	-5.05E-05	-3.80E-05
0.00062	3.11E-05	-9.14E-06	-4.56E-05	1.91E-05	4.94E-05	2.33E-05	-5.13E-05	-3.80E-05
0.00124	3.07E-05	-9.15E-06	-4.58E-05	1.94E-05	4.86E-05	2.34E-05	-5.08E-05	-3.78E-05
0.00186	3.08E-05	-9.61E-06	-4.63E-05	1.93E-05	4.92E-05	2.36E-05	-5.09E-05	-3.82E-05
0.00248	3.09E-05	-9.32E-06	-4.54E-05	1.91E-05	4.85E-05	2.29E-05	-5.13E-05	-3.80E-05
0.0031	3.08E-05	-8.78E-06	-4.59E-05	1.90E-05	4.92E-05	2.30E-05	-5.05E-05	-3.83E-05
0.00372	3.08E-05	-9.35E-06	-4.59E-05	1.89E-05	4.86E-05	2.29E-05	-5.12E-05	-3.78E-05
0.00434	3.09E-05	-9.29E-06	-4.57E-05	1.92E-05	4.87E-05	2.35E-05	-5.09E-05	-3.84E-05
0.00496	3.12E-05	-9.35E-06	-4.58E-05	1.88E-05	4.86E-05	2.37E-05	-5.10E-05	-3.83E-05
0.00558	3.09E-05	-8.91E-06	-4.61E-05	1.93E-05	4.85E-05	2.33E-05	-5.10E-05	-3.79E-05
0.0062	3.15E-05	-9.05E-06	-4.61E-05	1.93E-05	4.91E-05	2.28E-05	-5.11E-05	-3.83E-05
0.00682	3.09E-05	-9.29E-06	-4.58E-05	1.91E-05	4.86E-05	2.36E-05	-5.14E-05	-3.83E-05
0.00744	3.07E-05	-9.50E-06	-4.59E-05	1.91E-05	4.95E-05	2.34E-05	-5.07E-05	-3.78E-05
0.00806	3.11E-05	-8.96E-06	-4.60E-05	1.86E-05	4.88E-05	2.32E-05	-5.09E-05	-3.83E-05
0.00868	3.13E-05	-8.98E-06	-4.56E-05	1.85E-05	4.91E-05	2.29E-05	-5.09E-05	-3.84E-05
0.0093	3.11E-05	-9.49E-06	-4.59E-05	1.92E-05	4.90E-05	2.31E-05	-5.09E-05	-3.83E-05
0.00992	3.14E-05	-8.77E-06	-4.56E-05	1.93E-05	4.84E-05	2.37E-05	-5.07E-05	-3.84E-05
0.01054	3.15E-05	-9.34E-06	-4.58E-05	1.89E-05	4.90E-05	2.29E-05	-5.12E-05	-3.85E-05
0.01116	3.07E-05	-9.09E-06	-4.61E-05	1.90E-05	4.91E-05	2.29E-05	-5.08E-05	-3.77E-05
0.01178	3.07E-05	-8.85E-06	-4.54E-05	1.94E-05	4.87E-05	2.34E-05	-5.12E-05	-3.80E-05
0.0124	3.14E-05	-8.98E-06	-4.57E-05	1.91E-05	4.88E-05	2.28E-05	-5.08E-05	-3.83E-05
0.01302	3.11E-05	-9.11E-06	-4.58E-05	1.90E-05	4.89E-05	2.31E-05	-5.09E-05	-3.83E-05
0.01364	3.09E-05	-8.99E-06	-4.58E-05	1.95E-05	4.92E-05	2.34E-05	-5.08E-05	-3.83E-05
0.01426	3.09E-05	-9.24E-06	-4.58E-05	1.92E-05	4.86E-05	2.31E-05	-5.11E-05	-3.81E-05
0.01488	3.09E-05	-8.77E-06	-4.60E-05	1.90E-05	4.89E-05	2.31E-05	-5.14E-05	-3.85E-05
0.0155	3.12E-05	-9.27E-06	-4.62E-05	1.91E-05	4.85E-05	2.34E-05	-5.11E-05	-3.83E-05
0.01612	3.08E-05	-9.12E-06	-4.61E-05	1.89E-05	4.90E-05	2.29E-05	-5.10E-05	-3.82E-05
0.01674	3.13E-05	-9.68E-06	-4.56E-05	1.89E-05	4.91E-05	2.32E-05	-5.08E-05	-3.81E-05
0.01736	3.13E-05	-9.10E-06	-4.62E-05	1.91E-05	4.84E-05	2.37E-05	-5.07E-05	-3.80E-05
0.01798	3.08E-05	-8.62E-06	-4.62E-05	1.93E-05	4.88E-05	2.36E-05	-5.08E-05	-3.80E-05
0.0186	3.10E-05	-8.82E-06	-4.50E-05	1.90E-05	4.89E-05	2.31E-05	-5.06E-05	-3.83E-05
0.01922	3.13E-05	-9.16E-06	-4.63E-05	1.89E-05	4.86E-05	2.30E-05	-5.07E-05	-3.80E-05
0.01984	3.12E-05	-9.68E-06	-4.54E-05	1.90E-05	4.87E-05	2.27E-05	-5.08E-05	-3.83E-05
0.02046	3.09E-05	-9.03E-06	-4.57E-05	1.88E-05	4.93E-05	2.31E-05	-5.13E-05	-3.84E-05
0.02108	3.06E-05	-9.19E-06	-4.58E-05	1.89E-05	4.93E-05	2.30E-05	-5.09E-05	-3.81E-05
0.0217	3.12E-05	-9.61E-06	-4.59E-05	1.94E-05	4.86E-05	2.33E-05	-5.07E-05	-3.83E-05
0.02232	3.13E-05	-9.16E-06	-4.60E-05	1.88E-05	4.88E-05	2.31E-05	-5.08E-05	-3.85E-05
0.02294	3.12E-05	-8.99E-06	-4.63E-05	1.92E-05	4.88E-05	2.32E-05	-5.07E-05	-3.85E-05
0.02356	3.12E-05	-8.78E-06	-4.62E-05	1.92E-05	4.91E-05	2.33E-05	-5.02E-05	-3.82E-05
0.02418	3.10E-05	-9.16E-06	-4.56E-05	1.90E-05	4.90E-05	2.29E-05	-5.09E-05	-3.84E-05
0.0248	3.08E-05	-9.48E-06	-4.63E-05	1.91E-05	4.87E-05	2.32E-05	-5.08E-05	-3.81E-05
0.02542	3.09E-05	-9.28E-06	-4.56E-05	1.91E-05	4.87E-05	2.33E-05	-5.09E-05	-3.81E-05
0.02604	3.08E-05	-9.15E-06	-4.58E-05	1.88E-05	4.89E-05	2.31E-05	-5.06E-05	-3.86E-05
0.02666	3.10E-05	-9.43E-06	-4.57E-05	1.90E-05	4.88E-05	2.30E-05	-5.05E-05	-3.84E-05
0.02728	3.15E-05	-9.29E-06	-4.56E-05	1.92E-05	4.85E-05	2.30E-05	-5.13E-05	-3.80E-05
0.0279	3.13E-05	-9.17E-06	-4.58E-05	1.87E-05	4.95E-05	2.30E-05	-5.10E-05	-3.76E-05
0.02852	3.11E-05	-9.45E-06	-4.60E-05	1.91E-05	4.96E-05	2.33E-05	-5.11E-05	-3.80E-05
0.02914	3.12E-05	-9.41E-06	-4.60E-05	1.90E-05	4.91E-05	2.28E-05	-5.11E-05	-3.82E-05
0.02976	3.11E-05	-9.27E-06	-4.61E-05	1.89E-05	4.92E-05	2.31E-05	-5.07E-05	-3.83E-05
0.03038	3.15E-05	-9.18E-06	-4.59E-05	1.89E-05	4.88E-05	2.36E-05	-5.16E-05	-3.77E-05
0.031	3.12E-05	-8.83E-06	-4.58E-05	1.88E-05	4.90E-05	2.29E-05	-5.07E-05	-3.77E-05
0.03162	3.11E-05	-9.04E-06	-4.60E-05	1.90E-05	4.89E-05	2.32E-05	-5.07E-05	-3.83E-05
0.03224	3.12E-05	-9.14E-06	-4.62E-05	1.93E-05	4.90E-05	2.31E-05	-5.13E-05	-3.79E-05
0.03286	3.10E-05	-8.97E-06	-4.58E-05	1.92E-05	4.91E-05	2.31E-05	-5.09E-05	-3.81E-05
0.03348	3.08E-05	-9.06E-06	-4.60E-05	1.90E-05	4.88E-05	2.28E-05	-5.06E-05	-3.81E-05
0.0341	3.10E-05	-9.41E-06	-4.57E-05	1.94E-05	4.96E-05	2.35E-05	-5.09E-05	-3.81E-05
0.03472	3.07E-05	-9.15E-06	-4.60E-05	1.88E-05	4.86E-05	2.31E-05	-5.06E-05	-3.81E-05
0.03534	3.11E-05	-9.25E-06	-4.55E-05	1.91E-05	4.91E-05	2.30E-05	-5.12E-05	-3.79E-05
0.03596	3.12E-05	-9.18E-06	-4.62E-05	1.86E-05	4.93E-05	2.33E-05	-5.06E-05	-3.77E-05
0.03658	3.10E-05	-9.53E-06	-4.60E-05	1.92E-05	4.89E-05	2.34E-05	-5.09E-05	-3.83E-05
0.0372	3.09E-05	-8.99E-06	-4.56E-05	1.93E-05	4.89E-05	2.31E-05	-5.10E-05	-3.82E-05
0.03782	3.13E-05	-9.51E-06	-4.54E-05	1.88E-05	4.92E-05	2.35E-05	-5.09E-05	-3.83E-05
0.03844	3.10E-05	-9.51E-06	-4.57E-05	1.89E-05	4.91E-05	2.32E-05	-5.08E-05	-3.80E-05
0.03906	3.12E-05	-8.79E-06	-4.62E-05	1.91E-05	4.92E-05	2.32E-05	-5.12E-05	-3.78E-05
0.03968	3.12E-05	-9.30E-06	-4.60E-05	1.92E-05	4.96E-05	2.30E-05	-5.07E-05	-3.86E-05
0.0403	3.05E-05	-8.98E-06	-4.55E-05	1.91E-05	4.89E-05	2.28E-05	-5.09E-05	-3.83E-05
0.04092	3.11E-05	-8.97E-06	-4.61E-05	1.89E-05	4.90E-05	2.31E-05	-5.10E-05	-3.85E-05
0.04154	3.11E-05	-9.92E-06	-4.63E-05	1.86E-05	4.88E-05	2.30E-05	-5.07E-05	-3.83E-05
0.04216	3.10E-05	-9.04E-06	-4.55E-05	1.95E-05	4.88E-05	2.34E-05	-5.11E-05	-3.81E-05
0.04278	3.13E-05	-9.17E-06	-4.59E-05	1.89E-05	4.90E-05	2.33E-05	-5.13E-05	-3.84E-05
0.0434	3.07E-05	-9.46E-06	-4.61E-05	1.87E-05	4.88E-05	2.28E-05	-5.12E-05	-3.86E-05
0.04402	3.08E-05	-9.24E-06	-4.62E-05	1.92E-05	4.87E-05	2.31E-05	-5.08E-05	-3.85E-05
0.04464	3.08E-05	-8.95E-06	-4.61E-05	1.88E-05	4.92E-05	2.34E-05	-5.08E-05	-3.81E-05
0.04526	3.12E-05	-9.23E-06	-4.57E-05	1.91E-05	4.92E-05	2.32E-05	-5.09E-05	-3.82E-05
0.04588	3.12E-05	-9.63E-06	-4.63E-05	1.85E-05	4.94E-05	2.29E-05	-5.10E-05	-3.84E-05
0.0465	3.04E-05	-9.15E-06	-4.56E-05	1.95E-05	4.90E-05	2.33E-05	-5.11E-05	-3.75E-05
0.04712	3.11E-05	-8.94E-06	-4.52E-05	1.92E-05	4.92E-05	2.28E-05	-5.11E-05	-3.82E-05
0.04774	3.11E-05	-9.34E-06	-4.56E-05	1.90E-05	4.89E-05	2.33E-05	-5.05E-05	-3.81E-05
0.04836	3.14E-05	-8.51E-06	-4.56E-05	1.94E-05	4.91E-05	2.31E-05	-5.08E-05	-3.78E-05
0.04898	3.08E-05	-8.76E-06	-4.54E-05	1.92E-05	4.91E-05	2.31E-05	-5.10E-05	-3.82E-05
0.0496	3.11E-05	-9.11E-06	-4.62E-05	1.88E-05	4.94E-05	2.24E-05	-5.10E-05	-3.83E-05
0.05022	3.11E-05	-9.25E-06	-4.57E-05	1.92E-05	4.87E-05	2.30E-05	-5.10E-05	-3.81E-05
0.05084	3.09E-05	-9.35E-06	-4.59E-05	1.91E-05	4.91E-05	2.31E-05	-5.11E-05	-3.84E-05
0.05146	3.13E-05	-8.59E-06	-4.59E-05	1.89E-05	4.94E-05	2.31E-05	-5.09E-05	-3.81E-05
0.05208	3.12E-05	-8.82E-06	-4.54E-05	1.89E-05	4.91E-05	2.34E-05	-5.10E-05	-3.79E-05
0.0527	3.12E-05	-8.98E-06	-4.59E-05	1.92E-05	4.94E-05	2.31E-05	-5.09E-05	-3.83E-05
0.05332	3.10E-05	-9.05E-06	-4.59E-05	1.89E-05	4.93E-05	2.30E-05	-5.10E-05	-3.80E-05
0.05394	3.09E-05	-9.29E-06	-4.60E-05	1.89E-05	4.94E-05	2.33E-05	-5.08E-05	-3.81E-05
0.05456	3.13E-05	-9.03E-06	-4.62E-05	1.87E-05	4.88E-05	2.28E-05	-5.04E-05	-3.85E-05
0.05518	3.08E-05	-9.31E-06	-4.60E-05	1.90E-05	4.91E-05	2.34E-05	-5.08E-05	-3.78E-05
0.0558	3.10E-05	-9.13E-06	-4.59E-05	1.89E-05	4.91E-05	2.34E-05	-5.08E-05	-3.82E-05
0.05642	3.15E-05	-8.96E-06	-4.56E-05	1.89E-05	4.91E-05	2.30E-05	-5.15E-05	-3.77E-05
0.05704	3.10E-05	-9.24E-06	-4.59E-05	1.83E-05	4.88E-05	2.33E-05	-5.08E-05	-3.77E-05
0.05766	3.13E-05	-9.04E-06	-4.67E-05	1.89E-05	4.87E-05	2.30E-05	-5.09E-05	-3.80E-05
0.05828	3.10E-05	-9.99E-06	-4.64E-05	1.90E-05	4.90E-05	2.33E-05	-5.12E-05	-3.81E-05
0.0589	3.14E-05	-9.14E-06	-4.58E-05	1.87E-05	4.91E-05	2.34E-05	-5.07E-05	-3.84E-05
0.05952	3.08E-05	-9.15E-06	-4.64E-05	1.92E-05	4.91E-05	2.27E-05	-5.07E-05	-3.82E-05
0.06014	3.11E-05	-9.13E-06	-4.61E-05	1.88E-05	4.89E-05	2.34E-05	-5.08E-05	-3.75E-05
0.06076	3.13E-05	-8.86E-06	-4.55E-05	1.88E-05	4.89E-05	2.32E-05	-5.07E-05	-3.80E-05
0.06138	3.13E-05	-9.36E-06	-4.55E-05	1.90E-05	4.89E-05	2.31E-05	-5.10E-05	-3.86E-05
	3.11E-05	-9.17E-06	-4.59E-05	1.90E-05	4.90E-05	2.32E-05	-5.09E-05	-3.81E-05

APPENDIX C

	Load at Beam 23 with 600 kg				Load at Beam 23 with 700 kg			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	5.94E-05	2.44E-05	-5.98E-05	-2.52E-07	6.96E-05	2.38E-05	-6.93E-05	-7.73E-08
0.00062	5.95E-05	2.38E-05	-5.95E-05	2.37E-07	6.99E-05	2.34E-05	-6.94E-05	1.55E-09
0.00124	5.94E-05	2.40E-05	-5.99E-05	-1.45E-07	7.02E-05	2.39E-05	-6.95E-05	6.75E-08
0.00186	5.90E-05	2.34E-05	-6.00E-05	-2.29E-07	6.97E-05	2.35E-05	-6.95E-05	1.84E-07
0.00248	5.97E-05	2.41E-05	-5.99E-05	-2.14E-08	7.00E-05	2.36E-05	-6.96E-05	5.89E-08
0.0031	5.87E-05	2.40E-05	-5.99E-05	-4.30E-07	7.01E-05	2.31E-05	-6.99E-05	-3.77E-07
0.00372	5.95E-05	2.40E-05	-5.93E-05	-2.32E-07	7.01E-05	2.39E-05	-6.93E-05	3.89E-07
0.00434	5.98E-05	2.44E-05	-6.00E-05	-1.02E-07	6.97E-05	2.34E-05	-6.97E-05	3.41E-07
0.00496	5.93E-05	2.42E-05	-5.97E-05	3.41E-07	7.01E-05	2.39E-05	-6.94E-05	-7.87E-08
0.00558	5.95E-05	2.41E-05	-5.95E-05	-7.16E-08	6.98E-05	2.39E-05	-6.97E-05	7.32E-08
0.0062	5.92E-05	2.41E-05	-5.94E-05	-1.58E-07	6.97E-05	2.38E-05	-6.92E-05	1.41E-07
0.00682	5.88E-05	2.43E-05	-5.96E-05	-3.24E-07	7.01E-05	2.37E-05	-6.94E-05	-1.49E-07
0.00744	5.98E-05	2.36E-05	-6.00E-05	-2.12E-07	6.94E-05	2.37E-05	-6.95E-05	7.18E-08
0.00806	5.90E-05	2.37E-05	-6.00E-05	-1.73E-07	6.98E-05	2.36E-05	-6.95E-05	-2.62E-07
0.00868	5.90E-05	2.37E-05	-6.00E-05	-2.28E-08	6.97E-05	2.38E-05	-6.97E-05	8.76E-08
0.0093	5.93E-05	2.35E-05	-5.98E-05	2.98E-09	6.98E-05	2.38E-05	-6.92E-05	2.07E-07
0.00992	5.95E-05	2.35E-05	-5.99E-05	-6.88E-07	6.97E-05	2.38E-05	-6.96E-05	4.60E-08
0.01054	5.95E-05	2.38E-05	-5.97E-05	-2.81E-07	6.99E-05	2.40E-05	-6.96E-05	2.21E-07
0.01116	5.95E-05	2.38E-05	-5.98E-05	2.02E-08	6.98E-05	2.35E-05	-6.98E-05	-3.20E-07
0.01178	5.97E-05	2.40E-05	-5.99E-05	-1.79E-07	6.97E-05	2.35E-05	-6.95E-05	-2.29E-07
0.0124	5.94E-05	2.39E-05	-5.98E-05	-6.64E-07	6.98E-05	2.39E-05	-6.92E-05	-3.64E-07
0.01302	5.96E-05	2.36E-05	-5.92E-05	-9.16E-08	6.96E-05	2.36E-05	-6.99E-05	4.27E-07
0.01364	5.91E-05	2.39E-05	-6.00E-05	8.61E-08	6.99E-05	2.36E-05	-6.99E-05	1.89E-07
0.01426	5.95E-05	2.41E-05	-5.91E-05	-2.44E-07	6.93E-05	2.37E-05	-6.94E-05	-1.25E-07
0.01488	5.91E-05	2.40E-05	-5.95E-05	-5.15E-08	6.99E-05	2.38E-05	-6.98E-05	-3.32E-07
0.0155	5.94E-05	2.35E-05	-6.00E-05	-4.72E-08	6.95E-05	2.34E-05	-6.95E-05	2.77E-07
0.01612	5.88E-05	2.37E-05	-5.98E-05	1.73E-08	7.06E-05	2.39E-05	-6.94E-05	1.09E-07
0.01674	5.88E-05	2.41E-05	-5.97E-05	4.31E-08	6.96E-05	2.37E-05	-6.98E-05	1.48E-07
0.01736	5.89E-05	2.35E-05	-6.00E-05	-1.59E-07	7.00E-05	2.35E-05	-6.96E-05	-3.32E-07
0.01798	5.91E-05	2.44E-05	-5.98E-05	-3.40E-07	6.95E-05	2.35E-05	-6.97E-05	2.57E-07
0.0186	5.89E-05	2.40E-05	-5.94E-05	-3.20E-07	7.04E-05	2.36E-05	-6.96E-05	-2.56E-07
0.01922	5.94E-05	2.39E-05	-5.98E-05	-1.30E-07	6.90E-05	2.38E-05	-6.97E-05	-3.07E-07
0.01984	5.90E-05	2.36E-05	-5.96E-05	1.44E-08	6.98E-05	2.39E-05	-6.93E-05	4.16E-07
0.02046	5.91E-05	2.35E-05	-5.96E-05	-1.96E-07	7.00E-05	2.39E-05	-6.95E-05	1.76E-07
0.02108	5.92E-05	2.36E-05	-5.97E-05	1.25E-07	6.91E-05	2.38E-05	-6.96E-05	1.15E-07
0.0217	5.90E-05	2.38E-05	-5.97E-05	-1.15E-07	6.96E-05	2.41E-05	-6.94E-05	-3.14E-08
0.02232	5.96E-05	2.40E-05	-5.96E-05	-2.12E-07	6.98E-05	2.39E-05	-6.92E-05	1.51E-07
0.02294	5.90E-05	2.38E-05	-5.95E-05	-2.95E-07	6.98E-05	2.37E-05	-7.00E-05	5.42E-07
0.02356	5.92E-05	2.34E-05	-5.98E-05	-1.03E-06	6.95E-05	2.37E-05	-6.97E-05	-4.01E-07
0.02418	6.03E-05	2.37E-05	-5.98E-05	-6.16E-07	7.00E-05	2.37E-05	-6.99E-05	1.89E-07
0.0248	5.90E-05	2.35E-05	-6.01E-05	1.65E-07	6.99E-05	2.38E-05	-6.99E-05	-5.62E-09
0.02542	5.92E-05	2.41E-05	-6.00E-05	3.16E-08	6.97E-05	2.36E-05	-6.96E-05	2.87E-07
0.02604	5.94E-05	2.39E-05	-5.97E-05	1.58E-07	6.99E-05	2.36E-05	-6.98E-05	-2.06E-07
0.02666	5.97E-05	2.39E-05	-5.96E-05	-1.62E-07	6.95E-05	2.35E-05	-6.95E-05	4.41E-09
0.02728	5.96E-05	2.38E-05	-5.97E-05	5.69E-07	6.96E-05	2.37E-05	-6.94E-05	-1.42E-08
0.0279	5.92E-05	2.43E-05	-5.97E-05	-4.26E-07	7.02E-05	2.39E-05	-6.96E-05	-5.01E-08
0.02852	5.94E-05	2.36E-05	-5.98E-05	3.16E-08	6.98E-05	2.43E-05	-6 96E-05	4.79E-07
0.02914	5.93E-05	2.35E-05	-5.96E-05	-1.93E-07	7.03E-05	2.33E-05	-6.96E-05	-1.91E-07
0.02976	5.91E-05	2.40E-05	-5.97E-05	-4.41E-07	6.98E-05	2.35E-05	-6.95E-05	-2.54E-07
0.03038	5.90E-05	2.41E-05	-5.94E-05	-1.25E-07	6.97E-05	2.41E-05	-6.94E-05	-5.29E-08
0.031	5.95E-05	2.40E-05	-6.00E-05	-5.87E-08	6.95E-05	2.37E-05	-6.95E-05	5.72E-07
0.03162	5.93E-05	2.36E-05	-5.96E-05	4.95E-07	6.97E-05	2.38E-05	-6.96E-05	-1.05E-07
0.03224	5.96E-05	2.38E-05	-5.94E-05	-2.52E-07	7.00E-05	2.33E-05	-6.93E-05	8.90E-08
0.03286	5.91E-05	2.39E-05	-5.97E-05	-2.51E-07	7.00E-05	2.41E-05	-6.95E-05	1.01E-08
0.03348	5.88E-05	2.34E-05	-5.98E-05	2.58E-07	6.97E-05	2.35E-05	-6.95E-05	-6.73E-08
0.0341	5.95E-05	2.41E-05	-5.96E-05	-6.21E-07	7.04E-05	2.36E-05	-6.95E-05	-1.88E-07
0.03472	5.93E-05	2.38E-05	-5.97E-05	-2.88E-07	7.02E-05	2.38E-05	-6.95E-05	4.59E-07
0.03534	5.93E-05	2.38E-05	-5.96E-05	6.61E-08	6.98E-05	2.34E-05	-6.99E-05	9.33E-08
0.03596	5.93E-05	2.45E-05	-5.94E-05	-1.83E-07	6.99E-05	2.38E-05	-6.95E-05	3.69E-07
0.03658	5.95E-05	2.40E-05	-5.97E-05	-1.86E-07	7.01E-05	2.35E-05	-6.95E-05	4.72E-07
0.0372	5.98E-05	2.39E-05	-5.98E-05	2.73E-08	6.98E-05	2.40E-05	-6.94E-05	4.09E-07
0.03782	5.89E-05	2.39E-05	-6.01E-05	4.63E-07	7.03E-05	2.40E-05	-6.94E-05	-1.60E-07
0.03844	5.96E-05	2.41E-05	-5.98E-05	-2.45E-07	6.96E-05	2.37E-05	-6.98E-05	1.31E-07
0.03906	5.95E-05	2.38E-05	-5.97E-05	-1.25E-07	6.96E-05	2.39E-05	-6.95E-05	1.91E-07
0.03968	5.92E-05	2.39E-05	-5.94E-05	-3.48E-07	6.96E-05	2.39E-05	-6.97E-05	3.59E-08
0.0403	5.93E-05	2.42E-05	-5.93E-05	-1.36E-07	6.97E-05	2.36E-05	-6.92E-05	3.15E-07
0.04092	5.91E-05	2.37E-05	-6.00E-05	-3.57E-08	6.96E-05	2.36E-05	-6.94E-05	6.32E-08
0.04154	5.93E-05	2.37E-05	-5.95E-05	3.59E-08	6.99E-05	2.46E-05	-6.96E-05	-1.13E-07
0.04216	5.95E-05	2.38E-05	-5.97E-05	-3.18E-07	6.94E-05	2.34E-05	-6.97E-05	1.96E-07
0.04278	5.93E-05	2.39E-05	-6.02E-05	-4.27E-07	6.97E-05	2.39E-05	-6.96E-05	8.04E-08
0.0434	5.90E-05	2.37E-05	-5.96E-05	-2.62E-07	7.00E-05	2.40E-05	-6.97E-05	2.34E-07
0.04402	5.97E-05	2.41E-05	-5.96E-05	-1.76E-07	6.97E-05	2.34E-05	-6.95E-05	1.75E-07
0.04464	5.97E-05	2.40E-05	-6.02E-05	-2.78E-07	6.94E-05	2.38E-05	-6.94E-05	-2.24E-07
0.04526	5.97E-05	2.41E-05	-5.96E-05	2.98E-09	6.99E-05	2.43E-05	-6.97E-05	1.88E-07
0.04588	5.86E-05	2.42E-05	-5.98E-05	1.22E-07	7.02E-05	2.40E-05	-6.96E-05	-1.40E-07
0.0465	5.94E-05	2.39E-05	-6.01E-05	2.64E-07	7.00E-05	2.38E-05	-6.97E-05	-2.39E-07
0.04712	5.91E-05	2.38E-05	-5.93E-05	-4.41E-07	6.98E-05	2.39E-05	-6.92E-05	-4.86E-07
0.04774	5.89E-05	2.38E-05	-5.99E-05	2.74E-07	6.97E-05	2.36E-05	-6.96E-05	2.38E-07
0.04836	5.94E-05	2.37E-05	-5.95E-05	-6.99E-07	6.97E-05	2.35E-05	-6.92E-05	-4.67E-07
0.04898	5.96E-05	2.38E-05	-5.94E-05	-4.84E-07	6.93E-05	2.35E-05	-6.94E-05	2.87E-07
0.0496	5.91E-05	2.40E-05	-5.99E-05	-3.04E-07	6.99E-05	2.38E-05	-6.96E-05	-6.73E-08
0.05022	5.86E-05	2.33E-05	-6.00E-05	2.07E-07	6.95E-05	2.35E-05	-6.98E-05	8.90E-08
0.05084	5.91E-05	2.34E-05	-5.99E-05	-3.81E-07	6.95E-05	2.36E-05	-6.98E-05	-4.06E-07
0.05146	5.92E-05	2.41E-05	-5.96E-05	-7.68E-07	6.98E-05	2.38E-05	-6.98E-05	-1.50E-07
0.05208	5.95E-05	2.38E-05	-5.91E-05	1.87E-08	6.92E-05	2.39E-05	-6.96E-05	-7.01E-08
0.0527	5.92E-05	2.39E-05	-5.98E-05	-2.32E-07	7.00E-05	2.34E-05	-6.94E-05	1.75E-07
0.05332	5.90E-05	2.38E-05	-5.98E-05	-2.02E-07	6.98E-05	2.42E-05	-6.91E-05	-3.32E-07
0.05394	5.89E-05	2.38E-05	-5.95E-05	-2.72E-07	7.03E-05	2.32E-05	-6.96E-05	-3.55E-07
0.05456	5.89E-05	2.38E-05	-5.96E-05	-2.97E-07	6.96E-05	2.38E-05	-6.96E-05	-1.35E-07
0.05518	5.91E-05	2.36E-05	-5.96E-05	-2.19E-07	6.96E-05	2.32E-05	-6.93E-05	-9.88E-08
0.0558	5.97E-05	2.36E-05	-5.99E-05	-5.72E-08	6.95E-05	2.39E-05	-6.92E-05	2.88E-07
0.05642	5.93E-05	2.39E-05	-5.95E-05	-2.84E-07	6.96E-05	2.40E-05	-6.99E-05	1.18E-07
0.05704	5.89E-05	2.40E-05	-5.93E-05	-2.36E-07	6.97E-05	2.42E-05	-6.95E-05	-2.09E-07
0.05766	5.93E-05	2.33E-05	-5.93E-05	-3.73E-07	7.04E-05	2.36E-05	-6.99E-05	1.41E-07
0.05828	5.92E-05	2.44E-05	-5.92E-05	2.18E-07	6.98E-05	2.38E-05	-6.97E-05	1.08E-07
0.0589	5.95E-05	2.35E-05	-5.96E-05	1.73E-08	6.95E-05	2.31E-05	-6.97E-05	3.34E-07
0.05952	5.98E-05	2.40E-05	-6.00E-05	4.31E-08	6.98E-05	2.39E-05	-6.97E-05	-1.71E-08
0.06014	5.99E-05	2.41E-05	-6.01E-05	-6.68E-07	7.00E-05	2.39E-05	-6.97E-05	-1.07E-07
0.06076	5.93E-05	2.37E-05	-5.96E-05	-1.42E-07	6.96E-05	2.36E-05	-6.94E-05	6.46E-08
0.06138	5.90E-05	2.39E-05	-5.99E-05	-7.98E-07	6.95E-05	2.36E-05	-6.99E-05	5.03E-08
	5.93E-05	2.39E-05	-5.97E-05	-1.61E-07	6.98E-05	2.37E-05	-6.96E-05	3.07E-08

APPENDIX C

	Load at Beam 23 with 380 kg (Decreasing Order)				Load at Beam 23 with 500 kg (Decreasing Order)			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	3.09E-05	-9.20E-06	-4.60E-05	1.88E-05	4.87E-05	2.30E-05	-5.08E-05	-2.83E-05
0.00062	3.11E-05	-9.14E-06	-4.56E-05	1.91E-05	4.88E-05	2.27E-05	-5.00E-05	-2.76E-05
0.00124	3.07E-05	-9.15E-06	-4.58E-05	1.94E-05	4.92E-05	2.37E-05	-5.04E-05	-2.78E-05
0.00186	3.08E-05	-9.61E-06	-4.63E-05	1.93E-05	4.92E-05	2.26E-05	-5.04E-05	-2.76E-05
0.00248	3.09E-05	-9.32E-06	-4.54E-05	1.91E-05	4.90E-05	2.33E-05	-5.01E-05	-2.81E-05
0.0031	3.08E-05	-8.78E-06	-4.59E-05	1.90E-05	4.93E-05	2.30E-05	-5.01E-05	-2.77E-05
0.00372	3.08E-05	-9.35E-06	-4.59E-05	1.89E-05	4.92E-05	2.32E-05	-5.02E-05	-2.81E-05
0.00434	3.09E-05	-9.29E-06	-4.57E-05	1.92E-05	4.89E-05	2.29E-05	-5.07E-05	-2.80E-05
0.00496	3.12E-05	-9.35E-06	-4.58E-05	1.88E-05	4.90E-05	2.30E-05	-5.01E-05	-2.79E-05
0.00558	3.09E-05	-8.91E-06	-4.61E-05	1.93E-05	4.92E-05	2.32E-05	-5.06E-05	-2.76E-05
0.0062	3.15E-05	-9.05E-06	-4.61E-05	1.93E-05	4.85E-05	2.31E-05	-5.05E-05	-2.80E-05
0.00682	3.09E-05	-9.29E-06	-4.58E-05	1.91E-05	4.90E-05	2.31E-05	-5.07E-05	-2.80E-05
0.00744	3.07E-05	-9.50E-06	-4.59E-05	1.91E-05	4.92E-05	2.33E-05	-5.03E-05	-2.78E-05
0.00806	3.11E-05	-8.96E-06	-4.60E-05	1.86E-05	4.94E-05	2.32E-05	-5.01E-05	-2.76E-05
0.00868	3.13E-05	-8.98E-06	-4.56E-05	1.85E-05	4.87E-05	2.30E-05	-5.07E-05	-2.79E-05
0.0093	3.11E-05	-9.49E-06	-4.59E-05	1.92E-05	4.85E-05	2.28E-05	-5.05E-05	-2.76E-05
0.00992	3.14E-05	-8.77E-06	-4.56E-05	1.93E-05	4.87E-05	2.28E-05	-4.97E-05	-2.76E-05
0.01054	3.15E-05	-9.34E-06	-4.58E-05	1.89E-05	4.94E-05	2.34E-05	-5.08E-05	-2.74E-05
0.01116	3.07E-05	-9.09E-06	-4.61E-05	1.90E-05	4.87E-05	2.33E-05	-5.03E-05	-2.77E-05
0.01178	3.07E-05	-8.85E-06	-4.54E-05	1.94E-05	4.96E-05	2.33E-05	-5.09E-05	-2.83E-05
0.0124	3.14E-05	-8.98E-06	-4.57E-05	1.91E-05	4.93E-05	2.31E-05	-5.03E-05	-2.77E-05
0.01302	3.11E-05	-9.11E-06	-4.58E-05	1.90E-05	4.89E-05	2.33E-05	-5.07E-05	-2.81E-05
0.01364	3.09E-05	-8.99E-06	-4.58E-05	1.95E-05	4.90E-05	2.29E-05	-5.02E-05	-2.77E-05
0.01426	3.09E-05	-9.24E-06	-4.58E-05	1.92E-05	4.88E-05	2.25E-05	-5.02E-05	-2.79E-05
0.01488	3.09E-05	-8.77E-06	-4.60E-05	1.90E-05	4.89E-05	2.29E-05	-5.03E-05	-2.79E-05
0.0155	3.12E-05	-9.27E-06	-4.62E-05	1.91E-05	4.90E-05	2.32E-05	-5.01E-05	-2.79E-05
0.01612	3.08E-05	-9.12E-06	-4.61E-05	1.89E-05	4.86E-05	2.29E-05	-5.03E-05	-2.80E-05
0.01674	3.13E-05	-9.68E-06	-4.56E-05	1.89E-05	4.94E-05	2.32E-05	-5.02E-05	-2.81E-05
0.01736	3.13E-05	-9.10E-06	-4.62E-05	1.91E-05	4.90E-05	2.29E-05	-4.97E-05	-2.74E-05
0.01798	3.08E-05	-8.62E-06	-4.62E-05	1.93E-05	4.88E-05	2.28E-05	-4.98E-05	-2.79E-05
0.0186	3.10E-05	-8.82E-06	-4.50E-05	1.90E-05	4.91E-05	2.30E-05	-5.02E-05	-2.82E-05
0.01922	3.13E-05	-9.16E-06	-4.63E-05	1.89E-05	4.93E-05	2.33E-05	-5.04E-05	-2.83E-05
0.01984	3.12E-05	-9.68E-06	-4.54E-05	1.90E-05	4.87E-05	2.32E-05	-5.00E-05	-2.78E-05
0.02046	3.09E-05	-9.03E-06	-4.57E-05	1.88E-05	4.87E-05	2.29E-05	-5.03E-05	-2.78E-05
0.02108	3.06E-05	-9.19E-06	-4.58E-05	1.89E-05	4.91E-05	2.34E-05	-5.09E-05	-2.75E-05
0.0217	3.12E-05	-9.61E-06	-4.59E-05	1.94E-05	4.91E-05	2.28E-05	-5.10E-05	-2.84E-05
0.02232	3.13E-05	-9.16E-06	-4.60E-05	1.88E-05	4.91E-05	2.38E-05	-5.05E-05	-2.77E-05
0.02294	3.12E-05	-8.99E-06	-4.63E-05	1.92E-05	4.90E-05	2.32E-05	-5.00E-05	-2.77E-05
0.02356	3.12E-05	-8.78E-06	-4.62E-05	1.92E-05	4.89E-05	2.27E-05	-5.07E-05	-2.77E-05
0.02418	3.10E-05	-9.16E-06	-4.56E-05	1.90E-05	4.92E-05	2.33E-05	-5.09E-05	-2.76E-05
0.0248	3.08E-05	-9.48E-06	-4.63E-05	1.91E-05	4.90E-05	2.36E-05	-4.98E-05	-2.82E-05
0.02542	3.09E-05	-9.28E-06	-4.56E-05	1.91E-05	4.91E-05	2.29E-05	-5.02E-05	-2.76E-05
0.02604	3.08E-05	-9.15E-06	-4.58E-05	1.88E-05	4.92E-05	2.29E-05	-4.98E-05	-2.77E-05
0.02666	3.10E-05	-9.43E-06	-4.57E-05	1.90E-05	4.90E-05	2.26E-05	-5.04E-05	-2.77E-05
0.02728	3.15E-05	-9.29E-06	-4.56E-05	1.92E-05	4.91E-05	2.34E-05	-5.03E-05	-2.76E-05
0.0279	3.13E-05	-9.17E-06	-4.58E-05	1.87E-05	4.94E-05	2.34E-05	-4.99E-05	-2.75E-05
0.02852	3.11E-05	-9.45E-06	-4.60E-05	1.91E-05	4.91E-05	2.33E-05	-5.02E-05	-2.80E-05
0.02914	3.12E-05	-9.41E-06	-4.60E-05	1.90E-05	4.90E-05	2.36E-05	-5.06E-05	-2.77E-05
0.02976	3.11E-05	-9.27E-06	-4.61E-05	1.89E-05	4.91E-05	2.31E-05	-5.00E-05	-2.77E-05
0.03038	3.15E-05	-9.18E-06	-4.59E-05	1.89E-05	4.92E-05	2.34E-05	-5.01E-05	-2.75E-05
0.031	3.12E-05	-8.83E-06	-4.58E-05	1.88E-05	4.88E-05	2.32E-05	-5.06E-05	-2.78E-05
0.03162	3.11E-05	-9.04E-06	-4.60E-05	1.90E-05	4.88E-05	2.31E-05	-5.04E-05	-2.78E-05
0.03224	3.12E-05	-9.14E-06	-4.62E-05	1.93E-05	4.89E-05	2.33E-05	-5.01E-05	-2.78E-05
0.03286	3.10E-05	-8.97E-06	-4.58E-05	1.92E-05	4.91E-05	2.32E-05	-5.06E-05	-2.81E-05
0.03348	3.08E-05	-9.06E-06	-4.60E-05	1.90E-05	4.92E-05	2.33E-05	-5.04E-05	-2.79E-05
0.0341	3.10E-05	-9.41E-06	-4.57E-05	1.94E-05	4.93E-05	2.32E-05	-5.06E-05	-2.80E-05
0.03472	3.07E-05	-9.15E-06	-4.60E-05	1.88E-05	4.94E-05	2.32E-05	-5.00E-05	-2.78E-05
0.03534	3.11E-05	-9.25E-06	-4.55E-05	1.91E-05	4.88E-05	2.29E-05	-5.01E-05	-2.75E-05
0.03596	3.12E-05	-9.18E-06	-4.62E-05	1.86E-05	4.91E-05	2.30E-05	-5.03E-05	-2.81E-05
0.03658	3.10E-05	-9.53E-06	-4.60E-05	1.92E-05	4.93E-05	2.28E-05	-5.06E-05	-2.79E-05
0.0372	3.09E-05	-8.99E-06	-4.56E-05	1.93E-05	4.86E-05	2.24E-05	-5.05E-05	-2.80E-05
0.03782	3.13E-05	-9.51E-06	-4.54E-05	1.88E-05	4.92E-05	2.29E-05	-5.04E-05	-2.78E-05
0.03844	3.10E-05	-9.51E-06	-4.57E-05	1.89E-05	4.89E-05	2.30E-05	-5.01E-05	-2.77E-05
0.03906	3.12E-05	-8.79E-06	-4.62E-05	1.91E-05	4.89E-05	2.28E-05	-5.00E-05	-2.78E-05
0.03968	3.12E-05	-9.30E-06	-4.60E-05	1.92E-05	4.87E-05	2.32E-05	-5.02E-05	-2.77E-05
0.0403	3.05E-05	-8.98E-06	-4.55E-05	1.91E-05	4.91E-05	2.30E-05	-5.01E-05	-2.76E-05
0.04092	3.11E-05	-8.97E-06	-4.61E-05	1.89E-05	4.94E-05	2.36E-05	-5.01E-05	-2.78E-05
0.04154	3.11E-05	-9.92E-06	-4.63E-05	1.86E-05	4.87E-05	2.30E-05	-4.99E-05	-2.78E-05
0.04216	3.10E-05	-9.04E-06	-4.55E-05	1.95E-05	4.89E-05	2.31E-05	-5.07E-05	-2.77E-05
0.04278	3.13E-05	-9.17E-06	-4.59E-05	1.89E-05	4.94E-05	2.30E-05	-5.00E-05	-2.79E-05
0.0434	3.07E-05	-9.46E-06	-4.61E-05	1.87E-05	4.85E-05	2.26E-05	-5.04E-05	-2.76E-05
0.04402	3.08E-05	-9.24E-06	-4.62E-05	1.92E-05	4.95E-05	2.31E-05	-5.10E-05	-2.77E-05
0.04464	3.08E-05	-8.95E-06	-4.61E-05	1.88E-05	4.87E-05	2.32E-05	-5.05E-05	-2.77E-05
0.04526	3.12E-05	-9.23E-06	-4.57E-05	1.91E-05	4.91E-05	2.29E-05	-5.05E-05	-2.81E-05
0.04588	3.12E-05	-9.63E-06	-4.63E-05	1.85E-05	4.90E-05	2.32E-05	-5.04E-05	-2.79E-05
0.0465	3.04E-05	-9.15E-06	-4.56E-05	1.95E-05	4.87E-05	2.29E-05	-5.00E-05	-2.79E-05
0.04712	3.11E-05	-8.94E-06	-4.52E-05	1.92E-05	4.90E-05	2.30E-05	-5.02E-05	-2.77E-05
0.04774	3.11E-05	-9.34E-06	-4.56E-05	1.90E-05	4.89E-05	2.30E-05	-5.04E-05	-2.77E-05
0.04836	3.14E-05	-8.51E-06	-4.56E-05	1.94E-05	4.92E-05	2.30E-05	-5.02E-05	-2.77E-05
0.04898	3.08E-05	-8.76E-06	-4.54E-05	1.92E-05	4.93E-05	2.30E-05	-5.05E-05	-2.77E-05
0.0496	3.11E-05	-9.11E-06	-4.62E-05	1.88E-05	4.93E-05	2.29E-05	-5.02E-05	-2.77E-05
0.05022	3.11E-05	-9.25E-06	-4.57E-05	1.92E-05	4.92E-05	2.29E-05	-5.05E-05	-2.78E-05
0.05084	3.09E-05	-9.35E-06	-4.59E-05	1.91E-05	4.94E-05	2.30E-05	-5.04E-05	-2.81E-05
0.05146	3.13E-05	-8.59E-06	-4.59E-05	1.89E-05	4.90E-05	2.31E-05	-5.00E-05	-2.80E-05
0.05208	3.12E-05	-8.82E-06	-4.54E-05	1.89E-05	4.90E-05	2.31E-05	-5.02E-05	-2.79E-05
0.0527	3.12E-05	-8.98E-06	-4.59E-05	1.92E-05	4.93E-05	2.30E-05	-5.09E-05	-2.77E-05
0.05332	3.10E-05	-9.05E-06	-4.59E-05	1.89E-05	4.93E-05	2.36E-05	-5.02E-05	-2.76E-05
0.05394	3.09E-05	-9.29E-06	-4.60E-05	1.89E-05	4.94E-05	2.31E-05	-5.00E-05	-2.77E-05
0.05456	3.13E-05	-9.03E-06	-4.62E-05	1.87E-05	4.90E-05	2.32E-05	-5.04E-05	-2.87E-05
0.05518	3.08E-05	-9.31E-06	-4.60E-05	1.90E-05	4.90E-05	2.28E-05	-5.05E-05	-2.80E-05
0.0558	3.10E-05	-9.13E-06	-4.59E-05	1.89E-05	4.94E-05	2.35E-05	-5.00E-05	-2.75E-05
0.05642	3.15E-05	-8.96E-06	-4.56E-05	1.89E-05	4.90E-05	2.31E-05	-5.03E-05	-2.81E-05
0.05704	3.10E-05	-9.24E-06	-4.59E-05	1.83E-05	4.90E-05	2.28E-05	-5.01E-05	-2.78E-05
0.05766	3.13E-05	-9.04E-06	-4.67E-05	1.89E-05	4.89E-05	2.32E-05	-5.08E-05	-2.80E-05
0.05828	3.10E-05	-9.99E-06	-4.64E-05	1.90E-05	4.92E-05	2.31E-05	-5.05E-05	-2.77E-05
0.0589	3.14E-05	-9.14E-06	-4.58E-05	1.87E-05	4.83E-05	2.29E-05	-5.05E-05	-2.83E-05
0.05952	3.08E-05	-9.15E-06	-4.64E-05	1.92E-05	4.87E-05	2.32E-05	-5.07E-05	-2.77E-05
0.06014	3.11E-05	-9.13E-06	-4.61E-05	1.88E-05	4.92E-05	2.32E-05	-5.00E-05	-2.80E-05
0.06076	3.13E-05	-8.86E-06	-4.55E-05	1.88E-05	4.90E-05	2.27E-05	-5.02E-05	-2.80E-05
0.06138	3.13E-05	-9.36E-06	-4.55E-05	1.90E-05	4.90E-05	2.26E-05	-5.02E-05	-2.76E-05
	3.11E-05	-9.17E-06	-4.59E-05	1.90E-05	4.91E-05	2.31E-05	-5.03E-05	-2.78E-05

APPENDIX C

	Load at Beam 23 with 600 kg (Decreasing Order)				Load at Beam 23 with 700 kg (Decreasing Order)			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	5.90E-05	2.39E-05	-5.95E-05	-3.02E-07	7.00E-05	2.38E-05	-7.16E-05	3.07E-05
0.00062	5.94E-05	2.34E-05	-5.98E-05	-2.02E-07	6.96E-05	2.34E-05	-7.16E-05	3.06E-05
0.00124	5.87E-05	2.31E-05	-5.96E-05	-4.18E-07	7.01E-05	2.39E-05	-7.08E-05	3.05E-05
0.00186	5.92E-05	2.35E-05	-6.01E-05	-3.91E-07	6.96E-05	2.35E-05	-7.18E-05	3.04E-05
0.00248	5.91E-05	2.35E-05	-5.95E-05	-3.34E-07	6.92E-05	2.36E-05	-7.13E-05	3.05E-05
0.0031	5.91E-05	2.34E-05	-5.97E-05	-1.00E-07	6.94E-05	2.31E-05	-7.18E-05	3.10E-05
0.00372	5.89E-05	2.35E-05	-5.99E-05	-4.49E-07	7.00E-05	2.39E-05	-7.14E-05	3.02E-05
0.00434	5.92E-05	2.31E-05	-5.96E-05	-4.70E-08	6.99E-05	2.34E-05	-7.11E-05	3.03E-05
0.00496	5.91E-05	2.35E-05	-5.96E-05	-4.63E-07	6.93E-05	2.39E-05	-7.16E-05	3.07E-05
0.00558	5.93E-05	2.36E-05	-5.99E-05	-1.98E-07	6.92E-05	2.39E-05	-7.12E-05	3.05E-05
0.0062	5.93E-05	2.36E-05	-5.99E-05	-4.00E-09	6.94E-05	2.38E-05	-7.18E-05	3.05E-05
0.00682	5.92E-05	2.36E-05	-5.94E-05	1.46E-07	6.95E-05	2.37E-05	-7.14E-05	3.07E-05
0.00744	5.93E-05	2.36E-05	-6.00E-05	-1.85E-07	6.99E-05	2.37E-05	-7.14E-05	3.05E-05
0.00806	5.94E-05	2.34E-05	-5.99E-05	1.55E-07	6.96E-05	2.36E-05	-7.15E-05	3.09E-05
0.00868	5.90E-05	2.34E-05	-5.99E-05	-6.35E-07	6.98E-05	2.38E-05	-7.12E-05	3.05E-05
0.0093	5.92E-05	2.38E-05	-5.98E-05	-2.12E-07	6.97E-05	2.38E-05	-7.16E-05	3.04E-05
0.00992	5.93E-05	2.34E-05	-6.01E-05	-5.04E-07	6.99E-05	2.38E-05	-7.13E-05	3.06E-05
0.01054	5.91E-05	2.32E-05	-5.93E-05	2.57E-07	6.94E-05	2.40E-05	-7.17E-05	3.04E-05
0.01116	5.93E-05	2.33E-05	-5.96E-05	1.52E-07	6.97E-05	2.35E-05	-7.21E-05	3.09E-05
0.01178	5.92E-05	2.37E-05	-5.95E-05	-1.10E-07	7.01E-05	2.35E-05	-7.13E-05	3.08E-05
0.0124	5.94E-05	2.36E-05	-5.97E-05	4.52E-07	6.93E-05	2.39E-05	-7.11E-05	3.10E-05
0.01302	5.93E-05	2.34E-05	-5.94E-05	-4.69E-07	6.95E-05	2.36E-05	-7.12E-05	3.02E-05
0.01364	5.92E-05	2.35E-05	-5.94E-05	-9.31E-08	6.96E-05	2.36E-05	-7.10E-05	3.04E-05
0.01426	5.89E-05	2.31E-05	-5.97E-05	-4.04E-07	7.02E-05	2.37E-05	-7.11E-05	3.07E-05
0.01488	5.91E-05	2.37E-05	-5.99E-05	1.58E-07	6.94E-05	2.38E-05	-7.16E-05	3.09E-05
0.0155	5.89E-05	2.35E-05	-6.00E-05	8.20E-08	6.97E-05	2.34E-05	-7.16E-05	3.03E-05
0.01612	5.92E-05	2.36E-05	-5.97E-05	-2.57E-07	7.02E-05	2.39E-05	-7.15E-05	3.05E-05
0.01674	5.92E-05	2.33E-05	-5.98E-05	-2.21E-07	6.99E-05	2.37E-05	-7.14E-05	3.05E-05
0.01736	5.94E-05	2.36E-05	-5.96E-05	-1.03E-07	6.97E-05	2.35E-05	-7.12E-05	3.09E-05
0.01798	5.92E-05	2.29E-05	-5.95E-05	-3.58E-07	6.97E-05	2.35E-05	-7.14E-05	3.03E-05
0.0186	5.94E-05	2.35E-05	-6.00E-05	-3.65E-07	6.95E-05	2.36E-05	-7.17E-05	3.09E-05
0.01922	5.91E-05	2.35E-05	-5.99E-05	3.58E-07	6.95E-05	2.38E-05	-7.13E-05	3.09E-05
0.01984	5.94E-05	2.32E-05	-5.98E-05	-3.10E-08	6.97E-05	2.39E-05	-7.09E-05	3.02E-05
0.02046	5.88E-05	2.35E-05	-6.04E-05	1.49E-07	6.98E-05	2.39E-05	-7.16E-05	3.04E-05
0.02108	5.96E-05	2.33E-05	-5.96E-05	-1.00E-09	7.01E-05	2.38E-05	-7.12E-05	3.05E-05
0.0217	5.92E-05	2.33E-05	-5.99E-05	1.40E-08	6.94E-05	2.41E-05	-7.12E-05	3.06E-05
0.02232	5.92E-05	2.35E-05	-6.01E-05	3.53E-07	6.98E-05	2.39E-05	-7.12E-05	3.04E-05
0.02294	5.93E-05	2.33E-05	-5.98E-05	9.60E-08	6.94E-05	2.37E-05	-7.18E-05	3.01E-05
0.02356	5.89E-05	2.35E-05	-5.97E-05	-4.56E-07	6.96E-05	2.37E-05	-7.15E-05	3.10E-05
0.02418	5.94E-05	2.36E-05	-5.97E-05	4.20E-08	6.94E-05	2.37E-05	-7.11E-05	3.04E-05
0.0248	5.88E-05	2.36E-05	-5.99E-05	-4.80E-07	7.00E-05	2.38E-05	-7.17E-05	3.06E-05
0.02542	5.87E-05	2.34E-05	-6.02E-05	-5.99E-07	6.97E-05	2.36E-05	-7.11E-05	3.03E-05
0.02604	5.88E-05	2.37E-05	-5.95E-05	-4.64E-07	6.95E-05	2.36E-05	-7.10E-05	3.08E-05
0.02666	5.88E-05	2.29E-05	-5.96E-05	-4.83E-07	6.92E-05	2.35E-05	-7.12E-05	3.06E-05
0.02728	5.91E-05	2.36E-05	-6.01E-05	-9.00E-09	6.92E-05	2.37E-05	-7.18E-05	3.06E-05
0.0279	5.94E-05	2.35E-05	-6.01E-05	-2.04E-07	6.96E-05	2.39E-05	-7.14E-05	3.07E-05
0.02852	5.92E-05	2.34E-05	-5.98E-05	-7.30E-08	6.95E-05	2.43E-05	-7.13E-05	3.01E-05
0.02914	5.91E-05	2.38E-05	-5.94E-05	5.90E-08	6.98E-05	2.33E-05	-7.14E-05	3.08E-05
0.02976	5.91E-05	2.33E-05	-5.97E-05	-1.33E-07	6.96E-05	2.35E-05	-7.16E-05	3.09E-05
0.03038	5.92E-05	2.34E-05	-5.95E-05	5.70E-08	6.98E-05	2.41E-05	-7.09E-05	3.07E-05
0.031	5.93E-05	2.35E-05	-6.01E-05	-5.82E-07	6.96E-05	2.37E-05	-7.18E-05	3.00E-05
0.03162	5.92E-05	2.38E-05	-5.98E-05	-6.33E-07	6.95E-05	2.38E-05	-7.16E-05	3.07E-05
0.03224	5.92E-05	2.35E-05	-5.99E-05	1.25E-07	6.95E-05	2.33E-05	-7.11E-05	3.05E-05
0.03286	5.93E-05	2.32E-05	-5.93E-05	-1.93E-07	7.03E-05	2.41E-05	-7.17E-05	3.06E-05
0.03348	5.93E-05	2.30E-05	-6.00E-05	-4.90E-08	6.99E-05	2.35E-05	-7.12E-05	3.07E-05
0.0341	5.92E-05	2.32E-05	-6.02E-05	-2.24E-07	6.96E-05	2.36E-05	-7.19E-05	3.08E-05
0.03472	5.90E-05	2.39E-05	-5.97E-05	-9.45E-08	6.99E-05	2.38E-05	-7.10E-05	3.01E-05
0.03534	5.93E-05	2.34E-05	-6.00E-05	-1.82E-07	6.95E-05	2.34E-05	-7.17E-05	3.05E-05
0.03596	5.89E-05	2.36E-05	-5.98E-05	-2.51E-07	6.95E-05	2.38E-05	-7.11E-05	3.02E-05
0.03658	5.89E-05	2.33E-05	-5.96E-05	-1.66E-07	6.99E-05	2.35E-05	-7.19E-05	3.01E-05
0.0372	5.89E-05	2.33E-05	-5.95E-05	-1.09E-07	6.98E-05	2.40E-05	-7.15E-05	3.02E-05
0.03782	5.93E-05	2.38E-05	-6.01E-05	3.34E-07	6.94E-05	2.40E-05	-7.18E-05	3.08E-05
0.03844	5.89E-05	2.34E-05	-5.98E-05	-4.30E-08	7.01E-05	2.37E-05	-7.15E-05	3.05E-05
0.03906	5.91E-05	2.35E-05	-6.02E-05	-4.34E-07	6.96E-05	2.39E-05	-7.14E-05	3.04E-05
0.03968	5.92E-05	2.37E-05	-5.93E-05	-2.82E-07	6.97E-05	2.39E-05	-7.08E-05	3.06E-05
0.0403	5.91E-05	2.33E-05	-6.00E-05	-1.66E-07	7.00E-05	2.36E-05	-7.16E-05	3.03E-05
0.04092	5.94E-05	2.34E-05	-6.02E-05	-9.16E-08	6.95E-05	2.36E-05	-7.20E-05	3.05E-05
0.04154	5.92E-05	2.33E-05	-5.99E-05	-9.59E-08	6.96E-05	2.46E-05	-7.12E-05	3.07E-05
0.04216	5.93E-05	2.34E-05	-5.99E-05	8.30E-08	6.96E-05	2.34E-05	-7.11E-05	3.04E-05
0.04278	5.93E-05	2.31E-05	-6.00E-05	-3.27E-07	6.97E-05	2.39E-05	-7.13E-05	3.05E-05
0.0434	5.92E-05	2.31E-05	-6.00E-05	1.00E-08	6.95E-05	2.40E-05	-7.13E-05	3.04E-05
0.04402	5.93E-05	2.31E-05	-6.02E-05	4.90E-08	6.98E-05	2.34E-05	-7.12E-05	3.04E-05
0.04464	5.92E-05	2.32E-05	-5.99E-05	-4.18E-07	6.97E-05	2.38E-05	-7.10E-05	3.08E-05
0.04526	5.93E-05	2.37E-05	-5.99E-05	-5.60E-08	6.97E-05	2.43E-05	-7.10E-05	3.04E-05
0.04588	5.89E-05	2.32E-05	-5.94E-05	-3.77E-07	6.95E-05	2.40E-05	-7.18E-05	3.07E-05
0.0465	5.97E-05	2.34E-05	-5.96E-05	-3.70E-08	6.98E-05	2.38E-05	-7.16E-05	3.08E-05
0.04712	5.91E-05	2.36E-05	-5.96E-05	-1.86E-07	6.94E-05	2.39E-05	-7.20E-05	3.11E-05
0.04774	5.88E-05	2.35E-05	-5.99E-05	-2.29E-07	6.99E-05	2.36E-05	-7.22E-05	3.04E-05
0.04836	5.89E-05	2.34E-05	-5.97E-05	-1.63E-07	7.02E-05	2.35E-05	-7.14E-05	3.11E-05
0.04898	5.89E-05	2.36E-05	-5.97E-05	-5.30E-08	6.98E-05	2.35E-05	-7.17E-05	3.03E-05
0.0496	5.91E-05	2.30E-05	-5.96E-05	1.79E-07	6.95E-05	2.38E-05	-7.12E-05	3.07E-05
0.05022	5.89E-05	2.37E-05	-6.02E-05	-2.21E-07	6.92E-05	2.35E-05	-7.13E-05	3.05E-05
0.05084	5.92E-05	2.35E-05	-6.00E-05	4.00E-08	6.99E-05	2.36E-05	-7.12E-05	3.10E-05
0.05146	5.93E-05	2.29E-05	-5.99E-05	-5.63E-07	6.96E-05	2.38E-05	-7.12E-05	3.08E-05
0.05208	5.94E-05	2.34E-05	-5.94E-05	1.28E-07	6.94E-05	2.39E-05	-7.18E-05	3.07E-05
0.0527	5.91E-05	2.29E-05	-5.94E-05	-3.30E-07	6.91E-05	2.34E-05	-7.15E-05	3.04E-05
0.05332	5.94E-05	2.28E-05	-5.95E-05	-3.14E-07	6.98E-05	2.42E-05	-7.17E-05	3.09E-05
0.05394	5.93E-05	2.32E-05	-6.04E-05	1.52E-07	6.96E-05	2.32E-05	-7.12E-05	3.10E-05
0.05456	5.89E-05	2.36E-05	-5.99E-05	-5.98E-07	6.96E-05	2.38E-05	-7.13E-05	3.07E-05
0.05518	5.89E-05	2.31E-05	-5.93E-05	-1.22E-07	6.94E-05	2.32E-05	-7.11E-05	3.07E-05
0.0558	5.89E-05	2.37E-05	-6.00E-05	6.21E-07	6.94E-05	2.39E-05	-7.20E-05	3.03E-05
0.05642	5.91E-05	2.34E-05	-5.97E-05	-2.62E-07	6.97E-05	2.40E-05	-7.19E-05	3.05E-05
0.05704	5.92E-05	2.36E-05	-6.04E-05	-3.67E-07	6.93E-05	2.42E-05	-7.14E-05	3.08E-05
0.05766	5.99E-05	2.33E-05	-5.98E-05	3.00E-08	6.96E-05	2.36E-05	-7.16E-05	3.05E-05
0.05828	5.90E-05	2.39E-05	-6.00E-05	-4.49E-07	6.95E-05	2.38E-05	-7.14E-05	3.05E-05
0.0589	5.89E-05	2.33E-05	-5.96E-05	-5.56E-07	6.97E-05	2.31E-05	-7.13E-05	3.03E-05
0.05952	5.93E-05	2.36E-05	-5.97E-05	-3.14E-07	6.98E-05	2.39E-05	-7.09E-05	3.06E-05
0.06014	5.91E-05	2.33E-05	-5.99E-05	-2.42E-07	6.97E-05	2.39E-05	-7.12E-05	3.07E-05
0.06076	5.94E-05	2.31E-05	-5.96E-05	-2.67E-07	6.98E-05	2.36E-05	-7.16E-05	3.05E-05
0.06138	5.90E-05	2.36E-05	-5.95E-05	-5.45E-07	6.91E-05	2.36E-05	-7.11E-05	3.05E-05
	5.91E-05	2.34E-05	-5.98E-05	-1.61E-07	6.96E-05	2.37E-05	-7.14E-05	3.06E-05

APPENDIX D

	0 Degree 450 kg				30 Degree 448 kg			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	-4.12E-05	5.18E-06	4.03E-05	1.72E-06	-3.47E-05	-1.56E-05	3.64E-05	2.01E-05
0.00062	-4.20E-05	5.29E-06	4.11E-05	1.79E-06	-3.53E-05	-1.63E-05	3.74E-05	2.04E-05
0.00124	-4.27E-05	6.05E-06	4.06E-05	2.16E-06	-3.59E-05	-1.60E-05	3.79E-05	2.02E-05
0.00186	-4.25E-05	5.38E-06	4.09E-05	2.03E-06	-3.61E-05	-1.59E-05	3.77E-05	2.08E-05
0.00248	-4.25E-05	5.72E-06	4.08E-05	1.83E-06	-3.65E-05	-1.59E-05	3.70E-05	2.10E-05
0.0031	-4.32E-05	5.51E-06	4.11E-05	2.05E-06	-3.67E-05	-1.60E-05	3.71E-05	2.11E-05
0.00372	-4.31E-05	5.49E-06	4.08E-05	2.07E-06	-3.71E-05	-1.54E-05	3.76E-05	2.04E-05
0.00434	-4.35E-05	6.02E-06	4.12E-05	2.38E-06	-3.74E-05	-1.53E-05	3.75E-05	2.16E-05
0.00496	-4.41E-05	5.99E-06	4.07E-05	2.52E-06	-3.77E-05	-1.59E-05	3.72E-05	2.14E-05
0.00558	-4.36E-05	5.97E-06	4.11E-05	2.74E-06	-3.78E-05	-1.57E-05	3.78E-05	2.10E-05
0.0062	-4.36E-05	6.35E-06	4.04E-05	2.49E-06	-3.81E-05	-1.54E-05	3.76E-05	2.14E-05
0.00682	-4.55E-05	5.39E-06	4.11E-05	2.50E-06	-3.76E-05	-1.57E-05	3.71E-05	2.13E-05
0.00744	-4.55E-05	5.74E-06	4.17E-05	3.26E-06	-3.86E-05	-1.65E-05	3.80E-05	2.16E-05
0.00806	-4.57E-05	6.65E-06	4.15E-05	3.72E-06	-3.94E-05	-1.61E-05	3.77E-05	2.22E-05
0.00868	-4.50E-05	6.93E-06	4.11E-05	3.11E-06	-3.92E-05	-1.51E-05	3.75E-05	2.22E-05
0.0093	-4.42E-05	6.54E-06	4.09E-05	2.95E-06	-3.95E-05	-1.53E-05	3.74E-05	2.18E-05
0.00992	-4.33E-05	7.31E-06	4.03E-05	2.45E-06	-3.92E-05	-1.49E-05	3.79E-05	2.18E-05
0.01054	-4.28E-05	7.41E-06	4.02E-05	2.60E-06	-3.81E-05	-1.46E-05	3.70E-05	2.14E-05
0.01116	-4.25E-05	6.91E-06	4.00E-05	2.29E-06	-3.72E-05	-1.40E-05	3.67E-05	2.12E-05
0.01178	-4.24E-05	6.75E-06	4.02E-05	1.99E-06	-3.69E-05	-1.39E-05	3.76E-05	2.16E-05
0.0124	-4.25E-05	6.80E-06	4.02E-05	1.77E-06	-3.63E-05	-1.40E-05	3.65E-05	2.12E-05
0.01302	-4.21E-05	6.65E-06	4.00E-05	2.22E-06	-3.67E-05	-1.45E-05	3.69E-05	2.10E-05
0.01364	-4.15E-05	6.70E-06	4.00E-05	2.02E-06	-3.63E-05	-1.45E-05	3.69E-05	2.08E-05
0.01426	-4.19E-05	6.40E-06	4.01E-05	1.88E-06	-3.56E-05	-1.46E-05	3.70E-05	2.07E-05
0.01488	-4.13E-05	6.72E-06	4.01E-05	1.62E-06	-3.54E-05	-1.46E-05	3.72E-05	2.08E-05
0.0155	-4.11E-05	6.68E-06	4.00E-05	1.42E-06	-3.58E-05	-1.47E-05	3.70E-05	2.06E-05
0.01612	-4.13E-05	6.77E-06	4.04E-05	1.74E-06	-3.51E-05	-1.47E-05	3.68E-05	2.05E-05
0.01674	-4.04E-05	7.67E-06	3.99E-05	1.66E-06	-3.58E-05	-1.48E-05	3.66E-05	2.05E-05
0.01736	-3.87E-05	7.01E-06	3.97E-05	7.60E-07	-3.43E-05	-1.42E-05	3.65E-05	1.97E-05
0.01798	-3.88E-05	6.67E-06	3.98E-05	9.20E-07	-3.34E-05	-1.44E-05	3.61E-05	1.98E-05
0.0186	-3.92E-05	6.20E-06	4.04E-05	1.09E-06	-3.32E-05	-1.50E-05	3.70E-05	2.00E-05
0.01922	-4.02E-05	5.71E-06	4.06E-05	8.90E-07	-3.32E-05	-1.48E-05	3.67E-05	1.97E-05
0.01984	-4.13E-05	5.40E-06	4.09E-05	1.38E-06	-3.38E-05	-1.55E-05	3.70E-05	2.04E-05
0.02046	-4.17E-05	5.63E-06	4.07E-05	1.68E-06	-3.50E-05	-1.60E-05	3.72E-05	2.02E-05
0.02108	-4.22E-05	5.80E-06	4.07E-05	2.04E-06	-3.56E-05	-1.55E-05	3.73E-05	2.04E-05
0.0217	-4.26E-05	5.46E-06	4.04E-05	1.73E-06	-3.63E-05	-1.52E-05	3.73E-05	2.06E-05
0.02232	-4.29E-05	5.72E-06	4.12E-05	1.88E-06	-3.64E-05	-1.61E-05	3.77E-05	2.07E-05
0.02294	-4.26E-05	5.82E-06	4.08E-05	2.19E-06	-3.65E-05	-1.60E-05	3.73E-05	2.09E-05
0.02356	-4.26E-05	6.21E-06	4.10E-05	2.53E-06	-3.69E-05	-1.57E-05	3.78E-05	2.11E-05
0.02418	-4.37E-05	5.59E-06	4.09E-05	2.28E-06	-3.70E-05	-1.56E-05	3.76E-05	2.09E-05
0.0248	-4.30E-05	5.90E-06	4.07E-05	2.57E-06	-3.76E-05	-1.52E-05	3.76E-05	2.10E-05
0.02542	-4.34E-05	6.42E-06	4.06E-05	2.45E-06	-3.76E-05	-1.54E-05	3.77E-05	2.15E-05
0.02604	-4.41E-05	5.96E-06	4.15E-05	2.20E-06	-3.76E-05	-1.53E-05	3.68E-05	2.15E-05
0.02666	-4.49E-05	5.88E-06	4.13E-05	2.69E-06	-3.73E-05	-1.50E-05	3.77E-05	2.14E-05
0.02728	-4.57E-05	5.38E-06	4.11E-05	3.21E-06	-3.88E-05	-1.56E-05	3.80E-05	2.17E-05
0.0279	-4.54E-05	6.25E-06	4.06E-05	3.15E-06	-4.01E-05	-1.55E-05	3.82E-05	2.17E-05
0.02852	-4.53E-05	6.61E-06	4.09E-05	3.20E-06	-4.00E-05	-1.54E-05	3.72E-05	2.19E-05
0.02914	-4.44E-05	6.47E-06	4.04E-05	2.75E-06	-3.98E-05	-1.49E-05	3.74E-05	2.23E-05
0.02976	-4.39E-05	7.23E-06	4.02E-05	2.92E-06	-3.94E-05	-1.48E-05	3.71E-05	2.16E-05
0.03038	-4.31E-05	7.03E-06	4.07E-05	2.36E-06	-3.78E-05	-1.47E-05	3.72E-05	2.20E-05
0.031	-4.29E-05	7.27E-06	4.04E-05	2.58E-06	-3.72E-05	-1.39E-05	3.73E-05	2.17E-05
0.03162	-4.25E-05	7.31E-06	4.02E-05	2.17E-06	-3.68E-05	-1.44E-05	3.69E-05	2.14E-05
0.03224	-4.22E-05	6.80E-06	4.01E-05	2.02E-06	-3.64E-05	-1.43E-05	3.71E-05	2.13E-05
0.03286	-4.19E-05	7.25E-06	4.04E-05	2.21E-06	-3.67E-05	-1.41E-05	3.67E-05	2.15E-05
0.03348	-4.17E-05	6.20E-06	4.07E-05	1.83E-06	-3.62E-05	-1.43E-05	3.69E-05	2.08E-05
0.0341	-4.14E-05	6.94E-06	4.00E-05	1.87E-06	-3.59E-05	-1.51E-05	3.70E-05	2.07E-05
0.03472	-4.10E-05	6.80E-06	4.03E-05	1.60E-06	-3.59E-05	-1.38E-05	3.68E-05	2.00E-05
0.03534	-4.12E-05	6.52E-06	4.03E-05	1.83E-06	-3.58E-05	-1.46E-05	3.72E-05	2.01E-05
0.03596	-4.13E-05	7.09E-06	4.07E-05	1.67E-06	-3.59E-05	-1.48E-05	3.66E-05	2.06E-05
0.03658	-4.10E-05	6.80E-06	3.98E-05	1.43E-06	-3.57E-05	-1.49E-05	3.73E-05	2.07E-05
0.0372	-3.93E-05	6.93E-06	3.93E-05	7.20E-07	-3.51E-05	-1.43E-05	3.67E-05	2.03E-05
0.03782	-3.91E-05	6.48E-06	3.99E-05	1.06E-06	-3.33E-05	-1.42E-05	3.66E-05	1.99E-05
0.03844	-3.96E-05	5.69E-06	3.97E-05	1.15E-06	-3.36E-05	-1.48E-05	3.62E-05	1.96E-05
0.03906	-4.01E-05	5.89E-06	4.03E-05	1.35E-06	-3.35E-05	-1.46E-05	3.67E-05	2.02E-05
0.03968	-4.16E-05	5.43E-06	4.05E-05	1.22E-06	-3.36E-05	-1.51E-05	3.68E-05	2.03E-05
0.0403	-4.15E-05	5.47E-06	4.09E-05	1.73E-06	-3.46E-05	-1.59E-05	3.74E-05	2.05E-05
0.04092	-4.21E-05	5.90E-06	4.09E-05	1.55E-06	-3.55E-05	-1.63E-05	3.78E-05	2.01E-05
0.04154	-4.25E-05	5.35E-06	4.06E-05	2.15E-06	-3.59E-05	-1.56E-05	3.69E-05	2.05E-05
0.04216	-4.24E-05	5.80E-06	4.03E-05	2.28E-06	-3.64E-05	-1.57E-05	3.72E-05	2.11E-05
0.04278	-4.28E-05	6.03E-06	4.03E-05	2.39E-06	-3.66E-05	-1.56E-05	3.72E-05	2.12E-05
0.0434	-4.32E-05	5.69E-06	4.07E-05	2.37E-06	-3.71E-05	-1.60E-05	3.73E-05	2.09E-05
0.04402	-4.33E-05	5.84E-06	4.10E-05	1.91E-06	-3.74E-05	-1.56E-05	3.76E-05	2.10E-05
0.04464	-4.35E-05	5.85E-06	4.09E-05	2.79E-06	-3.77E-05	-1.56E-05	3.75E-05	2.17E-05
0.04526	-4.35E-05	6.41E-06	4.06E-05	2.70E-06	-3.75E-05	-1.52E-05	3.78E-05	2.10E-05
0.04588	-4.36E-05	6.67E-06	4.04E-05	2.34E-06	-3.80E-05	-1.54E-05	3.80E-05	2.07E-05
0.0465	-4.44E-05	6.14E-06	4.12E-05	3.07E-06	-3.80E-05	-1.52E-05	3.78E-05	2.14E-05
0.04712	-4.57E-05	5.40E-06	4.16E-05	3.50E-06	-3.83E-05	-1.52E-05	3.76E-05	2.21E-05
0.04774	-4.59E-05	5.89E-06	4.11E-05	3.37E-06	-3.99E-05	-1.66E-05	3.80E-05	2.18E-05
0.04836	-4.55E-05	6.59E-06	4.11E-05	3.03E-06	-3.98E-05	-1.53E-05	3.81E-05	2.23E-05
0.04898	-4.51E-05	6.59E-06	4.08E-05	3.03E-06	-3.97E-05	-1.51E-05	3.82E-05	2.21E-05
0.0496	-4.41E-05	7.19E-06	3.99E-05	3.00E-06	-3.96E-05	-1.46E-05	3.75E-05	2.25E-05
0.05022	-4.34E-05	7.06E-06	4.04E-05	2.56E-06	-3.85E-05	-1.40E-05	3.75E-05	2.20E-05
0.05084	-4.29E-05	7.66E-06	4.07E-05	2.27E-06	-3.78E-05	-1.44E-05	3.73E-05	2.16E-05
0.05146	-4.29E-05	7.01E-06	3.98E-05	2.55E-06	-3.76E-05	-1.40E-05	3.69E-05	2.11E-05
0.05208	-4.23E-05	7.02E-06	4.05E-05	2.50E-06	-3.68E-05	-1.42E-05	3.69E-05	2.12E-05
0.0527	-4.22E-05	6.84E-06	4.01E-05	1.89E-06	-3.69E-05	-1.44E-05	3.68E-05	2.13E-05
0.05332	-4.22E-05	6.73E-06	4.00E-05	1.63E-06	-3.65E-05	-1.47E-05	3.66E-05	2.06E-05
0.05394	-4.12E-05	7.35E-06	4.01E-05	1.90E-06	-3.60E-05	-1.46E-05	3.61E-05	2.09E-05
0.05456	-4.15E-05	6.47E-06	4.01E-05	1.43E-06	-3.60E-05	-1.47E-05	3.68E-05	2.06E-05
0.05518	-4.15E-05	6.97E-06	4.00E-05	1.46E-06	-3.55E-05	-1.48E-05	3.62E-05	2.06E-05
0.0558	-4.15E-05	6.34E-06	3.98E-05	1.57E-06	-3.54E-05	-1.45E-05	3.65E-05	2.09E-05
0.05642	-4.09E-05	6.84E-06	4.01E-05	1.62E-06	-3.53E-05	-1.47E-05	3.66E-05	2.04E-05
0.05704	-3.94E-05	6.81E-06	3.99E-05	1.12E-06	-3.51E-05	-1.49E-05	3.74E-05	2.04E-05
0.05766	-3.95E-05	6.98E-06	3.99E-05	1.44E-06	-3.37E-05	-1.49E-05	3.60E-05	2.02E-05
0.05828	-3.93E-05	6.11E-06	3.99E-05	8.40E-07	-3.32E-05	-1.43E-05	3.64E-05	1.97E-05
0.0589	-4.01E-05	5.84E-06	4.01E-05	8.10E-07	-3.33E-05	-1.51E-05	3.66E-05	1.96E-05
0.05952	-4.12E-05	5.69E-06	4.02E-05	1.36E-06	-3.37E-05	-1.51E-05	3.67E-05	1.97E-05
0.06014	-4.16E-05	5.51E-06	4.06E-05	1.60E-06	-3.46E-05	-1.60E-05	3.76E-05	2.00E-05
0.06076	-4.18E-05	6.10E-06	4.12E-05	1.52E-06	-3.57E-05	-1.60E-05	3.69E-05	2.00E-05
0.06138	-4.18E-05	5.72E-06	4.03E-05	2.23E-06	-3.61E-05	-1.60E-05	3.75E-05	2.07E-05
	-4.24E-05	6.33E-06	4.05E-05	2.08E-06	-3.65E-05	-1.51E-05	3.72E-05	2.09E-05

APPENDIX D

	60 Degree 446 kg				90 Degree 446 kg			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	-1.79E-05	-3.04E-05	2.41E-05	3.75E-05	4.84E-06	-4.68E-05	5.91E-06	4.35E-05
0.00062	-1.80E-05	-3.13E-05	2.40E-05	3.77E-05	4.48E-06	-4.68E-05	6.14E-06	4.31E-05
0.00124	-1.86E-05	-3.14E-05	2.42E-05	3.68E-05	2.96E-06	-4.74E-05	6.16E-06	4.41E-05
0.00186	-1.85E-05	-3.18E-05	2.46E-05	3.75E-05	2.70E-06	-4.78E-05	5.93E-06	4.38E-05
0.00248	-1.99E-05	-3.22E-05	2.49E-05	3.77E-05	2.51E-06	-4.72E-05	6.40E-06	4.42E-05
0.0031	-2.03E-05	-3.22E-05	2.51E-05	3.77E-05	2.91E-06	-4.61E-05	6.05E-06	4.42E-05
0.00372	-2.01E-05	-3.24E-05	2.47E-05	3.81E-05	4.03E-06	-4.58E-05	5.94E-06	4.42E-05
0.00434	-2.10E-05	-3.25E-05	2.45E-05	3.83E-05	4.94E-06	-4.55E-05	5.07E-06	4.35E-05
0.00496	-2.17E-05	-3.17E-05	2.52E-05	3.82E-05	5.24E-06	-4.59E-05	5.33E-06	4.35E-05
0.00558	-2.17E-05	-3.20E-05	2.49E-05	3.85E-05	5.44E-06	-4.61E-05	5.48E-06	4.34E-05
0.0062	-2.20E-05	-3.19E-05	2.50E-05	3.89E-05	5.93E-06	-4.60E-05	5.35E-06	4.28E-05
0.00682	-2.21E-05	-3.17E-05	2.47E-05	3.87E-05	6.20E-06	-4.56E-05	5.00E-06	4.31E-05
0.00744	-2.22E-05	-3.17E-05	2.53E-05	3.90E-05	6.79E-06	-4.63E-05	5.60E-06	4.30E-05
0.00806	-2.24E-05	-3.18E-05	2.53E-05	3.94E-05	6.38E-06	-4.63E-05	5.18E-06	4.28E-05
0.00868	-2.27E-05	-3.16E-05	2.48E-05	3.86E-05	6.75E-06	-4.66E-05	5.11E-06	4.23E-05
0.0093	-2.26E-05	-3.18E-05	2.54E-05	3.93E-05	6.73E-06	-4.63E-05	4.69E-06	4.27E-05
0.00992	-2.45E-05	-3.25E-05	2.58E-05	3.97E-05	6.59E-06	-4.63E-05	5.04E-06	4.20E-05
0.01054	-2.47E-05	-3.19E-05	2.58E-05	4.00E-05	6.93E-06	-4.65E-05	5.05E-06	4.26E-05
0.01116	-2.40E-05	-3.16E-05	2.54E-05	3.94E-05	8.73E-06	-4.54E-05	4.26E-06	4.22E-05
0.01178	-2.40E-05	-3.15E-05	2.52E-05	4.01E-05	9.47E-06	-4.60E-05	4.58E-06	4.17E-05
0.0124	-2.28E-05	-3.04E-05	2.52E-05	3.94E-05	9.54E-06	-4.67E-05	4.29E-06	4.22E-05
0.01302	-2.22E-05	-3.00E-05	2.43E-05	3.90E-05	9.32E-06	-4.67E-05	4.79E-06	4.14E-05
0.01364	-2.21E-05	-3.10E-05	2.42E-05	3.91E-05	7.85E-06	-4.74E-05	5.19E-06	4.22E-05
0.01426	-2.15E-05	-3.06E-05	2.43E-05	3.86E-05	7.12E-06	-4.74E-05	5.65E-06	4.23E-05
0.01488	-2.15E-05	-3.08E-05	2.43E-05	3.89E-05	6.55E-06	-4.77E-05	5.60E-06	4.23E-05
0.0155	-2.11E-05	-3.07E-05	2.46E-05	3.87E-05	6.12E-06	-4.79E-05	5.48E-06	4.27E-05
0.01612	-2.07E-05	-3.07E-05	2.45E-05	3.87E-05	6.28E-06	-4.73E-05	5.51E-06	4.30E-05
0.01674	-2.07E-05	-3.09E-05	2.43E-05	3.81E-05	5.76E-06	-4.74E-05	5.82E-06	4.28E-05
0.01736	-2.03E-05	-3.11E-05	2.38E-05	3.84E-05	5.39E-06	-4.70E-05	5.84E-06	4.27E-05
0.01798	-2.04E-05	-3.06E-05	2.43E-05	3.84E-05	5.20E-06	-4.74E-05	5.50E-06	4.31E-05
0.0186	-2.04E-05	-3.14E-05	2.50E-05	3.80E-05	5.06E-06	-4.70E-05	5.26E-06	4.31E-05
0.01922	-2.04E-05	-3.11E-05	2.42E-05	3.81E-05	5.11E-06	-4.72E-05	5.81E-06	4.33E-05
0.01984	-1.85E-05	-3.05E-05	2.40E-05	3.74E-05	4.74E-06	-4.66E-05	5.47E-06	4.33E-05
0.02046	-1.80E-05	-3.11E-05	2.42E-05	3.74E-05	4.99E-06	-4.65E-05	5.55E-06	4.32E-05
0.02108	-1.84E-05	-3.11E-05	2.46E-05	3.75E-05	3.91E-06	-4.77E-05	6.60E-06	4.40E-05
0.0217	-1.87E-05	-3.18E-05	2.41E-05	3.76E-05	2.84E-06	-4.72E-05	7.00E-06	4.38E-05
0.02232	-1.91E-05	-3.25E-05	2.46E-05	3.73E-05	2.53E-06	-4.72E-05	6.38E-06	4.43E-05
0.02294	-2.08E-05	-3.24E-05	2.48E-05	3.73E-05	3.17E-06	-4.64E-05	6.18E-06	4.43E-05
0.02356	-2.05E-05	-3.24E-05	2.46E-05	3.79E-05	2.90E-06	-4.63E-05	5.99E-06	4.42E-05
0.02418	-2.14E-05	-3.22E-05	2.49E-05	3.84E-05	4.79E-06	-4.60E-05	5.20E-06	4.33E-05
0.0248	-2.13E-05	-3.20E-05	2.50E-05	3.83E-05	5.38E-06	-4.59E-05	5.31E-06	4.34E-05
0.02542	-2.19E-05	-3.22E-05	2.48E-05	3.87E-05	5.54E-06	-4.60E-05	5.56E-06	4.38E-05
0.02604	-2.22E-05	-3.19E-05	2.54E-05	3.84E-05	5.75E-06	-4.58E-05	5.19E-06	4.36E-05
0.02666	-2.22E-05	-3.21E-05	2.52E-05	3.86E-05	6.31E-06	-4.56E-05	5.30E-06	4.32E-05
0.02728	-2.24E-05	-3.21E-05	2.47E-05	3.90E-05	6.14E-06	-4.59E-05	5.15E-06	4.30E-05
0.0279	-2.23E-05	-3.17E-05	2.50E-05	3.92E-05	6.34E-06	-4.60E-05	4.75E-06	4.30E-05
0.02852	-2.25E-05	-3.17E-05	2.49E-05	3.94E-05	6.70E-06	-4.60E-05	5.16E-06	4.30E-05
0.02914	-2.26E-05	-3.24E-05	2.54E-05	3.90E-05	6.21E-06	-4.65E-05	4.91E-06	4.29E-05
0.02976	-2.48E-05	-3.21E-05	2.54E-05	3.96E-05	7.60E-06	-4.62E-05	5.04E-06	4.21E-05
0.03038	-2.45E-05	-3.18E-05	2.61E-05	3.95E-05	6.95E-06	-4.68E-05	5.03E-06	4.23E-05
0.031	-2.43E-05	-3.18E-05	2.57E-05	3.92E-05	7.79E-06	-4.59E-05	4.59E-06	4.20E-05
0.03162	-2.39E-05	-3.06E-05	2.54E-05	3.97E-05	8.74E-06	-4.58E-05	4.66E-06	4.17E-05
0.03224	-2.33E-05	-3.03E-05	2.52E-05	3.94E-05	8.95E-06	-4.63E-05	5.21E-06	4.15E-05
0.03286	-2.27E-05	-3.04E-05	2.49E-05	3.89E-05	8.75E-06	-4.69E-05	4.91E-06	4.17E-05
0.03348	-2.17E-05	-3.02E-05	2.46E-05	3.92E-05	8.15E-06	-4.70E-05	5.12E-06	4.23E-05
0.0341	-2.16E-05	-3.02E-05	2.46E-05	3.87E-05	7.27E-06	-4.76E-05	5.62E-06	4.17E-05
0.03472	-2.16E-05	-3.10E-05	2.48E-05	3.88E-05	6.30E-06	-4.74E-05	5.75E-06	4.24E-05
0.03534	-2.11E-05	-3.04E-05	2.43E-05	3.85E-05	6.38E-06	-4.75E-05	6.05E-06	4.26E-05
0.03596	-2.12E-05	-3.08E-05	2.43E-05	3.84E-05	6.00E-06	-4.77E-05	5.52E-06	4.25E-05
0.03658	-2.10E-05	-3.12E-05	2.45E-05	3.84E-05	5.85E-06	-4.72E-05	5.97E-06	4.26E-05
0.0372	-2.05E-05	-3.10E-05	2.46E-05	3.87E-05	5.77E-06	-4.73E-05	5.88E-06	4.31E-05
0.03782	-1.99E-05	-3.07E-05	2.44E-05	3.84E-05	5.01E-06	-4.71E-05	5.11E-06	4.31E-05
0.03844	-2.04E-05	-3.15E-05	2.44E-05	3.84E-05	4.94E-06	-4.73E-05	5.09E-06	4.34E-05
0.03906	-2.02E-05	-3.13E-05	2.46E-05	3.78E-05	5.19E-06	-4.66E-05	5.96E-06	4.35E-05
0.03968	-1.87E-05	-3.06E-05	2.39E-05	3.76E-05	4.71E-06	-4.74E-05	5.80E-06	4.34E-05
0.0403	-1.83E-05	-3.06E-05	2.42E-05	3.77E-05	4.79E-06	-4.72E-05	5.74E-06	4.32E-05
0.04092	-1.87E-05	-3.15E-05	2.38E-05	3.78E-05	4.01E-06	-4.79E-05	6.65E-06	4.36E-05
0.04154	-1.84E-05	-3.16E-05	2.45E-05	3.73E-05	2.69E-06	-4.81E-05	6.13E-06	4.44E-05
0.04216	-1.93E-05	-3.20E-05	2.41E-05	3.75E-05	2.43E-06	-4.69E-05	6.04E-06	4.39E-05
0.04278	-2.02E-05	-3.21E-05	2.49E-05	3.82E-05	2.96E-06	-4.68E-05	5.84E-06	4.42E-05
0.0434	-2.06E-05	-3.23E-05	2.51E-05	3.83E-05	3.25E-06	-4.57E-05	6.49E-06	4.38E-05
0.04402	-2.10E-05	-3.21E-05	2.50E-05	3.80E-05	4.27E-06	-4.63E-05	5.70E-06	4.42E-05
0.04464	-2.12E-05	-3.28E-05	2.48E-05	3.88E-05	5.18E-06	-4.57E-05	5.33E-06	4.37E-05
0.04526	-2.17E-05	-3.23E-05	2.52E-05	3.83E-05	5.45E-06	-4.63E-05	5.12E-06	4.42E-05
0.04588	-2.15E-05	-3.24E-05	2.51E-05	3.81E-05	5.87E-06	-4.64E-05	5.25E-06	4.28E-05
0.0465	-2.18E-05	-3.19E-05	2.56E-05	3.88E-05	5.95E-06	-4.59E-05	5.18E-06	4.32E-05
0.04712	-2.22E-05	-3.19E-05	2.49E-05	3.89E-05	6.17E-06	-4.56E-05	5.22E-06	4.35E-05
0.04774	-2.25E-05	-3.15E-05	2.48E-05	3.88E-05	6.46E-06	-4.62E-05	5.04E-06	4.25E-05
0.04836	-2.28E-05	-3.19E-05	2.54E-05	3.83E-05	6.90E-06	-4.61E-05	4.44E-06	4.30E-05
0.04898	-2.27E-05	-3.17E-05	2.47E-05	3.88E-05	6.74E-06	-4.67E-05	5.39E-06	4.28E-05
0.0496	-2.44E-05	-3.20E-05	2.58E-05	3.92E-05	6.56E-06	-4.62E-05	5.31E-06	4.23E-05
0.05022	-2.49E-05	-3.20E-05	2.52E-05	3.97E-05	6.82E-06	-4.66E-05	5.37E-06	4.24E-05
0.05084	-2.44E-05	-3.15E-05	2.61E-05	4.01E-05	7.64E-06	-4.64E-05	4.41E-06	4.25E-05
0.05146	-2.42E-05	-3.14E-05	2.51E-05	3.94E-05	8.98E-06	-4.55E-05	4.38E-06	4.16E-05
0.05208	-2.38E-05	-3.09E-05	2.54E-05	3.97E-05	8.77E-06	-4.63E-05	4.84E-06	4.21E-05
0.0527	-2.23E-05	-3.06E-05	2.46E-05	3.89E-05	8.45E-06	-4.65E-05	4.87E-06	4.17E-05
0.05332	-2.23E-05	-3.05E-05	2.54E-05	3.88E-05	8.14E-06	-4.72E-05	4.97E-06	4.23E-05
0.05394	-2.11E-05	-3.05E-05	2.42E-05	3.91E-05	7.59E-06	-4.77E-05	5.44E-06	4.18E-05
0.05456	-2.16E-05	-3.03E-05	2.42E-05	3.85E-05	6.44E-06	-4.76E-05	5.62E-06	4.23E-05
0.05518	-2.11E-05	-3.06E-05	2.50E-05	3.89E-05	6.50E-06	-4.77E-05	5.52E-06	4.19E-05
0.0558	-2.14E-05	-3.10E-05	2.43E-05	3.82E-05	5.54E-06	-4.73E-05	5.71E-06	4.25E-05
0.05642	-2.12E-05	-3.10E-05	2.41E-05	3.79E-05	6.11E-06	-4.74E-05	5.65E-06	4.31E-05
0.05704	-2.06E-05	-3.06E-05	2.44E-05	3.83E-05	5.53E-06	-4.73E-05	6.14E-06	4.29E-05
0.05766	-2.02E-05	-3.14E-05	2.47E-05	3.83E-05	5.38E-06	-4.70E-05	5.51E-06	4.29E-05
0.05828	-2.06E-05	-3.12E-05	2.45E-05	3.82E-05	4.96E-06	-4.76E-05	5.89E-06	4.34E-05
0.0589	-2.05E-05	-3.12E-05	2.43E-05	3.78E-05	4.84E-06	-4.72E-05	5.76E-06	4.35E-05
0.05952	-1.90E-05	-3.10E-05	2.36E-05	3.82E-05	4.76E-06	-4.73E-05	5.97E-06	4.32E-05
0.06014	-1.79E-05	-3.08E-05	2.40E-05	3.72E-05	4.86E-06	-4.70E-05	5.51E-06	4.30E-05
0.06076	-1.84E-05	-3.14E-05	2.40E-05	3.78E-05	4.31E-06	-4.75E-05	6.15E-06	4.33E-05
0.06138	-1.84E-05	-3.15E-05	2.46E-05	3.75E-05	2.06E-06	-4.74E-05	6.40E-06	4.41E-05
	-2.13E-05	-3.14E-05	2.48E-05	3.85E-05	5.80E-06	-4.67E-05	5.47E-06	4.30E-05

APPENDIX D

	120 Degree 449 kg				150 Degree 449 kg			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	2.83E-05	-3.60E-05	-2.71E-05	3.40E-05	3.82E-05	-3.53E-05	-3.17E-05	1.42E-05
0.00062	2.85E-05	-3.61E-05	-2.65E-05	3.39E-05	3.75E-05	-3.51E-05	-3.17E-05	1.43E-05
0.00124	2.83E-05	-3.70E-05	-2.65E-05	3.36E-05	3.81E-05	-3.55E-05	-3.17E-05	1.39E-05
0.00186	2.76E-05	-3.70E-05	-2.63E-05	3.40E-05	3.79E-05	-3.53E-05	-3.18E-05	1.44E-05
0.00248	2.66E-05	-3.70E-05	-2.62E-05	3.37E-05	3.82E-05	-3.52E-05	-3.15E-05	1.39E-05
0.0031	2.59E-05	-3.68E-05	-2.60E-05	3.42E-05	3.57E-05	-3.58E-05	-3.13E-05	1.35E-05
0.00372	2.62E-05	-3.73E-05	-2.59E-05	3.43E-05	3.52E-05	-3.57E-05	-3.09E-05	1.27E-05
0.00434	2.55E-05	-3.77E-05	-2.60E-05	3.40E-05	3.53E-05	-3.55E-05	-3.12E-05	1.31E-05
0.00496	2.50E-05	-3.70E-05	-2.61E-05	3.42E-05	3.61E-05	-3.47E-05	-3.16E-05	1.31E-05
0.00558	2.55E-05	-3.71E-05	-2.61E-05	3.43E-05	3.70E-05	-3.44E-05	-3.17E-05	1.35E-05
0.0062	2.47E-05	-3.70E-05	-2.62E-05	3.44E-05	3.74E-05	-3.40E-05	-3.19E-05	1.32E-05
0.00682	2.48E-05	-3.73E-05	-2.66E-05	3.41E-05	3.79E-05	-3.42E-05	-3.20E-05	1.39E-05
0.00744	2.47E-05	-3.69E-05	-2.58E-05	3.45E-05	3.83E-05	-3.42E-05	-3.18E-05	1.41E-05
0.00806	2.48E-05	-3.72E-05	-2.61E-05	3.46E-05	3.89E-05	-3.45E-05	-3.18E-05	1.40E-05
0.00868	2.48E-05	-3.73E-05	-2.57E-05	3.44E-05	3.86E-05	-3.39E-05	-3.17E-05	1.40E-05
0.0093	2.34E-05	-3.72E-05	-2.54E-05	3.48E-05	3.93E-05	-3.45E-05	-3.23E-05	1.40E-05
0.00992	2.25E-05	-3.77E-05	-2.51E-05	3.48E-05	3.94E-05	-3.42E-05	-3.23E-05	1.46E-05
0.01054	2.23E-05	-3.69E-05	-2.57E-05	3.47E-05	3.97E-05	-3.47E-05	-3.24E-05	1.48E-05
0.01116	2.25E-05	-3.72E-05	-2.51E-05	3.51E-05	3.94E-05	-3.44E-05	-3.20E-05	1.49E-05
0.01178	2.33E-05	-3.68E-05	-2.61E-05	3.48E-05	4.00E-05	-3.48E-05	-3.25E-05	1.47E-05
0.0124	2.38E-05	-3.65E-05	-2.65E-05	3.48E-05	3.95E-05	-3.47E-05	-3.21E-05	1.45E-05
0.01302	2.49E-05	-3.60E-05	-2.58E-05	3.50E-05	4.08E-05	-3.39E-05	-3.27E-05	1.50E-05
0.01364	2.51E-05	-3.68E-05	-2.61E-05	3.51E-05	4.22E-05	-3.49E-05	-3.24E-05	1.51E-05
0.01426	2.54E-05	-3.64E-05	-2.65E-05	3.46E-05	4.19E-05	-3.47E-05	-3.28E-05	1.55E-05
0.01488	2.52E-05	-3.63E-05	-2.59E-05	3.44E-05	4.17E-05	-3.51E-05	-3.20E-05	1.52E-05
0.0155	2.55E-05	-3.65E-05	-2.63E-05	3.47E-05	4.09E-05	-3.51E-05	-3.25E-05	1.52E-05
0.01612	2.62E-05	-3.60E-05	-2.63E-05	3.44E-05	4.01E-05	-3.57E-05	-3.22E-05	1.49E-05
0.01674	2.54E-05	-3.60E-05	-2.63E-05	3.45E-05	3.93E-05	-3.56E-05	-3.24E-05	1.47E-05
0.01736	2.60E-05	-3.63E-05	-2.57E-05	3.42E-05	3.89E-05	-3.61E-05	-3.21E-05	1.44E-05
0.01798	2.61E-05	-3.66E-05	-2.67E-05	3.40E-05	3.87E-05	-3.53E-05	-3.20E-05	1.43E-05
0.0186	2.60E-05	-3.67E-05	-2.66E-05	3.40E-05	3.85E-05	-3.54E-05	-3.18E-05	1.43E-05
0.01922	2.74E-05	-3.64E-05	-2.61E-05	3.41E-05	3.86E-05	-3.55E-05	-3.18E-05	1.37E-05
0.01984	2.84E-05	-3.59E-05	-2.66E-05	3.43E-05	3.84E-05	-3.54E-05	-3.17E-05	1.44E-05
0.02046	2.87E-05	-3.64E-05	-2.66E-05	3.38E-05	3.80E-05	-3.52E-05	-3.17E-05	1.37E-05
0.02108	2.82E-05	-3.64E-05	-2.64E-05	3.40E-05	3.78E-05	-3.53E-05	-3.15E-05	1.39E-05
0.0217	2.76E-05	-3.65E-05	-2.60E-05	3.42E-05	3.75E-05	-3.52E-05	-3.14E-05	1.39E-05
0.02232	2.72E-05	-3.68E-05	-2.61E-05	3.37E-05	3.78E-05	-3.48E-05	-3.17E-05	1.39E-05
0.02294	2.59E-05	-3.73E-05	-2.57E-05	3.42E-05	3.65E-05	-3.55E-05	-3.07E-05	1.32E-05
0.02356	2.58E-05	-3.68E-05	-2.62E-05	3.43E-05	3.59E-05	-3.52E-05	-3.06E-05	1.33E-05
0.02418	2.58E-05	-3.69E-05	-2.54E-05	3.44E-05	3.54E-05	-3.49E-05	-3.16E-05	1.28E-05
0.0248	2.56E-05	-3.65E-05	-2.62E-05	3.46E-05	3.58E-05	-3.44E-05	-3.16E-05	1.25E-05
0.02542	2.50E-05	-3.73E-05	-2.61E-05	3.41E-05	3.70E-05	-3.43E-05	-3.16E-05	1.34E-05
0.02604	2.49E-05	-3.71E-05	-2.58E-05	3.45E-05	3.73E-05	-3.40E-05	-3.16E-05	1.41E-05
0.02666	2.49E-05	-3.70E-05	-2.52E-05	3.46E-05	3.80E-05	-3.33E-05	-3.21E-05	1.34E-05
0.02728	2.49E-05	-3.69E-05	-2.57E-05	3.46E-05	3.82E-05	-3.46E-05	-3.24E-05	1.38E-05
0.0279	2.44E-05	-3.68E-05	-2.60E-05	3.51E-05	3.88E-05	-3.45E-05	-3.23E-05	1.39E-05
0.02852	2.46E-05	-3.73E-05	-2.62E-05	3.40E-05	3.85E-05	-3.43E-05	-3.21E-05	1.36E-05
0.02914	2.37E-05	-3.69E-05	-2.58E-05	3.41E-05	3.93E-05	-3.47E-05	-3.21E-05	1.43E-05
0.02976	2.30E-05	-3.77E-05	-2.52E-05	3.50E-05	3.95E-05	-3.44E-05	-3.21E-05	1.45E-05
0.03038	2.24E-05	-3.67E-05	-2.55E-05	3.53E-05	3.96E-05	-3.44E-05	-3.21E-05	1.43E-05
0.031	2.30E-05	-3.65E-05	-2.57E-05	3.53E-05	3.97E-05	-3.44E-05	-3.23E-05	1.43E-05
0.03162	2.27E-05	-3.65E-05	-2.58E-05	3.48E-05	4.02E-05	-3.47E-05	-3.21E-05	1.43E-05
0.03224	2.33E-05	-3.65E-05	-2.64E-05	3.50E-05	4.01E-05	-3.48E-05	-3.19E-05	1.47E-05
0.03286	2.48E-05	-3.60E-05	-2.67E-05	3.48E-05	4.08E-05	-3.43E-05	-3.27E-05	1.52E-05
0.03348	2.51E-05	-3.63E-05	-2.64E-05	3.50E-05	4.20E-05	-3.41E-05	-3.32E-05	1.57E-05
0.0341	2.51E-05	-3.62E-05	-2.62E-05	3.47E-05	4.21E-05	-3.51E-05	-3.22E-05	1.49E-05
0.03472	2.52E-05	-3.60E-05	-2.61E-05	3.48E-05	4.21E-05	-3.48E-05	-3.22E-05	1.58E-05
0.03534	2.55E-05	-3.62E-05	-2.58E-05	3.45E-05	4.09E-05	-3.55E-05	-3.24E-05	1.49E-05
0.03596	2.58E-05	-3.61E-05	-2.60E-05	3.45E-05	4.02E-05	-3.58E-05	-3.20E-05	1.49E-05
0.03658	2.62E-05	-3.63E-05	-2.64E-05	3.45E-05	3.95E-05	-3.53E-05	-3.21E-05	1.46E-05
0.0372	2.58E-05	-3.67E-05	-2.61E-05	3.41E-05	3.94E-05	-3.57E-05	-3.14E-05	1.46E-05
0.03782	2.62E-05	-3.66E-05	-2.66E-05	3.41E-05	3.95E-05	-3.48E-05	-3.21E-05	1.46E-05
0.03844	2.64E-05	-3.65E-05	-2.60E-05	3.41E-05	3.85E-05	-3.55E-05	-3.14E-05	1.43E-05
0.03906	2.72E-05	-3.60E-05	-2.66E-05	3.38E-05	3.80E-05	-3.54E-05	-3.17E-05	1.43E-05
0.03968	2.75E-05	-3.57E-05	-2.66E-05	3.44E-05	3.83E-05	-3.49E-05	-3.15E-05	1.39E-05
0.0403	2.82E-05	-3.61E-05	-2.64E-05	3.41E-05	3.80E-05	-3.57E-05	-3.16E-05	1.39E-05
0.04092	2.84E-05	-3.61E-05	-2.59E-05	3.39E-05	3.76E-05	-3.53E-05	-3.16E-05	1.38E-05
0.04154	2.81E-05	-3.64E-05	-2.61E-05	3.39E-05	3.77E-05	-3.49E-05	-3.11E-05	1.37E-05
0.04216	2.77E-05	-3.70E-05	-2.64E-05	3.37E-05	3.78E-05	-3.53E-05	-3.12E-05	1.38E-05
0.04278	2.58E-05	-3.74E-05	-2.62E-05	3.40E-05	3.70E-05	-3.54E-05	-3.16E-05	1.34E-05
0.0434	2.62E-05	-3.73E-05	-2.59E-05	3.40E-05	3.53E-05	-3.60E-05	-3.10E-05	1.31E-05
0.04402	2.61E-05	-3.66E-05	-2.58E-05	3.40E-05	3.58E-05	-3.55E-05	-3.10E-05	1.30E-05
0.04464	2.59E-05	-3.72E-05	-2.60E-05	3.41E-05	3.57E-05	-3.47E-05	-3.13E-05	1.30E-05
0.04526	2.52E-05	-3.72E-05	-2.56E-05	3.44E-05	3.62E-05	-3.44E-05	-3.16E-05	1.33E-05
0.04588	2.50E-05	-3.68E-05	-2.61E-05	3.50E-05	3.76E-05	-3.39E-05	-3.16E-05	1.30E-05
0.0465	2.46E-05	-3.71E-05	-2.60E-05	3.43E-05	3.82E-05	-3.40E-05	-3.18E-05	1.41E-05
0.04712	2.47E-05	-3.66E-05	-2.60E-05	3.41E-05	3.89E-05	-3.41E-05	-3.27E-05	1.38E-05
0.04774	2.43E-05	-3.70E-05	-2.58E-05	3.49E-05	3.88E-05	-3.40E-05	-3.23E-05	1.38E-05
0.04836	2.47E-05	-3.70E-05	-2.60E-05	3.46E-05	3.93E-05	-3.48E-05	-3.22E-05	1.43E-05
0.04898	2.43E-05	-3.69E-05	-2.53E-05	3.43E-05	3.92E-05	-3.43E-05	-3.18E-05	1.37E-05
0.0496	2.30E-05	-3.74E-05	-2.51E-05	3.47E-05	3.94E-05	-3.39E-05	-3.20E-05	1.43E-05
0.05022	2.25E-05	-3.78E-05	-2.55E-05	3.45E-05	3.96E-05	-3.46E-05	-3.23E-05	1.45E-05
0.05084	2.21E-05	-3.69E-05	-2.53E-05	3.52E-05	4.00E-05	-3.47E-05	-3.23E-05	1.47E-05
0.05146	2.31E-05	-3.64E-05	-2.58E-05	3.53E-05	3.98E-05	-3.47E-05	-3.24E-05	1.48E-05
0.05208	2.30E-05	-3.67E-05	-2.52E-05	3.48E-05	3.97E-05	-3.45E-05	-3.22E-05	1.45E-05
0.0527	2.45E-05	-3.62E-05	-2.60E-05	3.49E-05	4.04E-05	-3.45E-05	-3.24E-05	1.48E-05
0.05332	2.44E-05	-3.64E-05	-2.59E-05	3.50E-05	4.17E-05	-3.41E-05	-3.24E-05	1.49E-05
0.05394	2.48E-05	-3.61E-05	-2.56E-05	3.45E-05	4.21E-05	-3.46E-05	-3.25E-05	1.56E-05
0.05456	2.56E-05	-3.64E-05	-2.61E-05	3.50E-05	4.18E-05	-3.46E-05	-3.25E-05	1.53E-05
0.05518	2.55E-05	-3.59E-05	-2.60E-05	3.45E-05	4.13E-05	-3.54E-05	-3.26E-05	1.54E-05
0.0558	2.58E-05	-3.62E-05	-2.65E-05	3.45E-05	4.07E-05	-3.54E-05	-3.19E-05	1.49E-05
0.05642	2.59E-05	-3.66E-05	-2.59E-05	3.45E-05	3.92E-05	-3.59E-05	-3.18E-05	1.53E-05
0.05704	2.61E-05	-3.70E-05	-2.65E-05	3.43E-05	3.93E-05	-3.56E-05	-3.20E-05	1.46E-05
0.05766	2.59E-05	-3.63E-05	-2.59E-05	3.53E-05	3.89E-05	-3.56E-05	-3.23E-05	1.41E-05
0.05828	2.62E-05	-3.63E-05	-2.62E-05	3.44E-05	3.86E-05	-3.57E-05	-3.17E-05	1.39E-05
0.0589	2.68E-05	-3.64E-05	-2.64E-05	3.44E-05	3.84E-05	-3.54E-05	-3.17E-05	1.41E-05
0.05952	2.80E-05	-3.55E-05	-2.65E-05	3.43E-05	3.83E-05	-3.51E-05	-3.19E-05	1.39E-05
0.06014	2.90E-05	-3.64E-05	-2.60E-05	3.43E-05	3.79E-05	-3.52E-05	-3.14E-05	1.39E-05
0.06076	2.86E-05	-3.64E-05	-2.64E-05	3.43E-05	3.81E-05	-3.51E-05	-3.13E-05	1.38E-05
0.06138	2.82E-05	-3.65E-05	-2.64E-05	3.36E-05	3.74E-05	-3.53E-05	-3.17E-05	1.41E-05
	2.55E-05	-3.67E-05	-2.60E-05	3.44E-05	3.88E-05	-3.49E-05	-3.19E-05	1.42E-05

APPENDIX D

	180 Degree 448 kg				210 Degree 450 kg			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	5.07E-05	1.17E-05	-4.00E-05	-1.06E-05	4.39E-05	3.28E-05	-2.77E-05	-1.12E-05
0.00062	4.96E-05	1.07E-05	-3.97E-05	-1.09E-05	4.41E-05	3.25E-05	-2.78E-05	-1.16E-05
0.00124	4.93E-05	1.08E-05	-3.92E-05	-1.05E-05	4.30E-05	3.18E-05	-2.71E-05	-1.10E-05
0.00186	4.97E-05	1.08E-05	-3.89E-05	-9.87E-06	4.19E-05	3.23E-05	-2.74E-05	-1.12E-05
0.00248	4.92E-05	1.11E-05	-3.93E-05	-1.00E-05	4.18E-05	3.25E-05	-2.75E-05	-1.10E-05
0.0031	4.87E-05	1.13E-05	-3.96E-05	-9.74E-06	4.23E-05	3.33E-05	-2.77E-05	-1.12E-05
0.00372	4.83E-05	1.15E-05	-3.91E-05	-9.94E-06	4.27E-05	3.31E-05	-2.74E-05	-1.07E-05
0.00434	4.80E-05	1.11E-05	-3.94E-05	-9.52E-06	4.34E-05	3.33E-05	-2.82E-05	-1.13E-05
0.00496	4.76E-05	1.16E-05	-3.90E-05	-9.69E-06	4.46E-05	3.32E-05	-2.80E-05	-1.13E-05
0.00558	4.77E-05	1.15E-05	-3.94E-05	-9.29E-06	4.49E-05	3.30E-05	-2.76E-05	-1.10E-05
0.0062	4.78E-05	1.19E-05	-3.91E-05	-9.53E-06	4.45E-05	3.30E-05	-2.77E-05	-1.17E-05
0.00682	4.74E-05	1.15E-05	-3.87E-05	-9.50E-06	4.49E-05	3.35E-05	-2.77E-05	-1.16E-05
0.00744	4.59E-05	1.11E-05	-3.83E-05	-9.74E-06	4.50E-05	3.32E-05	-2.84E-05	-1.14E-05
0.00806	4.58E-05	1.13E-05	-3.87E-05	-8.77E-06	4.56E-05	3.35E-05	-2.79E-05	-1.12E-05
0.00868	4.55E-05	1.14E-05	-3.89E-05	-8.82E-06	4.56E-05	3.31E-05	-2.76E-05	-1.19E-05
0.0093	4.58E-05	1.24E-05	-3.93E-05	-8.88E-06	4.54E-05	3.32E-05	-2.84E-05	-1.16E-05
0.00992	4.69E-05	1.23E-05	-4.01E-05	-8.98E-06	4.58E-05	3.29E-05	-2.79E-05	-1.21E-05
0.01054	4.82E-05	1.30E-05	-4.00E-05	-9.27E-06	4.58E-05	3.31E-05	-2.77E-05	-1.18E-05
0.01116	4.82E-05	1.22E-05	-3.95E-05	-9.73E-06	4.71E-05	3.33E-05	-2.84E-05	-1.15E-05
0.01178	4.89E-05	1.28E-05	-4.01E-05	-9.49E-06	4.82E-05	3.36E-05	-2.87E-05	-1.23E-05
0.0124	4.92E-05	1.22E-05	-4.01E-05	-1.01E-05	4.81E-05	3.34E-05	-2.78E-05	-1.15E-05
0.01302	4.90E-05	1.23E-05	-4.01E-05	-9.94E-06	4.78E-05	3.33E-05	-2.81E-05	-1.24E-05
0.01364	4.94E-05	1.20E-05	-3.97E-05	-1.01E-05	4.72E-05	3.22E-05	-2.82E-05	-1.20E-05
0.01426	4.94E-05	1.20E-05	-3.95E-05	-1.02E-05	4.61E-05	3.25E-05	-2.78E-05	-1.22E-05
0.01488	4.98E-05	1.28E-05	-3.98E-05	-1.02E-05	4.56E-05	3.26E-05	-2.74E-05	-1.21E-05
0.0155	5.00E-05	1.17E-05	-4.01E-05	-1.07E-05	4.52E-05	3.22E-05	-2.80E-05	-1.23E-05
0.01612	5.02E-05	1.22E-05	-4.01E-05	-1.01E-05	4.50E-05	3.27E-05	-2.76E-05	-1.19E-05
0.01674	5.04E-05	1.20E-05	-3.95E-05	-1.02E-05	4.49E-05	3.26E-05	-2.78E-05	-1.13E-05
0.01736	5.16E-05	1.26E-05	-4.04E-05	-1.06E-05	4.44E-05	3.20E-05	-2.79E-05	-1.16E-05
0.01798	5.21E-05	1.22E-05	-4.02E-05	-1.12E-05	4.41E-05	3.26E-05	-2.76E-05	-1.18E-05
0.0186	5.19E-05	1.22E-05	-4.03E-05	-1.12E-05	4.41E-05	3.24E-05	-2.78E-05	-1.14E-05
0.01922	5.17E-05	1.20E-05	-3.97E-05	-1.12E-05	4.47E-05	3.20E-05	-2.78E-05	-1.17E-05
0.01984	5.14E-05	1.13E-05	-4.03E-05	-1.13E-05	4.38E-05	3.30E-05	-2.76E-05	-1.10E-05
0.02046	5.04E-05	1.09E-05	-3.99E-05	-1.06E-05	4.38E-05	3.30E-05	-2.74E-05	-1.15E-05
0.02108	4.96E-05	1.13E-05	-3.94E-05	-1.05E-05	4.28E-05	3.22E-05	-2.73E-05	-1.14E-05
0.0217	4.89E-05	1.12E-05	-3.89E-05	-1.01E-05	4.23E-05	3.18E-05	-2.76E-05	-1.10E-05
0.02232	4.89E-05	1.06E-05	-3.89E-05	-1.00E-05	4.20E-05	3.17E-05	-2.73E-05	-1.11E-05
0.02294	4.89E-05	1.08E-05	-3.93E-05	-1.03E-05	4.26E-05	3.22E-05	-2.75E-05	-1.05E-05
0.02356	4.83E-05	1.11E-05	-3.95E-05	-9.68E-06	4.33E-05	3.31E-05	-2.72E-05	-1.08E-05
0.02418	4.80E-05	1.12E-05	-4.02E-05	-9.92E-06	4.33E-05	3.25E-05	-2.78E-05	-1.09E-05
0.0248	4.77E-05	1.15E-05	-3.95E-05	-9.80E-06	4.41E-05	3.33E-05	-2.76E-05	-1.12E-05
0.02542	4.78E-05	1.17E-05	-3.92E-05	-9.60E-06	4.47E-05	3.34E-05	-2.82E-05	-1.12E-05
0.02604	4.79E-05	1.18E-05	-3.91E-05	-9.19E-06	4.47E-05	3.34E-05	-2.83E-05	-1.11E-05
0.02666	4.81E-05	1.18E-05	-3.90E-05	-9.42E-06	4.51E-05	3.38E-05	-2.80E-05	-1.15E-05
0.02728	4.60E-05	1.11E-05	-3.91E-05	-9.10E-06	4.55E-05	3.33E-05	-2.82E-05	-1.16E-05
0.0279	4.53E-05	1.16E-05	-3.84E-05	-9.02E-06	4.51E-05	3.31E-05	-2.88E-05	-1.14E-05
0.02852	4.52E-05	1.19E-05	-3.87E-05	-9.44E-06	4.54E-05	3.31E-05	-2.84E-05	-1.15E-05
0.02914	4.60E-05	1.18E-05	-3.92E-05	-9.04E-06	4.55E-05	3.30E-05	-2.78E-05	-1.16E-05
0.02976	4.70E-05	1.20E-05	-3.92E-05	-9.43E-06	4.59E-05	3.29E-05	-2.82E-05	-1.19E-05
0.03038	4.76E-05	1.30E-05	-3.89E-05	-8.77E-06	4.55E-05	3.32E-05	-2.79E-05	-1.16E-05
0.031	4.82E-05	1.29E-05	-3.97E-05	-9.91E-06	4.63E-05	3.31E-05	-2.87E-05	-1.17E-05
0.03162	4.87E-05	1.28E-05	-3.99E-05	-9.60E-06	4.79E-05	3.37E-05	-2.80E-05	-1.19E-05
0.03224	4.89E-05	1.27E-05	-3.99E-05	-1.03E-05	4.83E-05	3.31E-05	-2.83E-05	-1.22E-05
0.03286	4.93E-05	1.25E-05	-4.00E-05	-1.02E-05	4.80E-05	3.29E-05	-2.87E-05	-1.24E-05
0.03348	4.97E-05	1.23E-05	-4.00E-05	-1.00E-05	4.76E-05	3.30E-05	-2.82E-05	-1.20E-05
0.0341	4.96E-05	1.18E-05	-3.98E-05	-1.03E-05	4.66E-05	3.23E-05	-2.75E-05	-1.20E-05
0.03472	4.97E-05	1.24E-05	-4.01E-05	-1.01E-05	4.58E-05	3.23E-05	-2.78E-05	-1.21E-05
0.03534	4.97E-05	1.24E-05	-4.00E-05	-1.04E-05	4.57E-05	3.19E-05	-2.82E-05	-1.19E-05
0.03596	5.00E-05	1.14E-05	-3.97E-05	-1.07E-05	4.50E-05	3.24E-05	-2.76E-05	-1.15E-05
0.03658	5.02E-05	1.22E-05	-3.97E-05	-1.03E-05	4.49E-05	3.22E-05	-2.75E-05	-1.18E-05
0.0372	5.12E-05	1.30E-05	-4.03E-05	-1.02E-05	4.48E-05	3.25E-05	-2.76E-05	-1.18E-05
0.03782	5.27E-05	1.20E-05	-4.03E-05	-1.10E-05	4.44E-05	3.21E-05	-2.77E-05	-1.20E-05
0.03844	5.23E-05	1.18E-05	-4.03E-05	-1.11E-05	4.44E-05	3.28E-05	-2.78E-05	-1.11E-05
0.03906	5.19E-05	1.21E-05	-4.02E-05	-1.12E-05	4.41E-05	3.26E-05	-2.83E-05	-1.11E-05
0.03968	5.09E-05	1.10E-05	-4.03E-05	-1.09E-05	4.38E-05	3.26E-05	-2.81E-05	-1.13E-05
0.0403	5.04E-05	1.09E-05	-3.99E-05	-1.09E-05	4.46E-05	3.34E-05	-2.74E-05	-1.13E-05
0.04092	4.98E-05	1.02E-05	-3.96E-05	-1.00E-05	4.34E-05	3.24E-05	-2.74E-05	-1.11E-05
0.04154	4.90E-05	1.10E-05	-3.96E-05	-1.03E-05	4.22E-05	3.21E-05	-2.76E-05	-1.16E-05
0.04216	4.92E-05	1.12E-05	-3.95E-05	-1.02E-05	4.18E-05	3.24E-05	-2.77E-05	-1.12E-05
0.04278	4.85E-05	1.13E-05	-3.93E-05	-1.01E-05	4.21E-05	3.30E-05	-2.74E-05	-1.11E-05
0.0434	4.86E-05	1.14E-05	-3.94E-05	-9.42E-06	4.25E-05	3.28E-05	-2.74E-05	-1.11E-05
0.04402	4.83E-05	1.11E-05	-3.93E-05	-9.95E-06	4.30E-05	3.33E-05	-2.79E-05	-1.07E-05
0.04464	4.77E-05	1.13E-05	-3.93E-05	-1.03E-05	4.40E-05	3.32E-05	-2.82E-05	-1.13E-05
0.04526	4.81E-05	1.14E-05	-3.95E-05	-9.60E-06	4.47E-05	3.32E-05	-2.83E-05	-1.15E-05
0.04588	4.76E-05	1.17E-05	-3.96E-05	-9.56E-06	4.45E-05	3.37E-05	-2.75E-05	-1.16E-05
0.0465	4.77E-05	1.23E-05	-3.89E-05	-9.49E-06	4.49E-05	3.35E-05	-2.86E-05	-1.14E-05
0.04712	4.66E-05	1.08E-05	-3.89E-05	-9.99E-06	4.51E-05	3.29E-05	-2.84E-05	-1.15E-05
0.04774	4.55E-05	1.11E-05	-3.82E-05	-8.61E-06	4.55E-05	3.33E-05	-2.81E-05	-1.18E-05
0.04836	4.54E-05	1.17E-05	-3.86E-05	-8.67E-06	4.53E-05	3.33E-05	-2.79E-05	-1.22E-05
0.04898	4.58E-05	1.19E-05	-3.90E-05	-9.06E-06	4.59E-05	3.31E-05	-2.76E-05	-1.13E-05
0.0496	4.67E-05	1.26E-05	-3.93E-05	-8.94E-06	4.58E-05	3.31E-05	-2.83E-05	-1.10E-05
0.05022	4.72E-05	1.30E-05	-3.93E-05	-9.06E-06	4.57E-05	3.31E-05	-2.79E-05	-1.16E-05
0.05084	4.82E-05	1.25E-05	-3.91E-05	-9.19E-06	4.61E-05	3.31E-05	-2.81E-05	-1.20E-05
0.05146	4.79E-05	1.26E-05	-3.91E-05	-9.69E-06	4.76E-05	3.37E-05	-2.84E-05	-1.13E-05
0.05208	4.93E-05	1.26E-05	-3.99E-05	-9.93E-06	4.76E-05	3.34E-05	-2.86E-05	-1.23E-05
0.0527	4.86E-05	1.24E-05	-3.98E-05	-1.00E-05	4.75E-05	3.30E-05	-2.86E-05	-1.18E-05
0.05332	4.94E-05	1.23E-05	-3.99E-05	-1.03E-05	4.74E-05	3.27E-05	-2.82E-05	-1.23E-05
0.05394	4.93E-05	1.27E-05	-3.96E-05	-1.04E-05	4.68E-05	3.24E-05	-2.84E-05	-1.23E-05
0.05456	4.97E-05	1.24E-05	-3.99E-05	-1.00E-05	4.62E-05	3.24E-05	-2.73E-05	-1.21E-05
0.05518	4.98E-05	1.24E-05	-4.00E-05	-1.05E-05	4.57E-05	3.22E-05	-2.74E-05	-1.19E-05
0.0558	5.01E-05	1.23E-05	-3.99E-05	-1.03E-05	4.50E-05	3.30E-05	-2.83E-05	-1.16E-05
0.05642	5.00E-05	1.19E-05	-4.01E-05	-1.05E-05	4.52E-05	3.23E-05	-2.81E-05	-1.16E-05
0.05704	5.01E-05	1.26E-05	-4.06E-05	-1.04E-05	4.44E-05	3.23E-05	-2.81E-05	-1.12E-05
0.05766	5.28E-05	1.26E-05	-4.05E-05	-1.10E-05	4.43E-05	3.28E-05	-2.71E-05	-1.15E-05
0.05828	5.19E-05	1.24E-05	-4.03E-05	-1.13E-05	4.45E-05	3.21E-05	-2.74E-05	-1.18E-05
0.0589	5.15E-05	1.19E-05	-4.03E-05	-1.08E-05	4.46E-05	3.25E-05	-2.78E-05	-1.15E-05
0.05952	5.10E-05	1.13E-05	-4.01E-05	-1.07E-05	4.40E-05	3.25E-05	-2.73E-05	-1.14E-05
0.06014	5.08E-05	1.09E-05	-3.97E-05	-1.08E-05	4.44E-05	3.31E-05	-2.78E-05	-1.16E-05
0.06076	5.00E-05	1.14E-05	-3.93E-05	-1.12E-05	4.40E-05	3.23E-05	-2.76E-05	-1.16E-05
0.06138	4.95E-05	1.11E-05	-3.93E-05	-1.04E-05	4.25E-05	3.22E-05	-2.76E-05	-1.14E-05
	4.89E-05	1.18E-05	-3.96E-05	-1.00E-05	4.49E-05	3.28E-05	-2.79E-05	-1.51E-05

APPENDIX D

	240 Degree 448 kg				270 Degree 450 kg			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	2.37E-05	3.74E-05	-2.99E-05	-2.99E-05	1.36E-05	4.70E-05	-3.23E-06	-3.80E-05
0.00062	2.30E-05	3.74E-05	-3.06E-05	-3.00E-05	1.32E-05	4.73E-05	-2.74E-06	-3.79E-05
0.00124	2.27E-05	3.75E-05	-3.09E-05	-3.01E-05	1.27E-05	4.72E-05	-2.66E-06	-3.81E-05
0.00186	2.27E-05	3.78E-05	-3.04E-05	-2.96E-05	1.31E-05	4.75E-05	-3.61E-06	-3.82E-05
0.00248	2.29E-05	3.73E-05	-3.05E-05	-2.97E-05	1.26E-05	4.76E-05	-3.04E-06	-3.76E-05
0.0031	2.32E-05	3.81E-05	-3.05E-05	-2.99E-05	1.30E-05	4.77E-05	-3.01E-06	-3.76E-05
0.00372	2.17E-05	3.71E-05	-3.03E-05	-2.96E-05	1.17E-05	4.68E-05	-3.05E-06	-3.80E-05
0.00434	2.08E-05	3.72E-05	-3.00E-05	-2.88E-05	1.07E-05	4.75E-05	-2.45E-06	-3.73E-05
0.00496	2.07E-05	3.80E-05	-3.00E-05	-2.90E-05	1.10E-05	4.77E-05	-2.16E-06	-3.76E-05
0.00558	2.08E-05	3.81E-05	-3.01E-05	-2.93E-05	1.12E-05	4.78E-05	-2.70E-06	-3.69E-05
0.0062	2.11E-05	3.78E-05	-2.99E-05	-2.91E-05	1.19E-05	4.82E-05	-2.84E-06	-3.71E-05
0.00682	2.25E-05	3.92E-05	-3.08E-05	-2.97E-05	1.22E-05	4.81E-05	-3.42E-06	-3.80E-05
0.00744	2.31E-05	3.89E-05	-3.12E-05	-2.96E-05	1.29E-05	4.89E-05	-3.09E-06	-3.85E-05
0.00806	2.30E-05	3.88E-05	-3.06E-05	-2.97E-05	1.33E-05	4.86E-05	-3.70E-06	-3.79E-05
0.00868	2.39E-05	3.85E-05	-3.13E-05	-3.01E-05	1.39E-05	4.83E-05	-3.36E-06	-3.80E-05
0.0093	2.38E-05	3.84E-05	-3.08E-05	-2.97E-05	1.35E-05	4.77E-05	-3.72E-06	-3.90E-05
0.00992	2.44E-05	3.84E-05	-3.09E-05	-3.02E-05	1.41E-05	4.83E-05	-3.69E-06	-3.89E-05
0.01054	2.47E-05	3.83E-05	-3.07E-05	-3.00E-05	1.39E-05	4.79E-05	-3.70E-06	-3.88E-05
0.01116	2.43E-05	3.86E-05	-3.11E-05	-3.09E-05	1.48E-05	4.82E-05	-3.58E-06	-3.87E-05
0.01178	2.50E-05	3.77E-05	-3.11E-05	-3.07E-05	1.45E-05	4.82E-05	-3.27E-06	-3.88E-05
0.0124	2.51E-05	3.80E-05	-3.09E-05	-3.01E-05	1.50E-05	4.83E-05	-3.23E-06	-3.89E-05
0.01302	2.48E-05	3.77E-05	-3.10E-05	-3.05E-05	1.47E-05	4.80E-05	-3.67E-06	-3.87E-05
0.01364	2.56E-05	3.80E-05	-3.12E-05	-3.07E-05	1.56E-05	4.84E-05	-3.85E-06	-3.88E-05
0.01426	2.70E-05	3.82E-05	-3.19E-05	-3.08E-05	1.68E-05	4.81E-05	-3.98E-06	-3.93E-05
0.01488	2.66E-05	3.81E-05	-3.14E-05	-3.12E-05	1.68E-05	4.77E-05	-3.95E-06	-3.92E-05
0.0155	2.71E-05	3.79E-05	-3.13E-05	-3.09E-05	1.69E-05	4.80E-05	-4.05E-06	-3.96E-05
0.01612	2.64E-05	3.75E-05	-3.09E-05	-3.11E-05	1.62E-05	4.70E-05	-3.77E-06	-3.94E-05
0.01674	2.53E-05	3.69E-05	-3.04E-05	-3.08E-05	1.52E-05	4.71E-05	-3.23E-06	-3.91E-05
0.01736	2.45E-05	3.69E-05	-3.07E-05	-3.07E-05	1.47E-05	4.66E-05	-3.25E-06	-3.89E-05
0.01798	2.45E-05	3.71E-05	-3.06E-05	-3.08E-05	1.39E-05	4.71E-05	-3.36E-06	-3.88E-05
0.0186	2.42E-05	3.69E-05	-3.07E-05	-3.04E-05	1.39E-05	4.72E-05	-2.70E-06	-3.83E-05
0.01922	2.41E-05	3.74E-05	-3.09E-05	-3.04E-05	1.37E-05	4.70E-05	-2.82E-06	-3.88E-05
0.01984	2.31E-05	3.74E-05	-3.02E-05	-3.00E-05	1.33E-05	4.71E-05	-3.07E-06	-3.84E-05
0.02046	2.31E-05	3.76E-05	-3.05E-05	-3.01E-05	1.36E-05	4.75E-05	-2.84E-06	-3.83E-05
0.02108	2.32E-05	3.76E-05	-3.08E-05	-2.97E-05	1.28E-05	4.73E-05	-3.42E-06	-3.78E-05
0.0217	2.32E-05	3.75E-05	-2.99E-05	-2.98E-05	1.33E-05	4.72E-05	-3.33E-06	-3.77E-05
0.02232	2.26E-05	3.76E-05	-3.02E-05	-2.95E-05	1.27E-05	4.73E-05	-2.98E-06	-3.78E-05
0.02294	2.27E-05	3.81E-05	-3.05E-05	-2.98E-05	1.30E-05	4.79E-05	-2.65E-06	-3.83E-05
0.02356	2.19E-05	3.71E-05	-3.06E-05	-2.99E-05	1.22E-05	4.69E-05	-2.46E-06	-3.78E-05
0.02418	2.06E-05	3.74E-05	-2.97E-05	-2.93E-05	1.04E-05	4.73E-05	-2.99E-06	-3.75E-05
0.0248	2.05E-05	3.80E-05	-2.98E-05	-2.89E-05	1.08E-05	4.71E-05	-2.50E-06	-3.70E-05
0.02542	2.05E-05	3.78E-05	-3.03E-05	-2.87E-05	1.12E-05	4.73E-05	-3.41E-06	-3.72E-05
0.02604	2.13E-05	3.82E-05	-2.98E-05	-2.89E-05	1.13E-05	4.80E-05	-3.64E-06	-3.78E-05
0.02666	2.21E-05	3.79E-05	-3.10E-05	-2.97E-05	1.24E-05	4.77E-05	-3.02E-06	-3.74E-05
0.02728	2.30E-05	3.84E-05	-3.11E-05	-3.02E-05	1.28E-05	4.86E-05	-3.61E-06	-3.80E-05
0.0279	2.37E-05	3.87E-05	-3.11E-05	-3.01E-05	1.31E-05	4.81E-05	-3.52E-06	-3.78E-05
0.02852	2.38E-05	3.85E-05	-3.12E-05	-2.96E-05	1.28E-05	4.86E-05	-3.69E-06	-3.84E-05
0.02914	2.41E-05	3.91E-05	-3.12E-05	-3.00E-05	1.35E-05	4.83E-05	-3.51E-06	-3.81E-05
0.02976	2.42E-05	3.85E-05	-3.06E-05	-3.04E-05	1.39E-05	4.79E-05	-3.91E-06	-3.88E-05
0.03038	2.42E-05	3.84E-05	-3.10E-05	-3.03E-05	1.42E-05	4.81E-05	-3.57E-06	-3.89E-05
0.031	2.45E-05	3.80E-05	-3.08E-05	-3.09E-05	1.51E-05	4.85E-05	-3.04E-06	-3.84E-05
0.03162	2.48E-05	3.78E-05	-3.06E-05	-3.02E-05	1.44E-05	4.81E-05	-3.44E-06	-3.87E-05
0.03224	2.48E-05	3.79E-05	-3.11E-05	-3.06E-05	1.53E-05	4.78E-05	-3.57E-06	-3.92E-05
0.03286	2.51E-05	3.77E-05	-3.05E-05	-3.02E-05	1.45E-05	4.80E-05	-3.18E-06	-3.93E-05
0.03348	2.56E-05	3.81E-05	-3.11E-05	-3.06E-05	1.55E-05	4.86E-05	-3.81E-06	-3.88E-05
0.0341	2.70E-05	3.86E-05	-3.18E-05	-3.11E-05	1.67E-05	4.86E-05	-4.40E-06	-3.97E-05
0.03472	2.67E-05	3.80E-05	-3.14E-05	-3.14E-05	1.68E-05	4.80E-05	-3.68E-06	-3.95E-05
0.03534	2.69E-05	3.74E-05	-3.06E-05	-3.18E-05	1.68E-05	4.80E-05	-3.45E-06	-3.98E-05
0.03596	2.63E-05	3.75E-05	-3.09E-05	-3.10E-05	1.66E-05	4.72E-05	-3.43E-06	-3.96E-05
0.03658	2.53E-05	3.69E-05	-3.08E-05	-3.11E-05	1.57E-05	4.71E-05	-3.54E-06	-3.94E-05
0.0372	2.48E-05	3.66E-05	-3.10E-05	-3.08E-05	1.48E-05	4.69E-05	-3.01E-06	-3.93E-05
0.03782	2.48E-05	3.75E-05	-3.03E-05	-3.01E-05	1.47E-05	4.73E-05	-3.00E-06	-3.83E-05
0.03844	2.40E-05	3.71E-05	-3.04E-05	-3.01E-05	1.39E-05	4.71E-05	-2.63E-06	-3.87E-05
0.03906	2.41E-05	3.73E-05	-3.03E-05	-3.00E-05	1.34E-05	4.73E-05	-3.50E-06	-3.87E-05
0.03968	2.36E-05	3.66E-05	-3.08E-05	-3.00E-05	1.38E-05	4.72E-05	-2.96E-06	-3.89E-05
0.0403	2.31E-05	3.75E-05	-3.01E-05	-3.05E-05	1.35E-05	4.74E-05	-2.35E-06	-3.85E-05
0.04092	2.32E-05	3.74E-05	-3.04E-05	-2.96E-05	1.29E-05	4.72E-05	-3.17E-06	-3.82E-05
0.04154	2.28E-05	3.74E-05	-3.07E-05	-2.99E-05	1.27E-05	4.75E-05	-3.22E-06	-3.82E-05
0.04216	2.27E-05	3.76E-05	-2.96E-05	-2.98E-05	1.31E-05	4.73E-05	-3.00E-06	-3.85E-05
0.04278	2.27E-05	3.76E-05	-3.03E-05	-3.00E-05	1.29E-05	4.72E-05	-2.86E-06	-3.82E-05
0.0434	2.25E-05	3.73E-05	-3.01E-05	-2.94E-05	1.25E-05	4.67E-05	-2.77E-06	-3.77E-05
0.04402	2.07E-05	3.73E-05	-2.96E-05	-2.92E-05	1.08E-05	4.66E-05	-2.44E-06	-3.75E-05
0.04464	2.10E-05	3.74E-05	-3.03E-05	-2.94E-05	1.03E-05	4.75E-05	-2.28E-06	-3.75E-05
0.04526	2.07E-05	3.78E-05	-3.04E-05	-2.89E-05	1.07E-05	4.75E-05	-3.20E-06	-3.65E-05
0.04588	2.09E-05	3.77E-05	-3.06E-05	-2.91E-05	1.15E-05	4.78E-05	-3.07E-06	-3.69E-05
0.0465	2.20E-05	3.92E-05	-3.04E-05	-2.88E-05	1.16E-05	4.84E-05	-3.15E-06	-3.78E-05
0.04712	2.27E-05	3.84E-05	-3.07E-05	-2.97E-05	1.26E-05	4.83E-05	-3.28E-06	-3.76E-05
0.04774	2.31E-05	3.85E-05	-3.07E-05	-2.97E-05	1.29E-05	4.84E-05	-3.36E-06	-3.83E-05
0.04836	2.39E-05	3.85E-05	-3.05E-05	-3.03E-05	1.34E-05	4.81E-05	-3.38E-06	-3.85E-05
0.04898	2.38E-05	3.83E-05	-3.00E-05	-2.99E-05	1.37E-05	4.79E-05	-3.96E-06	-3.87E-05
0.0496	2.38E-05	3.84E-05	-3.11E-05	-2.99E-05	1.43E-05	4.85E-05	-3.24E-06	-3.84E-05
0.05022	2.45E-05	3.85E-05	-3.12E-05	-3.01E-05	1.40E-05	4.86E-05	-3.53E-06	-3.86E-05
0.05084	2.47E-05	3.82E-05	-3.11E-05	-3.03E-05	1.49E-05	4.83E-05	-3.54E-06	-3.89E-05
0.05146	2.45E-05	3.81E-05	-3.10E-05	-3.04E-05	1.49E-05	4.83E-05	-3.46E-06	-3.86E-05
0.05208	2.50E-05	3.79E-05	-3.06E-05	-3.01E-05	1.49E-05	4.79E-05	-3.45E-06	-3.90E-05
0.0527	2.48E-05	3.79E-05	-3.09E-05	-3.01E-05	1.52E-05	4.75E-05	-3.88E-06	-3.88E-05
0.05332	2.50E-05	3.80E-05	-3.12E-05	-3.04E-05	1.47E-05	4.81E-05	-4.01E-06	-3.91E-05
0.05394	2.65E-05	3.85E-05	-3.14E-05	-3.11E-05	1.66E-05	4.84E-05	-4.03E-06	-3.91E-05
0.05456	2.74E-05	3.87E-05	-3.11E-05	-3.11E-05	1.67E-05	4.80E-05	-4.10E-06	-3.92E-05
0.05518	2.68E-05	3.80E-05	-3.09E-05	-3.12E-05	1.71E-05	4.79E-05	-3.59E-06	-3.97E-05
0.0558	2.64E-05	3.74E-05	-3.04E-05	-3.10E-05	1.70E-05	4.76E-05	-3.57E-06	-3.94E-05
0.05642	2.60E-05	3.67E-05	-3.07E-05	-3.10E-05	1.59E-05	4.70E-05	-3.34E-06	-3.94E-05
0.05704	2.46E-05	3.70E-05	-3.06E-05	-3.09E-05	1.50E-05	4.65E-05	-2.97E-06	-3.93E-05
0.05766	2.42E-05	3.72E-05	-3.01E-05	-3.00E-05	1.46E-05	4.65E-05	-3.11E-06	-3.87E-05
0.05828	2.42E-05	3.70E-05	-3.01E-05	-3.04E-05	1.39E-05	4.70E-05	-2.90E-06	-3.83E-05
0.0589	2.38E-05	3.68E-05	-3.05E-05	-3.05E-05	1.41E-05	4.70E-05	-3.23E-06	-3.85E-05
0.05952	2.36E-05	3.78E-05	-3.03E-05	-2.99E-05	1.37E-05	4.64E-05	-3.36E-06	-3.85E-05
0.06014	2.33E-05	3.67E-05	-3.02E-05	-3.03E-05	1.31E-05	4.71E-05	-3.09E-06	-3.81E-05
0.06076	2.30E-05	3.76E-05	-3.01E-05	-2.98E-05	1.32E-05	4.71E-05	-2.41E-06	-3.83E-05
0.06138	2.30E-05	3.76E-05	-3.03E-05	-2.93E-05	1.30E-05	4.74E-05	-2.65E-06	-3.80E-05
	2.38E-05	3.78E-05	-3.06E-05	-3.01E-05	1.38E-05	4.77E-05	-3.27E-06	-3.84E-05

APPENDIX D

	300 Degree 450 kg				330 Degree 450 kg			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	-3.62E-06	4.63E-05	1.36E-05	-4.37E-05	-2.23E-05	3.02E-05	3.14E-05	-4.34E-05
0.00062	-3.22E-06	4.57E-05	1.44E-05	-4.34E-05	-2.26E-05	2.97E-05	3.12E-05	-4.36E-05
0.00124	-3.87E-06	4.53E-05	1.48E-05	-4.31E-05	-2.25E-05	2.99E-05	3.12E-05	-4.37E-05
0.00186	-4.19E-06	4.47E-05	1.47E-05	-4.33E-05	-2.24E-05	2.99E-05	3.22E-05	-4.35E-05
0.00248	-5.53E-06	4.43E-05	1.48E-05	-4.30E-05	-2.15E-05	2.97E-05	3.10E-05	-4.34E-05
0.0031	-5.36E-06	4.43E-05	1.56E-05	-4.28E-05	-2.05E-05	3.06E-05	3.06E-05	-4.46E-05
0.00372	-6.49E-06	4.51E-05	1.49E-05	-4.27E-05	-2.00E-05	2.97E-05	3.13E-05	-4.41E-05
0.00434	-6.78E-06	4.56E-05	1.52E-05	-4.25E-05	-2.05E-05	3.00E-05	3.14E-05	-4.46E-05
0.00496	-6.87E-06	4.54E-05	1.53E-05	-4.24E-05	-2.08E-05	2.92E-05	3.12E-05	-4.45E-05
0.00558	-7.00E-06	4.53E-05	1.58E-05	-4.23E-05	-2.11E-05	2.86E-05	3.16E-05	-4.42E-05
0.0062	-7.16E-06	4.48E-05	1.52E-05	-4.22E-05	-2.28E-05	2.85E-05	3.17E-05	-4.36E-05
0.00682	-7.79E-06	4.51E-05	1.55E-05	-4.14E-05	-2.25E-05	2.87E-05	3.17E-05	-4.35E-05
0.00744	-7.82E-06	4.49E-05	1.56E-05	-4.20E-05	-2.32E-05	2.90E-05	3.15E-05	-4.32E-05
0.00806	-7.58E-06	4.48E-05	1.46E-05	-4.23E-05	-2.38E-05	2.87E-05	3.20E-05	-4.30E-05
0.00868	-7.40E-06	4.52E-05	1.52E-05	-4.26E-05	-2.39E-05	2.93E-05	3.17E-05	-4.33E-05
0.0093	-9.14E-06	4.47E-05	1.56E-05	-4.13E-05	-2.40E-05	2.88E-05	3.24E-05	-4.29E-05
0.00992	-9.91E-06	4.45E-05	1.57E-05	-4.10E-05	-2.42E-05	2.92E-05	3.20E-05	-4.33E-05
0.01054	-9.53E-06	4.52E-05	1.61E-05	-4.11E-05	-2.41E-05	2.93E-05	3.16E-05	-4.26E-05
0.01116	-9.72E-06	4.58E-05	1.54E-05	-4.13E-05	-2.44E-05	2.91E-05	3.28E-05	-4.26E-05
0.01178	-8.90E-06	4.60E-05	1.54E-05	-4.12E-05	-2.41E-05	2.96E-05	3.18E-05	-4.26E-05
0.0124	-8.03E-06	4.62E-05	1.52E-05	-4.15E-05	-2.45E-05	2.92E-05	3.16E-05	-4.30E-05
0.01302	-7.76E-06	4.64E-05	1.50E-05	-4.12E-05	-2.61E-05	2.90E-05	3.24E-05	-4.24E-05
0.01364	-7.02E-06	4.56E-05	1.48E-05	-4.16E-05	-2.70E-05	2.94E-05	3.27E-05	-4.24E-05
0.01426	-6.69E-06	4.65E-05	1.47E-05	-4.21E-05	-2.65E-05	2.93E-05	3.22E-05	-4.20E-05
0.01488	-6.63E-06	4.61E-05	1.51E-05	-4.26E-05	-2.60E-05	3.01E-05	3.27E-05	-4.23E-05
0.0155	-6.41E-06	4.63E-05	1.46E-05	-4.24E-05	-2.50E-05	3.03E-05	3.13E-05	-4.19E-05
0.01612	-6.38E-06	4.61E-05	1.48E-05	-4.26E-05	-2.46E-05	3.07E-05	3.21E-05	-4.30E-05
0.01674	-5.80E-06	4.63E-05	1.48E-05	-4.22E-05	-2.38E-05	3.04E-05	3.18E-05	-4.29E-05
0.01736	-5.76E-06	4.55E-05	1.46E-05	-4.21E-05	-2.41E-05	3.05E-05	3.13E-05	-4.34E-05
0.01798	-5.78E-06	4.56E-05	1.42E-05	-4.28E-05	-2.31E-05	3.02E-05	3.12E-05	-4.34E-05
0.0186	-5.90E-06	4.60E-05	1.47E-05	-4.23E-05	-2.27E-05	3.02E-05	3.14E-05	-4.32E-05
0.01922	-4.74E-06	4.60E-05	1.50E-05	-4.28E-05	-2.30E-05	3.03E-05	3.10E-05	-4.33E-05
0.01984	-3.09E-06	4.66E-05	1.42E-05	-4.34E-05	-2.25E-05	3.03E-05	3.15E-05	-4.34E-05
0.02046	-3.03E-06	4.59E-05	1.43E-05	-4.37E-05	-2.25E-05	2.98E-05	3.08E-05	-4.35E-05
0.02108	-3.66E-06	4.50E-05	1.41E-05	-4.39E-05	-2.27E-05	3.00E-05	3.11E-05	-4.33E-05
0.0217	-3.94E-06	4.52E-05	1.44E-05	-4.34E-05	-2.26E-05	2.97E-05	3.13E-05	-4.35E-05
0.02232	-5.02E-06	4.47E-05	1.54E-05	-4.33E-05	-2.24E-05	2.96E-05	3.05E-05	-4.38E-05
0.02294	-5.82E-06	4.45E-05	1.45E-05	-4.25E-05	-2.04E-05	3.07E-05	3.06E-05	-4.37E-05
0.02356	-6.00E-06	4.49E-05	1.56E-05	-4.24E-05	-2.03E-05	2.98E-05	3.08E-05	-4.41E-05
0.02418	-6.05E-06	4.50E-05	1.56E-05	-4.23E-05	-2.03E-05	3.02E-05	3.06E-05	-4.41E-05
0.0248	-6.36E-06	4.49E-05	1.55E-05	-4.19E-05	-2.05E-05	2.91E-05	3.13E-05	-4.38E-05
0.02542	-7.13E-06	4.45E-05	1.55E-05	-4.29E-05	-2.11E-05	2.90E-05	3.17E-05	-4.47E-05
0.02604	-7.39E-06	4.51E-05	1.55E-05	-4.18E-05	-2.22E-05	2.87E-05	3.13E-05	-4.40E-05
0.02666	-7.28E-06	4.51E-05	1.54E-05	-4.21E-05	-2.27E-05	2.91E-05	3.18E-05	-4.36E-05
0.02728	-7.49E-06	4.52E-05	1.53E-05	-4.25E-05	-2.29E-05	2.89E-05	3.19E-05	-4.35E-05
0.0279	-7.67E-06	4.50E-05	1.52E-05	-4.20E-05	-2.32E-05	2.86E-05	3.15E-05	-4.37E-05
0.02852	-7.52E-06	4.56E-05	1.47E-05	-4.21E-05	-2.37E-05	2.91E-05	3.19E-05	-4.31E-05
0.02914	-8.29E-06	4.48E-05	1.57E-05	-4.19E-05	-2.37E-05	2.92E-05	3.23E-05	-4.28E-05
0.02976	-9.44E-06	4.53E-05	1.59E-05	-4.09E-05	-2.41E-05	2.90E-05	3.19E-05	-4.32E-05
0.03038	-9.99E-06	4.45E-05	1.60E-05	-4.11E-05	-2.43E-05	2.92E-05	3.19E-05	-4.28E-05
0.031	-9.93E-06	4.55E-05	1.53E-05	-4.04E-05	-2.45E-05	2.94E-05	3.17E-05	-4.32E-05
0.03162	-9.17E-06	4.60E-05	1.50E-05	-4.10E-05	-2.42E-05	2.93E-05	3.22E-05	-4.26E-05
0.03224	-7.74E-06	4.59E-05	1.52E-05	-4.09E-05	-2.41E-05	2.93E-05	3.23E-05	-4.26E-05
0.03286	-7.44E-06	4.67E-05	1.49E-05	-4.18E-05	-2.58E-05	2.85E-05	3.21E-05	-4.24E-05
0.03348	-7.33E-06	4.57E-05	1.46E-05	-4.19E-05	-2.59E-05	2.89E-05	3.30E-05	-4.17E-05
0.0341	-6.42E-06	4.63E-05	1.47E-05	-4.20E-05	-2.68E-05	2.94E-05	3.23E-05	-4.20E-05
0.03472	-6.72E-06	4.59E-05	1.51E-05	-4.25E-05	-2.60E-05	3.01E-05	3.22E-05	-4.20E-05
0.03534	-6.50E-06	4.68E-05	1.47E-05	-4.21E-05	-2.52E-05	2.99E-05	3.18E-05	-4.23E-05
0.03596	-5.88E-06	4.62E-05	1.46E-05	-4.20E-05	-2.43E-05	3.03E-05	3.15E-05	-4.25E-05
0.03658	-6.13E-06	4.62E-05	1.48E-05	-4.25E-05	-2.41E-05	3.02E-05	3.15E-05	-4.27E-05
0.0372	-6.16E-06	4.59E-05	1.48E-05	-4.27E-05	-2.40E-05	3.00E-05	3.14E-05	-4.29E-05
0.03782	-5.44E-06	4.58E-05	1.47E-05	-4.22E-05	-2.30E-05	3.02E-05	3.11E-05	-4.30E-05
0.03844	-5.73E-06	4.60E-05	1.54E-05	-4.26E-05	-2.31E-05	3.06E-05	3.07E-05	-4.29E-05
0.03906	-4.37E-06	4.58E-05	1.41E-05	-4.28E-05	-2.31E-05	3.03E-05	3.14E-05	-4.32E-05
0.03968	-3.69E-06	4.65E-05	1.48E-05	-4.31E-05	-2.26E-05	2.97E-05	3.12E-05	-4.36E-05
0.0403	-3.24E-06	4.60E-05	1.45E-05	-4.36E-05	-2.25E-05	2.96E-05	3.13E-05	-4.38E-05
0.04092	-3.32E-06	4.54E-05	1.45E-05	-4.36E-05	-2.26E-05	3.02E-05	3.13E-05	-4.35E-05
0.04154	-4.38E-06	4.50E-05	1.45E-05	-4.31E-05	-2.22E-05	2.97E-05	3.12E-05	-4.33E-05
0.04216	-4.68E-06	4.52E-05	1.48E-05	-4.29E-05	-2.23E-05	2.99E-05	3.10E-05	-4.39E-05
0.04278	-5.45E-06	4.47E-05	1.52E-05	-4.29E-05	-2.11E-05	3.07E-05	3.11E-05	-4.41E-05
0.0434	-5.62E-06	4.45E-05	1.52E-05	-4.27E-05	-2.02E-05	3.02E-05	3.07E-05	-4.45E-05
0.04402	-6.36E-06	4.51E-05	1.53E-05	-4.25E-05	-2.03E-05	2.94E-05	3.10E-05	-4.43E-05
0.04464	-7.03E-06	4.48E-05	1.52E-05	-4.24E-05	-2.03E-05	2.93E-05	3.12E-05	-4.45E-05
0.04526	-7.14E-06	4.51E-05	1.58E-05	-4.21E-05	-2.11E-05	2.86E-05	3.14E-05	-4.41E-05
0.04588	-7.48E-06	4.44E-05	1.51E-05	-4.17E-05	-2.23E-05	2.90E-05	3.15E-05	-4.39E-05
0.0465	-7.64E-06	4.51E-05	1.56E-05	-4.20E-05	-2.29E-05	2.91E-05	3.19E-05	-4.37E-05
0.04712	-7.68E-06	4.48E-05	1.56E-05	-4.20E-05	-2.30E-05	2.89E-05	3.17E-05	-4.37E-05
0.04774	-7.86E-06	4.55E-05	1.57E-05	-4.21E-05	-2.30E-05	2.87E-05	3.13E-05	-4.33E-05
0.04836	-7.73E-06	4.58E-05	1.47E-05	-4.20E-05	-2.34E-05	2.85E-05	3.13E-05	-4.31E-05
0.04898	-8.04E-06	4.55E-05	1.57E-05	-4.20E-05	-2.39E-05	2.93E-05	3.23E-05	-4.28E-05
0.0496	-9.36E-06	4.42E-05	1.57E-05	-4.15E-05	-2.43E-05	2.94E-05	3.22E-05	-4.31E-05
0.05022	-9.69E-06	4.55E-05	1.57E-05	-4.09E-05	-2.41E-05	2.90E-05	3.19E-05	-4.27E-05
0.05084	-9.94E-06	4.55E-05	1.59E-05	-4.12E-05	-2.42E-05	2.95E-05	3.18E-05	-4.31E-05
0.05146	-9.47E-06	4.58E-05	1.53E-05	-4.14E-05	-2.44E-05	2.96E-05	3.20E-05	-4.27E-05
0.05208	-8.31E-06	4.63E-05	1.48E-05	-4.10E-05	-2.45E-05	2.94E-05	3.18E-05	-4.23E-05
0.0527	-7.43E-06	4.63E-05	1.51E-05	-4.19E-05	-2.55E-05	2.89E-05	3.17E-05	-4.24E-05
0.05332	-7.51E-06	4.62E-05	1.46E-05	-4.15E-05	-2.69E-05	2.91E-05	3.24E-05	-4.18E-05
0.05394	-7.14E-06	4.61E-05	1.48E-05	-4.21E-05	-2.62E-05	2.91E-05	3.31E-05	-4.21E-05
0.05456	-7.04E-06	4.64E-05	1.51E-05	-4.24E-05	-2.64E-05	2.96E-05	3.22E-05	-4.24E-05
0.05518	-6.03E-06	4.58E-05	1.45E-05	-4.23E-05	-2.57E-05	3.01E-05	3.20E-05	-4.21E-05
0.0558	-5.77E-06	4.63E-05	1.52E-05	-4.27E-05	-2.46E-05	3.04E-05	3.15E-05	-4.26E-05
0.05642	-5.80E-06	4.59E-05	1.43E-05	-4.24E-05	-2.39E-05	3.06E-05	3.19E-05	-4.26E-05
0.05704	-5.40E-06	4.58E-05	1.46E-05	-4.26E-05	-2.40E-05	3.06E-05	3.21E-05	-4.24E-05
0.05766	-5.65E-06	4.56E-05	1.50E-05	-4.29E-05	-2.35E-05	3.03E-05	3.08E-05	-4.26E-05
0.05828	-5.50E-06	4.58E-05	1.51E-05	-4.30E-05	-2.35E-05	3.00E-05	3.15E-05	-4.34E-05
0.0589	-5.29E-06	4.59E-05	1.51E-05	-4.26E-05	-2.27E-05	2.99E-05	3.14E-05	-4.33E-05
0.05952	-3.97E-06	4.65E-05	1.49E-05	-4.35E-05	-2.26E-05	3.02E-05	3.10E-05	-4.34E-05
0.06014	-3.34E-06	4.59E-05	1.45E-05	-4.38E-05	-2.24E-05	3.00E-05	3.15E-05	-4.35E-05
0.06076	-3.70E-06	4.60E-05	1.39E-05	-4.39E-05	-2.21E-05	2.97E-05	3.12E-05	-4.32E-05
0.06138	-3.60E-06	4.51E-05	1.50E-05	-4.38E-05	-2.18E-05	3.00E-05	3.10E-05	-4.39E-05
	-6.52E-06	4.55E-05	1.50E-05	-4.23E-05	-2.33E-05	2.96E-05	3.16E-05	-4.32E-05

APPENDIX D

	0 Degree 537 kg				30 Degree 540 kg			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	-4.42E-05	1.63E-05	5.51E-05	4.55E-07	-3.87E-05	-2.36E-05	5.05E-05	3.65E-05
0.00062	-4.40E-05	1.62E-05	5.58E-05	3.61E-07	-3.95E-05	-2.30E-05	5.13E-05	3.67E-05
0.00124	-4.36E-05	1.56E-05	5.57E-05	-2.08E-07	-3.88E-05	-2.21E-05	5.07E-05	3.67E-05
0.00186	-4.32E-05	1.61E-05	5.51E-05	5.51E-07	-3.86E-05	-2.15E-05	5.11E-05	3.66E-05
0.00248	-4.28E-05	1.58E-05	5.46E-05	7.61E-08	-3.76E-05	-2.10E-05	5.02E-05	3.68E-05
0.0031	-4.31E-05	1.60E-05	5.43E-05	1.94E-07	-3.63E-05	-2.15E-05	5.02E-05	3.60E-05
0.00372	-4.30E-05	1.58E-05	5.49E-05	-9.31E-08	-3.65E-05	-2.15E-05	5.00E-05	3.60E-05
0.00434	-4.27E-05	1.60E-05	5.52E-05	-3.97E-07	-3.57E-05	-2.17E-05	5.05E-05	3.61E-05
0.00496	-4.26E-05	1.62E-05	5.46E-05	1.94E-07	-3.64E-05	-2.11E-05	5.02E-05	3.58E-05
0.00558	-4.08E-05	1.69E-05	5.42E-05	-5.83E-07	-3.59E-05	-2.19E-05	4.95E-05	3.55E-05
0.0062	-4.08E-05	1.65E-05	5.49E-05	6.03E-08	-3.54E-05	-2.17E-05	4.98E-05	3.52E-05
0.00682	-4.10E-05	1.56E-05	5.48E-05	-5.72E-07	-3.54E-05	-2.21E-05	5.00E-05	3.54E-05
0.00744	-4.14E-05	1.58E-05	5.54E-05	-5.50E-07	-3.51E-05	-2.26E-05	4.99E-05	3.57E-05
0.00806	-4.21E-05	1.53E-05	5.48E-05	-8.43E-07	-3.47E-05	-2.24E-05	5.00E-05	3.50E-05
0.00868	-4.28E-05	1.52E-05	5.57E-05	-6.61E-07	-3.50E-05	-2.24E-05	4.99E-05	3.53E-05
0.0093	-4.35E-05	1.53E-05	5.53E-05	-3.20E-07	-3.54E-05	-2.20E-05	4.98E-05	3.50E-05
0.00992	-4.32E-05	1.52E-05	5.51E-05	-4.24E-07	-3.34E-05	-2.19E-05	4.90E-05	3.47E-05
0.01054	-4.31E-05	1.52E-05	5.52E-05	-3.30E-07	-3.24E-05	-2.22E-05	4.95E-05	3.44E-05
0.01116	-4.42E-05	1.54E-05	5.52E-05	-3.01E-07	-3.29E-05	-2.22E-05	4.95E-05	3.45E-05
0.01178	-4.37E-05	1.50E-05	5.54E-05	3.05E-07	-3.33E-05	-2.26E-05	4.96E-05	3.42E-05
0.0124	-4.41E-05	1.58E-05	5.56E-05	2.38E-07	-3.43E-05	-2.32E-05	4.99E-05	3.50E-05
0.01302	-4.40E-05	1.56E-05	5.48E-05	-3.67E-07	-3.51E-05	-2.33E-05	5.06E-05	3.52E-05
0.01364	-4.42E-05	1.55E-05	5.57E-05	-3.02E-07	-3.52E-05	-2.31E-05	5.02E-05	3.45E-05
0.01426	-4.40E-05	1.57E-05	5.54E-05	-4.15E-08	-3.53E-05	-2.32E-05	5.05E-05	3.53E-05
0.01488	-4.55E-05	1.49E-05	5.51E-05	-2.42E-07	-3.60E-05	-2.33E-05	5.07E-05	3.55E-05
0.0155	-4.63E-05	1.43E-05	5.54E-05	2.48E-07	-3.60E-05	-2.31E-05	5.09E-05	3.58E-05
0.01612	-4.67E-05	1.47E-05	5.52E-05	8.76E-08	-3.64E-05	-2.30E-05	5.01E-05	3.54E-05
0.01674	-4.69E-05	1.53E-05	5.52E-05	4.00E-07	-3.64E-05	-2.29E-05	5.05E-05	3.60E-05
0.01736	-4.62E-05	1.49E-05	5.50E-05	2.02E-07	-3.69E-05	-2.27E-05	5.07E-05	3.59E-05
0.01798	-4.52E-05	1.58E-05	5.49E-05	8.73E-07	-3.70E-05	-2.26E-05	5.09E-05	3.59E-05
0.0186	-4.43E-05	1.60E-05	5.47E-05	2.47E-07	-3.69E-05	-2.26E-05	5.03E-05	3.59E-05
0.01922	-4.46E-05	1.61E-05	5.48E-05	3.07E-07	-3.73E-05	-2.23E-05	5.09E-05	3.66E-05
0.01984	-4.43E-05	1.61E-05	5.47E-05	-1.63E-07	-3.89E-05	-2.37E-05	5.13E-05	3.61E-05
0.02046	-4.38E-05	1.62E-05	5.47E-05	1.01E-08	-3.90E-05	-2.30E-05	5.05E-05	3.63E-05
0.02108	-4.36E-05	1.59E-05	5.48E-05	-6.64E-07	-3.90E-05	-2.26E-05	5.05E-05	3.71E-05
0.0217	-4.33E-05	1.60E-05	5.42E-05	-2.19E-07	-3.87E-05	-2.18E-05	5.09E-05	3.64E-05
0.02232	-4.30E-05	1.60E-05	5.52E-05	-2.05E-07	-3.82E-05	-2.21E-05	5.04E-05	3.68E-05
0.02294	-4.27E-05	1.60E-05	5.49E-05	-3.24E-07	-3.69E-05	-2.13E-05	5.04E-05	3.62E-05
0.02356	-4.27E-05	1.61E-05	5.46E-05	3.05E-07	-3.66E-05	-2.14E-05	4.96E-05	3.60E-05
0.02418	-4.28E-05	1.55E-05	5.50E-05	-2.55E-07	-3.63E-05	-2.21E-05	4.99E-05	3.58E-05
0.0248	-4.27E-05	1.60E-05	5.47E-05	-2.64E-07	-3.61E-05	-2.15E-05	5.06E-05	3.57E-05
0.02542	-4.17E-05	1.72E-05	5.53E-05	-1.16E-07	-3.61E-05	-2.17E-05	5.02E-05	3.58E-05
0.02604	-4.05E-05	1.63E-05	5.47E-05	-1.53E-07	-3.53E-05	-2.25E-05	5.03E-05	3.53E-05
0.02666	-4.09E-05	1.56E-05	5.44E-05	-3.10E-07	-3.54E-05	-2.19E-05	5.00E-05	3.57E-05
0.02728	-4.10E-05	1.54E-05	5.52E-05	-4.01E-07	-3.49E-05	-2.20E-05	5.07E-05	3.56E-05
0.0279	-4.19E-05	1.54E-05	5.47E-05	-4.86E-07	-3.51E-05	-2.22E-05	4.97E-05	3.47E-05
0.02852	-4.28E-05	1.54E-05	5.49E-05	-5.29E-07	-3.51E-05	-2.22E-05	5.03E-05	3.50E-05
0.02914	-4.30E-05	1.54E-05	5.48E-05	-9.50E-07	-3.45E-05	-2.27E-05	5.02E-05	3.51E-05
0.02976	-4.29E-05	1.54E-05	5.48E-05	-2.92E-07	-3.39E-05	-2.22E-05	4.99E-05	3.47E-05
0.03038	-4.38E-05	1.50E-05	5.46E-05	-3.00E-08	-3.29E-05	-2.21E-05	4.92E-05	3.48E-05
0.031	-4.37E-05	1.57E-05	5.51E-05	-1.93E-07	-3.32E-05	-2.27E-05	4.93E-05	3.44E-05
0.03162	-4.40E-05	1.50E-05	5.56E-05	2.72E-07	-3.30E-05	-2.32E-05	5.00E-05	3.46E-05
0.03224	-4.45E-05	1.49E-05	5.47E-05	4.60E-08	-3.38E-05	-2.40E-05	4.99E-05	3.47E-05
0.03286	-4.44E-05	1.55E-05	5.53E-05	-2.03E-07	-3.46E-05	-2.31E-05	5.04E-05	3.44E-05
0.03348	-4.43E-05	1.56E-05	5.52E-05	-1.79E-07	-3.56E-05	-2.30E-05	5.03E-05	3.50E-05
0.0341	-4.45E-05	1.54E-05	5.53E-05	1.88E-07	-3.58E-05	-2.32E-05	5.04E-05	3.51E-05
0.03472	-4.51E-05	1.50E-05	5.60E-05	3.60E-07	-3.58E-05	-2.33E-05	5.02E-05	3.56E-05
0.03534	-4.63E-05	1.45E-05	5.53E-05	-7.30E-08	-3.60E-05	-2.32E-05	5.02E-05	3.54E-05
0.03596	-4.70E-05	1.48E-05	5.59E-05	8.90E-08	-3.64E-05	-2.31E-05	5.08E-05	3.55E-05
0.03658	-4.71E-05	1.52E-05	5.54E-05	3.76E-07	-3.67E-05	-2.31E-05	5.08E-05	3.54E-05
0.0372	-4.63E-05	1.59E-05	5.53E-05	8.72E-07	-3.68E-05	-2.30E-05	5.06E-05	3.61E-05
0.03782	-4.60E-05	1.53E-05	5.49E-05	5.78E-07	-3.72E-05	-2.30E-05	5.07E-05	3.59E-05
0.03844	-4.49E-05	1.59E-05	5.49E-05	3.90E-07	-3.69E-05	-2.22E-05	5.09E-05	3.60E-05
0.03906	-4.43E-05	1.60E-05	5.51E-05	4.59E-07	-3.72E-05	-2.24E-05	5.04E-05	3.59E-05
0.03968	-4.45E-05	1.60E-05	5.51E-05	5.13E-07	-3.83E-05	-2.32E-05	5.06E-05	3.64E-05
0.0403	-4.43E-05	1.60E-05	5.47E-05	5.53E-07	-3.92E-05	-2.29E-05	5.10E-05	3.68E-05
0.04092	-4.36E-05	1.59E-05	5.49E-05	1.29E-07	-3.93E-05	-2.19E-05	5.03E-05	3.68E-05
0.04154	-4.32E-05	1.56E-05	5.49E-05	7.63E-07	-3.85E-05	-2.18E-05	5.05E-05	3.68E-05
0.04216	-4.29E-05	1.63E-05	5.52E-05	5.85E-09	-3.83E-05	-2.18E-05	5.09E-05	3.68E-05
0.04278	-4.33E-05	1.56E-05	5.48E-05	-1.32E-07	-3.73E-05	-2.12E-05	5.00E-05	3.60E-05
0.0434	-4.31E-05	1.61E-05	5.46E-05	-1.58E-07	-3.66E-05	-2.15E-05	4.99E-05	3.60E-05
0.04402	-4.31E-05	1.57E-05	5.49E-05	-9.02E-08	-3.66E-05	-2.17E-05	5.02E-05	3.61E-05
0.04464	-4.27E-05	1.63E-05	5.53E-05	-4.93E-07	-3.59E-05	-2.16E-05	5.02E-05	3.59E-05
0.04526	-4.16E-05	1.64E-05	5.41E-05	-3.60E-07	-3.55E-05	-2.19E-05	5.06E-05	3.61E-05
0.04588	-4.11E-05	1.57E-05	5.41E-05	-2.18E-07	-3.50E-05	-2.20E-05	4.99E-05	3.56E-05
0.0465	-4.08E-05	1.64E-05	5.51E-05	-6.45E-07	-3.55E-05	-2.19E-05	5.04E-05	3.55E-05
0.04712	-4.14E-05	1.58E-05	5.47E-05	-5.50E-07	-3.54E-05	-2.17E-05	4.99E-05	3.53E-05
0.04774	-4.14E-05	1.56E-05	5.46E-05	-4.94E-07	-3.53E-05	-2.22E-05	4.96E-05	3.53E-05
0.04836	-4.27E-05	1.52E-05	5.46E-05	-4.00E-07	-3.52E-05	-2.24E-05	5.03E-05	3.50E-05
0.04898	-4.33E-05	1.54E-05	5.51E-05	-8.74E-07	-3.52E-05	-2.23E-05	4.98E-05	3.53E-05
0.0496	-4.37E-05	1.52E-05	5.51E-05	-6.13E-07	-3.40E-05	-2.20E-05	4.98E-05	3.48E-05
0.05022	-4.35E-05	1.56E-05	5.50E-05	-4.00E-08	-3.24E-05	-2.24E-05	4.90E-05	3.44E-05
0.05084	-4.39E-05	1.49E-05	5.54E-05	-3.50E-07	-3.28E-05	-2.23E-05	4.98E-05	3.46E-05
0.05146	-4.39E-05	1.51E-05	5.49E-05	-1.23E-07	-3.36E-05	-2.28E-05	4.99E-05	3.42E-05
0.05208	-4.41E-05	1.48E-05	5.58E-05	-2.06E-07	-3.39E-05	-2.35E-05	4.95E-05	3.43E-05
0.0527	-4.34E-05	1.49E-05	5.55E-05	-9.31E-08	-3.48E-05	-2.31E-05	5.07E-05	3.50E-05
0.05332	-4.46E-05	1.51E-05	5.53E-05	4.86E-07	-3.53E-05	-2.34E-05	5.03E-05	3.49E-05
0.05394	-4.39E-05	1.54E-05	5.51E-05	2.45E-07	-3.57E-05	-2.27E-05	5.03E-05	3.51E-05
0.05456	-4.48E-05	1.55E-05	5.46E-05	1.42E-07	-3.61E-05	-2.34E-05	5.06E-05	3.54E-05
0.05518	-4.60E-05	1.47E-05	5.58E-05	8.33E-08	-3.62E-05	-2.34E-05	5.03E-05	3.54E-05
0.0558	-4.69E-05	1.47E-05	5.57E-05	2.24E-07	-3.65E-05	-2.32E-05	5.04E-05	3.58E-05
0.05642	-4.65E-05	1.51E-05	5.51E-05	6.42E-07	-3.63E-05	-2.32E-05	5.04E-05	3.54E-05
0.05704	-4.57E-05	1.53E-05	5.54E-05	6.09E-07	-3.74E-05	-2.29E-05	5.10E-05	3.58E-05
0.05766	-4.59E-05	1.60E-05	5.53E-05	7.18E-07	-3.69E-05	-2.28E-05	5.04E-05	3.61E-05
0.05828	-4.50E-05	1.60E-05	5.50E-05	8.43E-07	-3.70E-05	-2.26E-05	5.03E-05	3.59E-05
0.0589	-4.46E-05	1.61E-05	5.47E-05	-1.91E-07	-3.72E-05	-2.21E-05	5.09E-05	3.54E-05
0.05952	-4.40E-05	1.61E-05	5.52E-05	1.42E-07	-3.74E-05	-2.30E-05	5.07E-05	3.62E-05
0.06014	-4.38E-05	1.63E-05	5.49E-05	9.99E-07	-3.90E-05	-2.30E-05	5.12E-05	3.63E-05
0.06076	-4.37E-05	1.60E-05	5.51E-05	-1.57E-08	-3.92E-05	-2.24E-05	5.06E-05	3.66E-05
0.06138	-4.33E-05	1.60E-05	5.45E-05	-9.59E-08	-3.90E-05	-2.25E-05	5.03E-05	3.70E-05
	-4.37E-05	1.56E-05	5.50E-05	-2.54E-08	-3.61E-05	-2.25E-05	5.03E-05	3.56E-05

APPENDIX D

	60 Degree 540 kg				90 Degree 548 kg			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	-2.41E-05	-4.86E-05	3.01E-05	4.02E-05	5.05E-06	-5.34E-05	1.01E-05	4.94E-05
0.00062	-2.35E-05	-4.85E-05	2.94E-05	4.01E-05	6.38E-06	-5.26E-05	9.81E-06	4.89E-05
0.00124	-2.27E-05	-4.81E-05	2.98E-05	4.02E-05	7.33E-06	-5.35E-05	9.18E-06	4.88E-05
0.00186	-2.17E-05	-4.85E-05	2.95E-05	4.04E-05	7.08E-06	-5.34E-05	9.65E-06	4.92E-05
0.00248	-2.16E-05	-4.86E-05	2.96E-05	4.09E-05	6.92E-06	-5.39E-05	9.48E-06	4.89E-05
0.0031	-2.11E-05	-4.90E-05	2.91E-05	4.08E-05	6.23E-06	-5.45E-05	1.05E-05	4.93E-05
0.00372	-2.13E-05	-4.91E-05	2.94E-05	4.10E-05	5.56E-06	-5.45E-05	1.01E-05	4.91E-05
0.00434	-2.04E-05	-4.88E-05	2.98E-05	4.13E-05	5.20E-06	-5.46E-05	9.89E-06	4.91E-05
0.00496	-2.04E-05	-4.89E-05	2.90E-05	4.12E-05	4.26E-06	-5.46E-05	1.09E-05	4.98E-05
0.00558	-2.02E-05	-4.95E-05	2.93E-05	4.13E-05	4.55E-06	-5.43E-05	1.04E-05	4.91E-05
0.0062	-2.07E-05	-4.89E-05	2.97E-05	4.12E-05	3.94E-06	-5.40E-05	1.05E-05	5.01E-05
0.00682	-2.00E-05	-4.98E-05	2.91E-05	4.23E-05	3.68E-06	-5.43E-05	1.05E-05	5.02E-05
0.00744	-2.03E-05	-4.93E-05	2.94E-05	4.12E-05	3.23E-06	-5.39E-05	1.08E-05	4.97E-05
0.00806	-1.95E-05	-4.90E-05	2.92E-05	4.17E-05	2.92E-06	-5.36E-05	1.03E-05	5.05E-05
0.00868	-1.80E-05	-4.93E-05	2.90E-05	4.19E-05	3.26E-06	-5.39E-05	1.05E-05	5.01E-05
0.0093	-1.82E-05	-4.94E-05	2.92E-05	4.21E-05	3.06E-06	-5.38E-05	1.05E-05	5.00E-05
0.00992	-1.83E-05	-4.98E-05	2.94E-05	4.22E-05	3.09E-06	-5.38E-05	9.89E-06	5.03E-05
0.01054	-1.89E-05	-5.02E-05	3.01E-05	4.20E-05	9.59E-07	-5.45E-05	1.08E-05	5.07E-05
0.01116	-1.95E-05	-5.03E-05	3.03E-05	4.17E-05	9.47E-07	-5.42E-05	1.05E-05	5.14E-05
0.01178	-2.06E-05	-5.08E-05	2.97E-05	4.14E-05	1.01E-06	-5.37E-05	1.04E-05	5.09E-05
0.0124	-2.04E-05	-5.03E-05	2.98E-05	4.13E-05	1.10E-06	-5.33E-05	1.04E-05	5.07E-05
0.01302	-2.13E-05	-5.03E-05	3.03E-05	4.12E-05	1.63E-06	-5.27E-05	1.06E-05	5.10E-05
0.01364	-2.10E-05	-5.03E-05	2.95E-05	4.17E-05	2.83E-06	-5.29E-05	9.87E-06	5.09E-05
0.01426	-2.16E-05	-5.02E-05	3.02E-05	4.08E-05	3.67E-06	-5.26E-05	1.01E-05	5.02E-05
0.01488	-2.15E-05	-5.01E-05	3.04E-05	4.07E-05	3.12E-06	-5.30E-05	1.02E-05	5.02E-05
0.0155	-2.22E-05	-5.00E-05	2.96E-05	4.08E-05	3.61E-06	-5.29E-05	9.79E-06	5.00E-05
0.01612	-2.22E-05	-5.00E-05	3.03E-05	4.07E-05	3.75E-06	-5.28E-05	1.04E-05	4.97E-05
0.01674	-2.21E-05	-4.94E-05	3.04E-05	4.07E-05	4.24E-06	-5.27E-05	1.00E-05	4.96E-05
0.01736	-2.23E-05	-4.91E-05	3.01E-05	4.06E-05	4.80E-06	-5.33E-05	9.80E-06	4.95E-05
0.01798	-2.30E-05	-4.99E-05	3.01E-05	4.02E-05	4.78E-06	-5.27E-05	1.00E-05	4.93E-05
0.0186	-2.42E-05	-5.01E-05	3.03E-05	4.03E-05	5.38E-06	-5.31E-05	9.53E-06	4.96E-05
0.01922	-2.46E-05	-4.91E-05	3.05E-05	4.03E-05	5.31E-06	-5.33E-05	9.38E-06	4.97E-05
0.01984	-2.45E-05	-4.90E-05	3.01E-05	4.01E-05	4.82E-06	-5.34E-05	1.00E-05	4.96E-05
0.02046	-2.34E-05	-4.90E-05	2.98E-05	3.99E-05	6.33E-06	-5.33E-05	9.51E-06	4.92E-05
0.02108	-2.25E-05	-4.84E-05	3.00E-05	4.04E-05	7.35E-06	-5.28E-05	9.49E-06	4.83E-05
0.0217	-2.18E-05	-4.87E-05	2.92E-05	4.07E-05	7.28E-06	-5.33E-05	9.82E-06	4.90E-05
0.02232	-2.15E-05	-4.88E-05	2.92E-05	4.02E-05	6.86E-06	-5.39E-05	9.18E-06	4.87E-05
0.02294	-2.11E-05	-4.86E-05	2.92E-05	4.06E-05	5.82E-06	-5.39E-05	9.42E-06	4.87E-05
0.02356	-2.08E-05	-4.87E-05	2.91E-05	4.10E-05	5.74E-06	-5.42E-05	1.07E-05	4.96E-05
0.02418	-2.07E-05	-4.87E-05	2.97E-05	4.10E-05	4.74E-06	-5.45E-05	1.06E-05	4.95E-05
0.0248	-2.08E-05	-4.90E-05	2.95E-05	4.14E-05	4.65E-06	-5.44E-05	1.05E-05	4.95E-05
0.02542	-2.04E-05	-4.93E-05	2.91E-05	4.11E-05	4.50E-06	-5.43E-05	1.08E-05	4.98E-05
0.02604	-2.06E-05	-4.93E-05	2.89E-05	4.13E-05	4.20E-06	-5.43E-05	1.05E-05	4.97E-05
0.02666	-2.00E-05	-4.89E-05	2.95E-05	4.13E-05	3.30E-06	-5.43E-05	1.07E-05	4.99E-05
0.02728	-1.99E-05	-4.92E-05	2.93E-05	4.12E-05	3.10E-06	-5.41E-05	1.03E-05	5.00E-05
0.0279	-1.97E-05	-4.88E-05	2.93E-05	4.12E-05	3.47E-06	-5.37E-05	1.06E-05	5.01E-05
0.02852	-1.82E-05	-4.88E-05	2.85E-05	4.21E-05	3.12E-06	-5.40E-05	1.10E-05	4.98E-05
0.02914	-1.79E-05	-4.94E-05	2.89E-05	4.20E-05	3.24E-06	-5.40E-05	1.04E-05	5.01E-05
0.02976	-1.83E-05	-4.98E-05	2.89E-05	4.20E-05	2.83E-06	-5.35E-05	1.02E-05	5.02E-05
0.03038	-1.86E-05	-5.02E-05	2.92E-05	4.19E-05	1.58E-06	-5.39E-05	1.12E-05	5.08E-05
0.031	-1.93E-05	-5.08E-05	2.94E-05	4.21E-05	9.96E-07	-5.40E-05	1.08E-05	5.12E-05
0.03162	-2.05E-05	-5.02E-05	2.99E-05	4.17E-05	5.55E-07	-5.37E-05	1.09E-05	5.13E-05
0.03224	-2.04E-05	-5.03E-05	3.01E-05	4.17E-05	1.14E-06	-5.32E-05	1.10E-05	5.09E-05
0.03286	-2.11E-05	-5.02E-05	2.91E-05	4.10E-05	1.80E-06	-5.28E-05	1.08E-05	5.09E-05
0.03348	-2.16E-05	-4.98E-05	3.07E-05	4.09E-05	2.66E-06	-5.27E-05	1.06E-05	5.06E-05
0.0341	-2.17E-05	-4.98E-05	2.97E-05	4.10E-05	3.24E-06	-5.30E-05	1.01E-05	5.08E-05
0.03472	-2.17E-05	-5.00E-05	3.02E-05	4.06E-05	3.95E-06	-5.27E-05	1.01E-05	5.02E-05
0.03534	-2.17E-05	-4.97E-05	3.04E-05	4.07E-05	4.54E-06	-5.30E-05	9.81E-06	4.99E-05
0.03596	-2.22E-05	-4.96E-05	3.02E-05	4.08E-05	4.04E-06	-5.33E-05	9.58E-06	4.98E-05
0.03658	-2.25E-05	-4.96E-05	2.99E-05	4.03E-05	4.39E-06	-5.31E-05	9.47E-06	5.00E-05
0.0372	-2.22E-05	-4.92E-05	2.95E-05	4.08E-05	4.59E-06	-5.31E-05	9.87E-06	4.96E-05
0.03782	-2.22E-05	-4.96E-05	3.05E-05	4.04E-05	4.68E-06	-5.30E-05	9.59E-06	4.96E-05
0.03844	-2.41E-05	-5.04E-05	3.03E-05	4.02E-05	4.92E-06	-5.31E-05	1.01E-05	4.96E-05
0.03906	-2.43E-05	-4.93E-05	3.00E-05	3.99E-05	5.44E-06	-5.35E-05	9.47E-06	4.93E-05
0.03968	-2.41E-05	-4.87E-05	2.99E-05	4.03E-05	5.05E-06	-5.36E-05	1.00E-05	4.98E-05
0.0403	-2.40E-05	-4.87E-05	2.95E-05	3.99E-05	5.51E-06	-5.31E-05	9.25E-06	4.90E-05
0.04092	-2.32E-05	-4.88E-05	2.98E-05	4.03E-05	7.51E-06	-5.33E-05	9.50E-06	4.88E-05
0.04154	-2.22E-05	-4.83E-05	2.97E-05	4.04E-05	7.48E-06	-5.35E-05	9.35E-06	4.84E-05
0.04216	-2.20E-05	-4.85E-05	2.92E-05	4.08E-05	7.15E-06	-5.40E-05	9.57E-06	4.88E-05
0.04278	-2.16E-05	-4.86E-05	2.90E-05	4.07E-05	6.57E-06	-5.44E-05	9.97E-06	4.80E-05
0.0434	-2.14E-05	-4.86E-05	2.94E-05	4.06E-05	5.97E-06	-5.43E-05	9.53E-06	4.92E-05
0.04402	-2.08E-05	-4.87E-05	2.95E-05	4.16E-05	5.16E-06	-5.47E-05	1.03E-05	4.91E-05
0.04464	-2.08E-05	-4.88E-05	2.93E-05	4.08E-05	5.11E-06	-5.41E-05	1.02E-05	4.96E-05
0.04526	-2.03E-05	-4.96E-05	2.97E-05	4.13E-05	4.44E-06	-5.42E-05	1.04E-05	4.99E-05
0.04588	-2.03E-05	-4.92E-05	2.90E-05	4.11E-05	4.37E-06	-5.44E-05	1.02E-05	4.99E-05
0.0465	-2.04E-05	-4.92E-05	2.93E-05	4.21E-05	3.47E-06	-5.44E-05	1.01E-05	4.98E-05
0.04712	-2.03E-05	-4.91E-05	2.91E-05	4.18E-05	3.72E-06	-5.41E-05	1.08E-05	5.00E-05
0.04774	-1.96E-05	-4.92E-05	2.93E-05	4.18E-05	3.12E-06	-5.35E-05	1.03E-05	5.00E-05
0.04836	-1.81E-05	-4.91E-05	2.90E-05	4.16E-05	3.43E-06	-5.38E-05	1.03E-05	4.99E-05
0.04898	-1.78E-05	-4.93E-05	2.92E-05	4.25E-05	3.07E-06	-5.38E-05	1.04E-05	5.00E-05
0.0496	-1.83E-05	-4.97E-05	2.94E-05	4.21E-05	2.91E-06	-5.35E-05	1.05E-05	5.02E-05
0.05022	-1.88E-05	-5.02E-05	2.93E-05	4.17E-05	2.64E-06	-5.38E-05	1.11E-05	5.08E-05
0.05084	-1.91E-05	-5.01E-05	2.97E-05	4.21E-05	1.09E-06	-5.43E-05	1.05E-05	5.04E-05
0.05146	-1.96E-05	-5.04E-05	2.98E-05	4.13E-05	1.06E-06	-5.39E-05	1.07E-05	5.13E-05
0.05208	-2.08E-05	-5.04E-05	2.99E-05	4.14E-05	1.11E-06	-5.34E-05	1.09E-05	5.11E-05
0.0527	-2.08E-05	-5.02E-05	2.99E-05	4.15E-05	1.38E-06	-5.27E-05	1.06E-05	5.07E-05
0.05332	-2.16E-05	-5.03E-05	3.00E-05	4.12E-05	2.26E-06	-5.27E-05	1.00E-05	5.04E-05
0.05394	-2.13E-05	-5.00E-05	2.95E-05	4.09E-05	3.53E-06	-5.27E-05	1.01E-05	5.00E-05
0.05456	-2.14E-05	-5.00E-05	3.00E-05	4.09E-05	3.47E-06	-5.23E-05	1.00E-05	5.02E-05
0.05518	-2.18E-05	-5.02E-05	2.98E-05	4.10E-05	4.16E-06	-5.28E-05	1.02E-05	5.01E-05
0.0558	-2.24E-05	-4.96E-05	3.01E-05	4.05E-05	3.95E-06	-5.34E-05	9.58E-06	5.06E-05
0.05642	-2.25E-05	-4.94E-05	3.01E-05	4.07E-05	4.45E-06	-5.30E-05	9.64E-06	5.00E-05
0.05704	-2.17E-05	-4.91E-05	2.98E-05	4.05E-05	4.49E-06	-5.33E-05	9.62E-06	4.95E-05
0.05766	-2.26E-05	-5.00E-05	2.99E-05	4.05E-05	4.62E-06	-5.38E-05	9.78E-06	4.96E-05
0.05828	-2.40E-05	-5.00E-05	3.00E-05	4.02E-05	5.25E-06	-5.34E-05	9.70E-06	4.97E-05
0.0589	-2.44E-05	-4.90E-05	3.06E-05	3.97E-05	5.10E-06	-5.30E-05	9.47E-06	4.97E-05
0.05952	-2.39E-05	-4.89E-05	3.01E-05	3.99E-05	4.83E-06	-5.38E-05	9.89E-06	4.95E-05
0.06014	-2.39E-05	-4.92E-05	3.00E-05	3.94E-05	5.48E-06	-5.32E-05	9.84E-06	4.93E-05
0.06076	-2.31E-05	-4.84E-05	2.96E-05	3.96E-05	6.78E-06	-5.33E-05	9.63E-06	4.90E-05
0.06138	-2.22E-05	-4.81E-05	2.94E-05	4.08E-05	7.10E-06	-5.31E-05	9.27E-06	4.85E-05
	-2.12E-05	-4.94E-05	2.97E-05	4.10E-05	4.15E-06	-5.36E-05	1.01E-05	4.98E-05

APPENDIX D

	120 Degree 544 kg				150 Degree 539 kg			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	2.48E-05	-5.75E-05	-1.58E-05	4.44E-05	4.55E-05	-5.22E-05	-3.18E-05	3.34E-05
0.00062	2.45E-05	-5.73E-05	-1.55E-05	4.45E-05	4.61E-05	-5.27E-05	-3.15E-05	3.33E-05
0.00124	2.45E-05	-5.70E-05	-1.56E-05	4.43E-05	4.76E-05	-5.21E-05	-3.24E-05	3.42E-05
0.00186	2.38E-05	-5.70E-05	-1.61E-05	4.43E-05	4.77E-05	-5.22E-05	-3.21E-05	3.39E-05
0.00248	2.40E-05	-5.70E-05	-1.62E-05	4.41E-05	4.78E-05	-5.21E-05	-3.21E-05	3.38E-05
0.0031	2.40E-05	-5.68E-05	-1.56E-05	4.43E-05	4.80E-05	-5.24E-05	-3.24E-05	3.40E-05
0.00372	2.37E-05	-5.65E-05	-1.62E-05	4.38E-05	4.81E-05	-5.23E-05	-3.18E-05	3.44E-05
0.00434	2.24E-05	-5.75E-05	-1.55E-05	4.37E-05	4.83E-05	-5.26E-05	-3.27E-05	3.42E-05
0.00496	2.17E-05	-5.73E-05	-1.50E-05	4.38E-05	4.87E-05	-5.25E-05	-3.25E-05	3.44E-05
0.00558	2.18E-05	-5.67E-05	-1.59E-05	4.30E-05	4.93E-05	-5.25E-05	-3.31E-05	3.46E-05
0.0062	2.26E-05	-5.64E-05	-1.55E-05	4.33E-05	4.92E-05	-5.27E-05	-3.30E-05	3.43E-05
0.00682	2.30E-05	-5.61E-05	-1.57E-05	4.36E-05	4.94E-05	-5.30E-05	-3.22E-05	3.48E-05
0.00744	2.41E-05	-5.59E-05	-1.62E-05	4.39E-05	4.94E-05	-5.28E-05	-3.23E-05	3.49E-05
0.00806	2.45E-05	-5.63E-05	-1.60E-05	4.42E-05	5.08E-05	-5.17E-05	-3.29E-05	3.47E-05
0.00868	2.42E-05	-5.61E-05	-1.65E-05	4.47E-05	5.14E-05	-5.29E-05	-3.28E-05	3.54E-05
0.0093	2.51E-05	-5.61E-05	-1.67E-05	4.49E-05	5.12E-05	-5.28E-05	-3.28E-05	3.47E-05
0.00992	2.51E-05	-5.58E-05	-1.62E-05	4.45E-05	5.08E-05	-5.31E-05	-3.23E-05	3.55E-05
0.01054	2.53E-05	-5.59E-05	-1.62E-05	4.50E-05	4.97E-05	-5.37E-05	-3.22E-05	3.56E-05
0.01116	2.57E-05	-5.64E-05	-1.65E-05	4.43E-05	4.97E-05	-5.36E-05	-3.21E-05	3.47E-05
0.01178	2.60E-05	-5.62E-05	-1.64E-05	4.46E-05	4.88E-05	-5.38E-05	-3.18E-05	3.49E-05
0.0124	2.62E-05	-5.60E-05	-1.66E-05	4.51E-05	4.87E-05	-5.41E-05	-3.18E-05	3.52E-05
0.01302	2.58E-05	-5.64E-05	-1.65E-05	4.50E-05	4.81E-05	-5.33E-05	-3.17E-05	3.42E-05
0.01364	2.55E-05	-5.68E-05	-1.60E-05	4.50E-05	4.77E-05	-5.41E-05	-3.15E-05	3.46E-05
0.01426	2.76E-05	-5.61E-05	-1.65E-05	4.53E-05	4.79E-05	-5.38E-05	-3.16E-05	3.40E-05
0.01488	2.82E-05	-5.57E-05	-1.70E-05	4.51E-05	4.73E-05	-5.37E-05	-3.10E-05	3.40E-05
0.0155	2.78E-05	-5.64E-05	-1.73E-05	4.55E-05	4.73E-05	-5.34E-05	-3.16E-05	3.41E-05
0.01612	2.79E-05	-5.67E-05	-1.65E-05	4.54E-05	4.72E-05	-5.30E-05	-3.13E-05	3.42E-05
0.01674	2.68E-05	-5.70E-05	-1.64E-05	4.51E-05	4.70E-05	-5.31E-05	-3.16E-05	3.40E-05
0.01736	2.58E-05	-5.71E-05	-1.61E-05	4.51E-05	4.73E-05	-5.32E-05	-3.16E-05	3.41E-05
0.01798	2.53E-05	-5.72E-05	-1.58E-05	4.50E-05	4.54E-05	-5.40E-05	-3.13E-05	3.33E-05
0.0186	2.52E-05	-5.76E-05	-1.66E-05	4.53E-05	4.48E-05	-5.37E-05	-3.15E-05	3.30E-05
0.01922	2.54E-05	-5.76E-05	-1.54E-05	4.42E-05	4.52E-05	-5.29E-05	-3.19E-05	3.32E-05
0.01984	2.50E-05	-5.69E-05	-1.63E-05	4.48E-05	4.51E-05	-5.24E-05	-3.11E-05	3.29E-05
0.02046	2.42E-05	-5.74E-05	-1.58E-05	4.45E-05	4.62E-05	-5.23E-05	-3.16E-05	3.32E-05
0.02108	2.47E-05	-5.67E-05	-1.54E-05	4.43E-05	4.70E-05	-5.20E-05	-3.17E-05	3.32E-05
0.0217	2.42E-05	-5.71E-05	-1.62E-05	4.47E-05	4.75E-05	-5.14E-05	-3.20E-05	3.41E-05
0.02232	2.35E-05	-5.69E-05	-1.59E-05	4.44E-05	4.76E-05	-5.22E-05	-3.24E-05	3.43E-05
0.02294	2.38E-05	-5.63E-05	-1.58E-05	4.39E-05	4.81E-05	-5.17E-05	-3.14E-05	3.35E-05
0.02356	2.38E-05	-5.65E-05	-1.58E-05	4.38E-05	4.82E-05	-5.22E-05	-3.23E-05	3.41E-05
0.02418	2.26E-05	-5.80E-05	-1.54E-05	4.43E-05	4.87E-05	-5.24E-05	-3.20E-05	3.43E-05
0.0248	2.21E-05	-5.75E-05	-1.55E-05	4.39E-05	4.87E-05	-5.25E-05	-3.27E-05	3.44E-05
0.02542	2.17E-05	-5.71E-05	-1.56E-05	4.35E-05	4.89E-05	-5.25E-05	-3.25E-05	3.47E-05
0.02604	2.22E-05	-5.66E-05	-1.52E-05	4.32E-05	4.87E-05	-5.26E-05	-3.27E-05	3.48E-05
0.02666	2.26E-05	-5.55E-05	-1.59E-05	4.34E-05	4.95E-05	-5.25E-05	-3.23E-05	3.45E-05
0.02728	2.35E-05	-5.57E-05	-1.59E-05	4.39E-05	4.92E-05	-5.28E-05	-3.19E-05	3.43E-05
0.0279	2.45E-05	-5.58E-05	-1.58E-05	4.39E-05	5.03E-05	-5.22E-05	-3.24E-05	3.52E-05
0.02852	2.45E-05	-5.57E-05	-1.62E-05	4.45E-05	5.18E-05	-5.24E-05	-3.29E-05	3.52E-05
0.02914	2.47E-05	-5.62E-05	-1.62E-05	4.44E-05	5.11E-05	-5.32E-05	-3.23E-05	3.54E-05
0.02976	2.50E-05	-5.61E-05	-1.63E-05	4.47E-05	5.11E-05	-5.29E-05	-3.20E-05	3.53E-05
0.03038	2.51E-05	-5.62E-05	-1.66E-05	4.48E-05	5.04E-05	-5.36E-05	-3.18E-05	3.52E-05
0.031	2.55E-05	-5.65E-05	-1.63E-05	4.48E-05	4.92E-05	-5.38E-05	-3.22E-05	3.48E-05
0.03162	2.54E-05	-5.60E-05	-1.65E-05	4.50E-05	4.89E-05	-5.39E-05	-3.18E-05	3.47E-05
0.03224	2.57E-05	-5.60E-05	-1.62E-05	4.48E-05	4.88E-05	-5.38E-05	-3.17E-05	3.45E-05
0.03286	2.58E-05	-5.60E-05	-1.61E-05	4.48E-05	4.86E-05	-5.33E-05	-3.20E-05	3.45E-05
0.03348	2.60E-05	-5.69E-05	-1.66E-05	4.41E-05	4.82E-05	-5.35E-05	-3.15E-05	3.35E-05
0.0341	2.69E-05	-5.60E-05	-1.64E-05	4.51E-05	4.75E-05	-5.34E-05	-3.14E-05	3.38E-05
0.03472	2.82E-05	-5.61E-05	-1.70E-05	4.55E-05	4.75E-05	-5.33E-05	-3.14E-05	3.40E-05
0.03534	2.84E-05	-5.63E-05	-1.66E-05	4.55E-05	4.70E-05	-5.33E-05	-3.15E-05	3.41E-05
0.03596	2.81E-05	-5.69E-05	-1.73E-05	4.58E-05	4.69E-05	-5.32E-05	-3.16E-05	3.43E-05
0.03658	2.78E-05	-5.69E-05	-1.63E-05	4.56E-05	4.68E-05	-5.30E-05	-3.10E-05	3.40E-05
0.0372	2.64E-05	-5.75E-05	-1.63E-05	4.55E-05	4.73E-05	-5.29E-05	-3.19E-05	3.40E-05
0.03782	2.57E-05	-5.77E-05	-1.61E-05	4.47E-05	4.60E-05	-5.34E-05	-3.09E-05	3.33E-05
0.03844	2.57E-05	-5.74E-05	-1.61E-05	4.52E-05	4.45E-05	-5.34E-05	-3.17E-05	3.30E-05
0.03906	2.54E-05	-5.74E-05	-1.54E-05	4.42E-05	4.51E-05	-5.30E-05	-3.11E-05	3.32E-05
0.03968	2.52E-05	-5.74E-05	-1.55E-05	4.44E-05	4.48E-05	-5.24E-05	-3.15E-05	3.34E-05
0.0403	2.40E-05	-5.72E-05	-1.59E-05	4.42E-05	4.60E-05	-5.26E-05	-3.14E-05	3.34E-05
0.04092	2.45E-05	-5.72E-05	-1.52E-05	4.48E-05	4.69E-05	-5.19E-05	-3.17E-05	3.34E-05
0.04154	2.43E-05	-5.69E-05	-1.57E-05	4.43E-05	4.75E-05	-5.18E-05	-3.19E-05	3.38E-05
0.04216	2.39E-05	-5.69E-05	-1.50E-05	4.40E-05	4.79E-05	-5.21E-05	-3.20E-05	3.36E-05
0.04278	2.41E-05	-5.71E-05	-1.58E-05	4.44E-05	4.80E-05	-5.21E-05	-3.21E-05	3.43E-05
0.0434	2.43E-05	-5.66E-05	-1.55E-05	4.37E-05	4.84E-05	-5.23E-05	-3.17E-05	3.43E-05
0.04402	2.32E-05	-5.74E-05	-1.57E-05	4.38E-05	4.85E-05	-5.24E-05	-3.25E-05	3.41E-05
0.04464	2.17E-05	-5.73E-05	-1.52E-05	4.35E-05	4.90E-05	-5.23E-05	-3.23E-05	3.46E-05
0.04526	2.16E-05	-5.70E-05	-1.55E-05	4.34E-05	4.89E-05	-5.24E-05	-3.23E-05	3.44E-05
0.04588	2.20E-05	-5.63E-05	-1.55E-05	4.37E-05	4.95E-05	-5.29E-05	-3.23E-05	3.48E-05
0.0465	2.23E-05	-5.65E-05	-1.58E-05	4.34E-05	4.91E-05	-5.28E-05	-3.18E-05	3.46E-05
0.04712	2.30E-05	-5.58E-05	-1.60E-05	4.38E-05	4.93E-05	-5.30E-05	-3.22E-05	3.46E-05
0.04774	2.42E-05	-5.55E-05	-1.57E-05	4.45E-05	5.02E-05	-5.23E-05	-3.22E-05	3.47E-05
0.04836	2.40E-05	-5.59E-05	-1.66E-05	4.42E-05	5.13E-05	-5.19E-05	-3.25E-05	3.54E-05
0.04898	2.51E-05	-5.59E-05	-1.62E-05	4.43E-05	5.16E-05	-5.27E-05	-3.29E-05	3.55E-05
0.0496	2.51E-05	-5.54E-05	-1.58E-05	4.48E-05	5.07E-05	-5.28E-05	-3.20E-05	3.58E-05
0.05022	2.50E-05	-5.57E-05	-1.63E-05	4.43E-05	5.08E-05	-5.35E-05	-3.20E-05	3.50E-05
0.05084	2.51E-05	-5.62E-05	-1.62E-05	4.45E-05	4.96E-05	-5.32E-05	-3.20E-05	3.46E-05
0.05146	2.57E-05	-5.60E-05	-1.66E-05	4.46E-05	4.91E-05	-5.37E-05	-3.22E-05	3.53E-05
0.05208	2.56E-05	-5.61E-05	-1.59E-05	4.43E-05	4.86E-05	-5.38E-05	-3.22E-05	3.49E-05
0.0527	2.59E-05	-5.61E-05	-1.66E-05	4.48E-05	4.86E-05	-5.42E-05	-3.12E-05	3.43E-05
0.05332	2.62E-05	-5.65E-05	-1.58E-05	4.47E-05	4.81E-05	-5.39E-05	-3.17E-05	3.48E-05
0.05394	2.65E-05	-5.60E-05	-1.61E-05	4.55E-05	4.73E-05	-5.36E-05	-3.11E-05	3.41E-05
0.05456	2.76E-05	-5.62E-05	-1.67E-05	4.57E-05	4.77E-05	-5.32E-05	-3.11E-05	3.36E-05
0.05518	2.82E-05	-5.66E-05	-1.67E-05	4.56E-05	4.73E-05	-5.34E-05	-3.13E-05	3.41E-05
0.0558	2.83E-05	-5.66E-05	-1.66E-05	4.55E-05	4.71E-05	-5.34E-05	-3.13E-05	3.39E-05
0.05642	2.80E-05	-5.72E-05	-1.61E-05	4.57E-05	4.71E-05	-5.33E-05	-3.15E-05	3.38E-05
0.05704	2.66E-05	-5.75E-05	-1.64E-05	4.49E-05	4.68E-05	-5.28E-05	-3.18E-05	3.37E-05
0.05766	2.60E-05	-5.76E-05	-1.57E-05	4.52E-05	4.61E-05	-5.34E-05	-3.16E-05	3.38E-05
0.05828	2.56E-05	-5.75E-05	-1.59E-05	4.47E-05	4.47E-05	-5.34E-05	-3.11E-05	3.33E-05
0.0589	2.51E-05	-5.77E-05	-1.61E-05	4.45E-05	4.51E-05	-5.27E-05	-3.12E-05	3.33E-05
0.05952	2.57E-05	-5.75E-05	-1.55E-05	4.47E-05	4.51E-05	-5.27E-05	-3.14E-05	3.30E-05
0.06014	2.45E-05	-5.70E-05	-1.57E-05	4.48E-05	4.56E-05	-5.26E-05	-3.16E-05	3.32E-05
0.06076	2.45E-05	-5.70E-05	-1.53E-05	4.40E-05	4.65E-05	-5.21E-05	-3.18E-05	3.37E-05
0.06138	2.44E-05	-5.67E-05	-1.56E-05	4.42E-05	4.73E-05	-5.14E-05	-3.17E-05	3.35E-05
	2.49383E-05	-5.66E-05	-1.60E-05	4.45E-05	4.81E-05	-5.29E-05	-3.19E-05	3.42E-05

APPENDIX D

	180 Degree 538 kg				210 Degree 541 kg			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	5.94E-05	1.13E-05	-5.06E-05	-1.91E-06	5.45E-05	3.80E-05	-3.71E-05	-3.88E-05
0.00062	5.98E-05	1.09E-05	-5.05E-05	-1.70E-06	5.59E-05	3.88E-05	-3.77E-05	-3.88E-05
0.00124	5.98E-05	1.12E-05	-5.06E-05	-1.88E-06	5.71E-05	3.94E-05	-3.75E-05	-3.83E-05
0.00186	5.95E-05	1.11E-05	-5.07E-05	-1.29E-06	5.68E-05	3.84E-05	-3.68E-05	-3.88E-05
0.00248	6.05E-05	1.13E-05	-5.07E-05	-1.41E-06	5.62E-05	3.85E-05	-3.74E-05	-3.88E-05
0.0031	6.07E-05	1.09E-05	-5.06E-05	-1.84E-06	5.59E-05	3.81E-05	-3.68E-05	-3.90E-05
0.00372	6.03E-05	1.10E-05	-5.02E-05	-1.84E-06	5.52E-05	3.73E-05	-3.76E-05	-3.95E-05
0.00434	6.10E-05	1.10E-05	-5.08E-05	-2.06E-06	5.47E-05	3.77E-05	-3.71E-05	-3.91E-05
0.00496	6.19E-05	1.21E-05	-5.14E-05	-2.59E-06	5.38E-05	3.76E-05	-3.68E-05	-3.88E-05
0.00558	6.21E-05	1.09E-05	-5.13E-05	-2.94E-06	5.39E-05	3.75E-05	-3.68E-05	-3.90E-05
0.0062	6.21E-05	1.08E-05	-5.14E-05	-2.82E-06	5.37E-05	3.76E-05	-3.72E-05	-3.84E-05
0.00682	6.24E-05	9.87E-06	-5.12E-05	-2.78E-06	5.35E-05	3.74E-05	-3.70E-05	-3.86E-05
0.00744	6.09E-05	1.00E-05	-5.01E-05	-2.37E-06	5.38E-05	3.76E-05	-3.64E-05	-3.84E-05
0.00806	6.06E-05	9.61E-06	-5.03E-05	-2.00E-06	5.31E-05	3.80E-05	-3.65E-05	-3.85E-05
0.00868	6.02E-05	1.01E-05	-5.02E-05	-2.19E-06	5.29E-05	3.76E-05	-3.69E-05	-3.85E-05
0.0093	5.95E-05	9.91E-06	-4.99E-05	-1.79E-06	5.30E-05	3.80E-05	-3.67E-05	-3.82E-05
0.00992	5.97E-05	1.01E-05	-5.04E-05	-1.63E-06	5.30E-05	3.76E-05	-3.66E-05	-3.80E-05
0.01054	5.91E-05	1.05E-05	-5.00E-05	-1.74E-06	5.18E-05	3.72E-05	-3.63E-05	-3.84E-05
0.01116	5.88E-05	1.00E-05	-5.04E-05	-8.66E-07	5.10E-05	3.68E-05	-3.57E-05	-3.78E-05
0.01178	5.86E-05	1.05E-05	-4.96E-05	-8.41E-07	5.06E-05	3.71E-05	-3.68E-05	-3.78E-05
0.0124	5.87E-05	1.03E-05	-5.04E-05	-1.41E-06	5.08E-05	3.76E-05	-3.69E-05	-3.77E-05
0.01302	5.85E-05	1.07E-05	-5.04E-05	-1.50E-06	5.13E-05	3.79E-05	-3.67E-05	-3.82E-05
0.01364	5.88E-05	1.05E-05	-5.07E-05	-8.42E-07	5.20E-05	3.81E-05	-3.72E-05	-3.78E-05
0.01426	5.77E-05	9.90E-06	-4.94E-05	-1.43E-06	5.31E-05	3.86E-05	-3.73E-05	-3.75E-05
0.01488	5.69E-05	9.91E-06	-4.97E-05	-6.50E-07	5.29E-05	3.82E-05	-3.71E-05	-3.80E-05
0.0155	5.63E-05	1.05E-05	-4.96E-05	-7.23E-08	5.35E-05	3.80E-05	-3.71E-05	-3.81E-05
0.01612	5.63E-05	1.06E-05	-4.95E-05	-1.77E-07	5.38E-05	3.85E-05	-3.74E-05	-3.76E-05
0.01674	5.66E-05	1.08E-05	-5.02E-05	-4.36E-07	5.36E-05	3.84E-05	-3.79E-05	-3.85E-05
0.01736	5.79E-05	1.13E-05	-4.98E-05	-6.40E-07	5.43E-05	3.84E-05	-3.74E-05	-3.83E-05
0.01798	5.88E-05	1.17E-05	-5.03E-05	-1.32E-06	5.43E-05	3.79E-05	-3.73E-05	-3.82E-05
0.0186	5.85E-05	1.14E-05	-5.04E-05	-1.07E-06	5.46E-05	3.80E-05	-3.67E-05	-3.86E-05
0.01922	5.94E-05	1.06E-05	-5.12E-05	-1.35E-06	5.47E-05	3.85E-05	-3.77E-05	-3.87E-05
0.01984	5.95E-05	1.13E-05	-4.99E-05	-1.88E-06	5.46E-05	3.83E-05	-3.75E-05	-3.84E-05
0.02046	5.96E-05	1.17E-05	-5.10E-05	-1.22E-06	5.52E-05	3.83E-05	-3.70E-05	-3.86E-05
0.02108	5.98E-05	1.10E-05	-5.10E-05	-1.39E-06	5.62E-05	3.85E-05	-3.75E-05	-3.86E-05
0.0217	6.02E-05	1.10E-05	-5.03E-05	-2.11E-06	5.63E-05	3.85E-05	-3.76E-05	-3.90E-05
0.02232	6.04E-05	1.06E-05	-5.06E-05	-1.94E-06	5.61E-05	3.86E-05	-3.74E-05	-3.89E-05
0.02294	6.05E-05	1.15E-05	-5.06E-05	-1.87E-06	5.63E-05	3.77E-05	-3.76E-05	-3.89E-05
0.02356	6.05E-05	1.09E-05	-5.08E-05	-1.74E-06	5.53E-05	3.76E-05	-3.72E-05	-3.88E-05
0.02418	6.04E-05	1.06E-05	-5.09E-05	-1.78E-06	5.45E-05	3.78E-05	-3.68E-05	-3.91E-05
0.0248	6.23E-05	1.18E-05	-5.12E-05	-1.90E-06	5.47E-05	3.75E-05	-3.71E-05	-3.87E-05
0.02542	6.25E-05	1.11E-05	-5.10E-05	-2.83E-06	5.44E-05	3.76E-05	-3.71E-05	-3.86E-05
0.02604	6.26E-05	1.09E-05	-5.10E-05	-2.92E-06	5.40E-05	3.76E-05	-3.66E-05	-3.84E-05
0.02666	6.21E-05	1.05E-05	-5.09E-05	-2.84E-06	5.38E-05	3.75E-05	-3.72E-05	-3.82E-05
0.02728	6.18E-05	1.01E-05	-5.03E-05	-2.19E-06	5.31E-05	3.74E-05	-3.61E-05	-3.86E-05
0.0279	6.05E-05	9.14E-06	-4.99E-05	-1.85E-06	5.34E-05	3.71E-05	-3.69E-05	-3.89E-05
0.02852	6.01E-05	9.56E-06	-5.07E-05	-2.15E-06	5.31E-05	3.74E-05	-3.67E-05	-3.86E-05
0.02914	5.95E-05	9.88E-06	-5.02E-05	-1.95E-06	5.31E-05	3.80E-05	-3.66E-05	-3.83E-05
0.02976	5.96E-05	1.05E-05	-5.01E-05	-2.16E-06	5.28E-05	3.70E-05	-3.68E-05	-3.81E-05
0.03038	5.93E-05	1.03E-05	-4.99E-05	-1.79E-06	5.25E-05	3.72E-05	-3.72E-05	-3.85E-05
0.031	5.86E-05	1.02E-05	-5.03E-05	-1.22E-06	5.09E-05	3.72E-05	-3.63E-05	-3.79E-05
0.03162	5.87E-05	1.02E-05	-5.01E-05	-1.55E-06	5.03E-05	3.77E-05	-3.62E-05	-3.76E-05
0.03224	5.82E-05	1.04E-05	-5.02E-05	-1.65E-06	5.08E-05	3.76E-05	-3.61E-05	-3.75E-05
0.03286	5.86E-05	1.07E-05	-4.98E-05	-1.20E-06	5.14E-05	3.78E-05	-3.67E-05	-3.78E-05
0.03348	5.85E-05	1.05E-05	-5.01E-05	-9.40E-07	5.19E-05	3.80E-05	-3.70E-05	-3.77E-05
0.0341	5.86E-05	1.04E-05	-5.00E-05	-1.54E-06	5.33E-05	3.87E-05	-3.69E-05	-3.77E-05
0.03472	5.66E-05	9.82E-06	-4.94E-05	-7.32E-07	5.31E-05	3.83E-05	-3.76E-05	-3.77E-05
0.03534	5.63E-05	1.02E-05	-4.97E-05	-2.17E-07	5.30E-05	3.81E-05	-3.70E-05	-3.79E-05
0.03596	5.63E-05	1.01E-05	-4.96E-05	-3.19E-07	5.34E-05	3.79E-05	-3.72E-05	-3.85E-05
0.03658	5.64E-05	1.15E-05	-4.97E-05	-3.63E-07	5.35E-05	3.84E-05	-3.76E-05	-3.80E-05
0.0372	5.71E-05	1.12E-05	-5.02E-05	-7.25E-07	5.42E-05	3.81E-05	-3.74E-05	-3.82E-05
0.03782	5.84E-05	1.12E-05	-5.06E-05	-1.30E-06	5.42E-05	3.86E-05	-3.77E-05	-3.85E-05
0.03844	5.91E-05	1.07E-05	-5.10E-05	-1.58E-06	5.44E-05	3.86E-05	-3.71E-05	-3.89E-05
0.03906	5.91E-05	1.19E-05	-5.08E-05	-1.19E-06	5.42E-05	3.80E-05	-3.73E-05	-3.83E-05
0.03968	5.91E-05	1.15E-05	-5.03E-05	-1.63E-06	5.49E-05	3.81E-05	-3.70E-05	-3.84E-05
0.0403	5.99E-05	1.12E-05	-5.06E-05	-1.62E-06	5.52E-05	3.85E-05	-3.71E-05	-3.83E-05
0.04092	5.98E-05	1.10E-05	-5.05E-05	-1.22E-06	5.65E-05	3.85E-05	-3.78E-05	-3.84E-05
0.04154	6.00E-05	1.09E-05	-5.07E-05	-1.61E-06	5.67E-05	3.86E-05	-3.77E-05	-3.88E-05
0.04216	6.02E-05	1.14E-05	-5.11E-05	-1.80E-06	5.62E-05	3.76E-05	-3.69E-05	-3.92E-05
0.04278	6.07E-05	1.10E-05	-4.97E-05	-1.44E-06	5.64E-05	3.80E-05	-3.70E-05	-3.91E-05
0.0434	6.05E-05	1.09E-05	-5.05E-05	-1.35E-06	5.58E-05	3.75E-05	-3.77E-05	-3.88E-05
0.04402	6.00E-05	1.11E-05	-5.05E-05	-1.28E-06	5.45E-05	3.83E-05	-3.65E-05	-3.93E-05
0.04464	6.12E-05	1.16E-05	-5.10E-05	-2.39E-06	5.41E-05	3.76E-05	-3.71E-05	-3.90E-05
0.04526	6.27E-05	1.11E-05	-5.11E-05	-2.29E-06	5.41E-05	3.78E-05	-3.69E-05	-3.92E-05
0.04588	6.27E-05	1.08E-05	-5.12E-05	-2.43E-06	5.35E-05	3.73E-05	-3.71E-05	-3.89E-05
0.0465	6.20E-05	1.04E-05	-5.10E-05	-2.58E-06	5.37E-05	3.74E-05	-3.71E-05	-3.92E-05
0.04712	6.14E-05	9.55E-06	-5.08E-05	-2.59E-06	5.35E-05	3.72E-05	-3.69E-05	-3.90E-05
0.04774	6.04E-05	9.98E-06	-5.00E-05	-2.60E-06	5.32E-05	3.75E-05	-3.67E-05	-3.90E-05
0.04836	6.01E-05	9.86E-06	-5.05E-05	-2.55E-06	5.36E-05	3.76E-05	-3.69E-05	-3.82E-05
0.04898	6.03E-05	1.00E-05	-5.04E-05	-2.11E-06	5.27E-05	3.72E-05	-3.72E-05	-3.82E-05
0.0496	5.99E-05	1.02E-05	-4.99E-05	-1.78E-06	5.29E-05	3.74E-05	-3.71E-05	-3.82E-05
0.05022	5.93E-05	9.88E-06	-4.98E-05	-1.63E-06	5.27E-05	3.76E-05	-3.72E-05	-3.80E-05
0.05084	5.90E-05	9.83E-06	-5.05E-05	-1.56E-06	5.11E-05	3.69E-05	-3.65E-05	-3.78E-05
0.05146	5.87E-05	1.00E-05	-5.02E-05	-1.69E-06	5.05E-05	3.70E-05	-3.62E-05	-3.82E-05
0.05208	5.81E-05	1.05E-05	-5.03E-05	-1.24E-06	5.08E-05	3.76E-05	-3.64E-05	-3.74E-05
0.0527	5.85E-05	1.03E-05	-5.00E-05	-1.03E-06	5.11E-05	3.78E-05	-3.68E-05	-3.77E-05
0.05332	5.82E-05	1.08E-05	-4.98E-05	-1.12E-06	5.14E-05	3.78E-05	-3.69E-05	-3.78E-05
0.05394	5.82E-05	1.09E-05	-5.03E-05	-1.04E-06	5.25E-05	3.81E-05	-3.72E-05	-3.75E-05
0.05456	5.72E-05	1.00E-05	-4.96E-05	-6.18E-07	5.31E-05	3.87E-05	-3.69E-05	-3.76E-05
0.05518	5.65E-05	1.04E-05	-4.99E-05	-4.31E-07	5.32E-05	3.82E-05	-3.68E-05	-3.83E-05
0.0558	5.67E-05	1.07E-05	-5.00E-05	-2.06E-07	5.35E-05	3.82E-05	-3.73E-05	-3.79E-05
0.05642	5.62E-05	1.10E-05	-4.93E-05	-8.46E-07	5.37E-05	3.87E-05	-3.72E-05	-3.81E-05
0.05704	5.67E-05	1.13E-05	-5.03E-05	-1.24E-07	5.36E-05	3.87E-05	-3.70E-05	-3.85E-05
0.05766	5.81E-05	1.14E-05	-5.04E-05	-8.54E-07	5.43E-05	3.79E-05	-3.75E-05	-3.82E-05
0.05828	5.91E-05	1.14E-05	-5.09E-05	-1.69E-06	5.44E-05	3.84E-05	-3.73E-05	-3.82E-05
0.0589	5.87E-05	1.08E-05	-5.03E-05	-1.33E-06	5.47E-05	3.80E-05	-3.71E-05	-3.87E-05
0.05952	5.93E-05	1.14E-05	-5.06E-05	-1.24E-06	5.46E-05	3.83E-05	-3.72E-05	-3.87E-05
0.06014	5.97E-05	1.13E-05	-5.08E-05	-1.64E-06	5.48E-05	3.85E-05	-3.72E-05	-3.81E-05
0.06076	5.96E-05	1.10E-05	-5.10E-05	-1.89E-06	5.60E-05	3.87E-05	-3.76E-05	-3.88E-05
0.06138	5.95E-05	1.10E-05	-5.10E-05	-1.70E-06	5.63E-05	3.90E-05	-3.72E-05	-3.88E-05
	5.94E-05	1.07E-05	-5.04E-05	-1.56E-06	0.000053771	0.000037931	-3.70E-05	-3.84E-05

APPENDIX D

	240 Degree 541 kg				270 Degree 542 kg			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	3.40E-05	4.64E-05	-2.35E-05	-4.50E-05	1.36E-05	5.25E-05	-2.71E-06	-5.72E-05
0.00062	3.48E-05	4.63E-05	-2.33E-05	-4.47E-05	1.37E-05	5.29E-05	-3.09E-06	-5.67E-05
0.00124	3.56E-05	4.68E-05	-2.38E-05	-4.46E-05	1.22E-05	5.19E-05	-2.25E-06	-5.69E-05
0.00186	3.60E-05	4.71E-05	-2.45E-05	-4.45E-05	1.14E-05	5.25E-05	-1.86E-06	-5.74E-05
0.00248	3.66E-05	4.63E-05	-2.44E-05	-4.40E-05	1.16E-05	5.22E-05	-2.21E-06	-5.77E-05
0.0031	3.66E-05	4.67E-05	-2.46E-05	-4.41E-05	1.11E-05	5.34E-05	-2.77E-06	-5.78E-05
0.00372	3.70E-05	4.67E-05	-2.44E-05	-4.39E-05	1.23E-05	5.34E-05	-2.32E-06	-5.78E-05
0.00434	3.74E-05	4.64E-05	-2.43E-05	-4.39E-05	1.26E-05	5.35E-05	-2.99E-06	-5.71E-05
0.00496	3.71E-05	4.66E-05	-2.42E-05	-4.38E-05	1.36E-05	5.38E-05	-3.01E-06	-5.72E-05
0.00558	3.76E-05	4.66E-05	-2.45E-05	-4.37E-05	1.41E-05	5.34E-05	-3.14E-06	-5.64E-05
0.0062	3.78E-05	4.63E-05	-2.45E-05	-4.36E-05	1.42E-05	5.37E-05	-3.86E-06	-5.71E-05
0.00682	3.75E-05	4.60E-05	-2.44E-05	-4.39E-05	1.44E-05	5.34E-05	-3.08E-06	-5.69E-05
0.00744	3.76E-05	4.57E-05	-2.44E-05	-4.36E-05	1.52E-05	5.34E-05	-3.42E-06	-5.66E-05
0.00806	3.92E-05	4.67E-05	-2.52E-05	-4.35E-05	1.52E-05	5.31E-05	-3.58E-06	-5.62E-05
0.00868	4.02E-05	4.64E-05	-2.54E-05	-4.27E-05	1.55E-05	5.33E-05	-3.13E-06	-5.65E-05
0.0093	4.00E-05	4.64E-05	-2.47E-05	-4.29E-05	1.52E-05	5.31E-05	-3.15E-06	-5.63E-05
0.00992	3.98E-05	4.57E-05	-2.49E-05	-4.24E-05	1.60E-05	5.32E-05	-3.37E-06	-5.63E-05
0.01054	3.90E-05	4.49E-05	-2.48E-05	-4.32E-05	1.57E-05	5.31E-05	-2.50E-06	-5.60E-05
0.01116	3.82E-05	4.50E-05	-2.41E-05	-4.32E-05	1.69E-05	5.36E-05	-3.64E-06	-5.56E-05
0.01178	3.70E-05	4.45E-05	-2.40E-05	-4.36E-05	1.80E-05	5.36E-05	-3.90E-06	-5.58E-05
0.0124	3.70E-05	4.50E-05	-2.42E-05	-4.38E-05	1.73E-05	5.31E-05	-3.25E-06	-5.54E-05
0.01302	3.73E-05	4.54E-05	-2.41E-05	-4.38E-05	1.73E-05	5.30E-05	-4.13E-06	-5.54E-05
0.01364	3.76E-05	4.53E-05	-2.40E-05	-4.38E-05	1.68E-05	5.26E-05	-2.83E-06	-5.52E-05
0.01426	3.64E-05	4.54E-05	-2.39E-05	-4.41E-05	1.61E-05	5.20E-05	-3.29E-06	-5.55E-05
0.01488	3.61E-05	4.55E-05	-2.41E-05	-4.39E-05	1.52E-05	5.20E-05	-3.05E-06	-5.60E-05
0.0155	3.59E-05	4.53E-05	-2.42E-05	-4.45E-05	1.51E-05	5.19E-05	-3.28E-06	-5.62E-05
0.01612	3.60E-05	4.52E-05	-2.42E-05	-4.47E-05	1.45E-05	5.21E-05	-2.81E-06	-5.62E-05
0.01674	3.56E-05	4.52E-05	-2.37E-05	-4.41E-05	1.46E-05	5.21E-05	-2.79E-06	-5.64E-05
0.01736	3.58E-05	4.56E-05	-2.40E-05	-4.42E-05	1.41E-05	5.22E-05	-2.51E-06	-5.67E-05
0.01798	3.44E-05	4.52E-05	-2.35E-05	-4.49E-05	1.47E-05	5.16E-05	-2.54E-06	-5.67E-05
0.0186	3.39E-05	4.54E-05	-2.36E-05	-4.51E-05	1.40E-05	5.19E-05	-2.90E-06	-5.63E-05
0.01922	3.40E-05	4.55E-05	-2.36E-05	-4.52E-05	1.34E-05	5.22E-05	-2.81E-06	-5.67E-05
0.01984	3.42E-05	4.59E-05	-2.33E-05	-4.48E-05	1.33E-05	5.21E-05	-2.91E-06	-5.65E-05
0.02046	3.43E-05	4.65E-05	-2.37E-05	-4.50E-05	1.36E-05	5.27E-05	-2.41E-06	-5.69E-05
0.02108	3.58E-05	4.62E-05	-2.42E-05	-4.47E-05	1.29E-05	5.22E-05	-2.66E-06	-5.71E-05
0.0217	3.58E-05	4.68E-05	-2.42E-05	-4.43E-05	1.15E-05	5.22E-05	-2.64E-06	-5.73E-05
0.02232	3.62E-05	4.63E-05	-2.43E-05	-4.40E-05	1.16E-05	5.23E-05	-2.77E-06	-5.77E-05
0.02294	3.69E-05	4.65E-05	-2.45E-05	-4.39E-05	1.16E-05	5.27E-05	-1.59E-06	-5.73E-05
0.02356	3.68E-05	4.65E-05	-2.42E-05	-4.41E-05	1.19E-05	5.38E-05	-2.45E-06	-5.73E-05
0.02418	3.73E-05	4.64E-05	-2.43E-05	-4.39E-05	1.27E-05	5.42E-05	-2.50E-06	-5.72E-05
0.0248	3.73E-05	4.64E-05	-2.47E-05	-4.38E-05	1.41E-05	5.40E-05	-3.30E-06	-5.69E-05
0.02542	3.80E-05	4.63E-05	-2.48E-05	-4.35E-05	1.39E-05	5.34E-05	-2.87E-06	-5.66E-05
0.02604	3.73E-05	4.61E-05	-2.48E-05	-4.28E-05	1.39E-05	5.33E-05	-3.40E-06	-5.67E-05
0.02666	3.82E-05	4.63E-05	-2.43E-05	-4.35E-05	1.47E-05	5.31E-05	-3.03E-06	-5.66E-05
0.02728	3.74E-05	4.58E-05	-2.44E-05	-4.38E-05	1.46E-05	5.31E-05	-3.67E-06	-5.65E-05
0.0279	3.83E-05	4.65E-05	-2.49E-05	-4.34E-05	1.52E-05	5.34E-05	-3.38E-06	-5.60E-05
0.02852	3.97E-05	4.57E-05	-2.50E-05	-4.30E-05	1.55E-05	5.36E-05	-2.88E-06	-5.64E-05
0.02914	3.98E-05	4.60E-05	-2.49E-05	-4.25E-05	1.53E-05	5.34E-05	-3.25E-06	-5.62E-05
0.02976	3.96E-05	4.61E-05	-2.49E-05	-4.29E-05	1.52E-05	5.29E-05	-3.52E-06	-5.61E-05
0.03038	3.93E-05	4.55E-05	-2.49E-05	-4.26E-05	1.52E-05	5.31E-05	-3.18E-06	-5.61E-05
0.031	3.85E-05	4.51E-05	-2.45E-05	-4.27E-05	1.59E-05	5.29E-05	-3.60E-06	-5.59E-05
0.03162	3.74E-05	4.50E-05	-2.41E-05	-4.30E-05	1.78E-05	5.38E-05	-3.31E-06	-5.55E-05
0.03224	3.77E-05	4.56E-05	-2.36E-05	-4.37E-05	1.77E-05	5.31E-05	-2.87E-06	-5.55E-05
0.03286	3.71E-05	4.52E-05	-2.38E-05	-4.39E-05	1.77E-05	5.30E-05	-4.22E-06	-5.55E-05
0.03348	3.68E-05	4.53E-05	-2.40E-05	-4.38E-05	1.72E-05	5.25E-05	-3.70E-06	-5.49E-05
0.0341	3.67E-05	4.48E-05	-2.41E-05	-4.36E-05	1.63E-05	5.23E-05	-2.83E-06	-5.54E-05
0.03472	3.65E-05	4.56E-05	-2.37E-05	-4.42E-05	1.54E-05	5.17E-05	-2.69E-06	-5.59E-05
0.03534	3.62E-05	4.57E-05	-2.34E-05	-4.45E-05	1.53E-05	5.23E-05	-2.60E-06	-5.61E-05
0.03596	3.58E-05	4.55E-05	-2.37E-05	-4.39E-05	1.51E-05	5.22E-05	-2.45E-06	-5.61E-05
0.03658	3.58E-05	4.52E-05	-2.35E-05	-4.42E-05	1.45E-05	5.22E-05	-2.74E-06	-5.65E-05
0.0372	3.61E-05	4.56E-05	-2.35E-05	-4.47E-05	1.37E-05	5.21E-05	-2.67E-06	-5.59E-05
0.03782	3.49E-05	4.53E-05	-2.38E-05	-4.45E-05	1.41E-05	5.22E-05	-2.66E-06	-5.63E-05
0.03844	3.39E-05	4.49E-05	-2.38E-05	-4.49E-05	1.35E-05	5.27E-05	-2.85E-06	-5.68E-05
0.03906	3.39E-05	4.55E-05	-2.35E-05	-4.50E-05	1.33E-05	5.27E-05	-3.29E-06	-5.67E-05
0.03968	3.40E-05	4.55E-05	-2.35E-05	-4.55E-05	1.38E-05	5.26E-05	-2.89E-06	-5.67E-05
0.0403	3.48E-05	4.60E-05	-2.44E-05	-4.53E-05	1.36E-05	5.26E-05	-2.86E-06	-5.67E-05
0.04092	3.52E-05	4.61E-05	-2.42E-05	-4.46E-05	1.28E-05	5.24E-05	-2.89E-06	-5.68E-05
0.04154	3.60E-05	4.66E-05	-2.46E-05	-4.49E-05	1.16E-05	5.20E-05	-1.53E-06	-5.78E-05
0.04216	3.61E-05	4.64E-05	-2.44E-05	-4.41E-05	1.09E-05	5.24E-05	-1.88E-06	-5.74E-05
0.04278	3.70E-05	4.65E-05	-2.48E-05	-4.40E-05	1.11E-05	5.25E-05	-2.36E-06	-5.76E-05
0.0434	3.68E-05	4.64E-05	-2.39E-05	-4.39E-05	1.16E-05	5.32E-05	-2.97E-06	-5.76E-05
0.04402	3.72E-05	4.64E-05	-2.48E-05	-4.39E-05	1.25E-05	5.37E-05	-2.86E-06	-5.72E-05
0.04464	3.78E-05	4.67E-05	-2.43E-05	-4.40E-05	1.33E-05	5.36E-05	-3.37E-06	-5.72E-05
0.04526	3.79E-05	4.64E-05	-2.46E-05	-4.35E-05	1.41E-05	5.35E-05	-3.35E-06	-5.64E-05
0.04588	3.75E-05	4.64E-05	-2.42E-05	-4.39E-05	1.39E-05	5.37E-05	-2.75E-06	-5.65E-05
0.0465	3.78E-05	4.63E-05	-2.49E-05	-4.37E-05	1.42E-05	5.32E-05	-3.38E-06	-5.66E-05
0.04712	3.81E-05	4.62E-05	-2.46E-05	-4.34E-05	1.43E-05	5.31E-05	-2.89E-06	-5.60E-05
0.04774	3.82E-05	4.60E-05	-2.44E-05	-4.36E-05	1.54E-05	5.34E-05	-3.27E-06	-5.63E-05
0.04836	3.98E-05	4.67E-05	-2.54E-05	-4.31E-05	1.50E-05	5.34E-05	-3.33E-06	-5.60E-05
0.04898	3.98E-05	4.62E-05	-2.51E-05	-4.35E-05	1.52E-05	5.36E-05	-3.87E-06	-5.67E-05
0.0496	3.95E-05	4.57E-05	-2.50E-05	-4.25E-05	1.57E-05	5.29E-05	-3.28E-06	-5.59E-05
0.05022	3.98E-05	4.55E-05	-2.52E-05	-4.28E-05	1.53E-05	5.27E-05	-3.22E-06	-5.55E-05
0.05084	3.87E-05	4.49E-05	-2.47E-05	-4.32E-05	1.56E-05	5.34E-05	-3.17E-06	-5.58E-05
0.05146	3.78E-05	4.45E-05	-2.42E-05	-4.29E-05	1.77E-05	5.42E-05	-4.12E-06	-5.57E-05
0.05208	3.75E-05	4.53E-05	-2.47E-05	-4.37E-05	1.76E-05	5.34E-05	-3.46E-06	-5.52E-05
0.0527	3.73E-05	4.49E-05	-2.38E-05	-4.33E-05	1.74E-05	5.30E-05	-3.59E-06	-5.52E-05
0.05332	3.68E-05	4.53E-05	-2.40E-05	-4.37E-05	1.68E-05	5.27E-05	-3.01E-06	-5.53E-05
0.05394	3.66E-05	4.57E-05	-2.42E-05	-4.37E-05	1.64E-05	5.22E-05	-2.96E-06	-5.56E-05
0.05456	3.63E-05	4.53E-05	-2.41E-05	-4.41E-05	1.55E-05	5.18E-05	-3.05E-06	-5.59E-05
0.05518	3.61E-05	4.53E-05	-2.36E-05	-4.40E-05	1.58E-05	5.19E-05	-2.58E-06	-5.59E-05
0.0558	3.64E-05	4.55E-05	-2.39E-05	-4.44E-05	1.46E-05	5.19E-05	-2.48E-06	-5.63E-05
0.05642	3.60E-05	4.55E-05	-2.41E-05	-4.48E-05	1.47E-05	5.17E-05	-2.16E-06	-5.65E-05
0.05704	3.61E-05	4.52E-05	-2.43E-05	-4.41E-05	1.40E-05	5.19E-05	-2.79E-06	-5.61E-05
0.05766	3.56E-05	4.55E-05	-2.35E-05	-4.48E-05	1.40E-05	5.23E-05	-2.47E-06	-5.70E-05
0.05828	3.38E-05	4.51E-05	-2.32E-05	-4.50E-05	1.36E-05	5.21E-05	-2.16E-06	-5.68E-05
0.0589	3.38E-05	4.56E-05	-2.36E-05	-4.52E-05	1.38E-05	5.26E-05	-2.66E-06	-5.65E-05
0.05952	3.39E-05	4.54E-05	-2.35E-05	-4.54E-05	1.38E-05	5.27E-05	-2.54E-06	-5.73E-05
0.06014	3.41E-05	4.62E-05	-2.37E-05	-4.54E-05	1.37E-05	5.28E-05	-2.52E-06	-5.68E-05
0.06076	3.49E-05	4.65E-05	-2.39E-05	-4.53E-05	1.36E-05	5.25E-05	-2.84E-06	-5.71E-05
0.06138	3.61E-05	4.67E-05	-2.43E-05	-4.43E-05	1.17E-05	5.18E-05	-1.64E-06	-5.74E-05
	3.68E-05	4.58E-05	-2.42E-05	-4.40E-05	1.44E-05	5.28E-05	-2.94E-06	-5.65E-05

APPENDIX D

	300 Degree 542 kg				330 Degree 540 kg			
X_Value	Strain_0	Strain_1	Strain_2	Strain_3	Strain_0	Strain_1	Strain_2	Strain_3
0	-9.61E-06	5.24E-05	2.23E-05	-5.84E-05	-9.74E-06	6.88E-05	1.94E-05	-7.48E-05
0.00062	-1.04E-05	5.22E-05	2.23E-05	-5.80E-05	-8.17E-06	6.90E-05	1.87E-05	-7.44E-05
0.00124	-1.08E-05	5.26E-05	2.22E-05	-5.76E-05	-8.41E-06	6.85E-05	1.87E-05	-7.44E-05
0.00186	-1.13E-05	5.26E-05	2.27E-05	-5.73E-05	-8.41E-06	6.81E-05	1.92E-05	-7.46E-05
0.00248	-1.15E-05	5.29E-05	2.24E-05	-5.75E-05	-8.82E-06	6.78E-05	1.95E-05	-7.47E-05
0.0031	-1.20E-05	5.28E-05	2.25E-05	-5.73E-05	-9.70E-06	6.70E-05	1.98E-05	-7.48E-05
0.00372	-1.19E-05	5.28E-05	2.25E-05	-5.68E-05	-1.03E-05	6.67E-05	2.00E-05	-7.49E-05
0.00434	-1.21E-05	5.31E-05	2.29E-05	-5.67E-05	-1.08E-05	6.72E-05	2.03E-05	-7.54E-05
0.00496	-1.22E-05	5.32E-05	2.27E-05	-5.69E-05	-1.14E-05	6.72E-05	2.02E-05	-7.49E-05
0.00558	-1.23E-05	5.25E-05	2.23E-05	-5.63E-05	-1.13E-05	6.71E-05	2.01E-05	-7.54E-05
0.0062	-1.29E-05	5.34E-05	2.28E-05	-5.66E-05	-1.17E-05	6.75E-05	2.04E-05	-7.59E-05
0.00682	-1.27E-05	5.33E-05	2.27E-05	-5.67E-05	-1.21E-05	6.73E-05	2.05E-05	-7.51E-05
0.00744	-1.42E-05	5.26E-05	2.36E-05	-5.61E-05	-1.23E-05	6.75E-05	2.01E-05	-7.58E-05
0.00806	-1.49E-05	5.31E-05	2.29E-05	-5.60E-05	-1.25E-05	6.75E-05	2.06E-05	-7.55E-05
0.00868	-1.43E-05	5.31E-05	2.32E-05	-5.59E-05	-1.30E-05	6.73E-05	2.07E-05	-7.56E-05
0.0093	-1.46E-05	5.32E-05	2.23E-05	-5.60E-05	-1.22E-05	6.78E-05	2.02E-05	-7.55E-05
0.00992	-1.34E-05	5.39E-05	2.28E-05	-5.56E-05	-1.31E-05	6.70E-05	2.05E-05	-7.60E-05
0.01054	-1.29E-05	5.43E-05	2.20E-05	-5.67E-05	-1.46E-05	6.68E-05	2.10E-05	-7.61E-05
0.01116	-1.19E-05	5.43E-05	2.17E-05	-5.67E-05	-1.47E-05	6.75E-05	2.09E-05	-7.68E-05
0.01178	-1.18E-05	5.49E-05	2.20E-05	-5.70E-05	-1.45E-05	6.76E-05	2.10E-05	-7.69E-05
0.0124	-1.13E-05	5.39E-05	2.23E-05	-5.70E-05	-1.39E-05	6.77E-05	2.01E-05	-7.66E-05
0.01302	-1.10E-05	5.39E-05	2.24E-05	-5.71E-05	-1.37E-05	6.91E-05	2.03E-05	-7.62E-05
0.01364	-1.13E-05	5.38E-05	2.21E-05	-5.74E-05	-1.21E-05	6.86E-05	2.00E-05	-7.59E-05
0.01426	-1.05E-05	5.41E-05	2.18E-05	-5.72E-05	-1.20E-05	6.87E-05	1.99E-05	-7.65E-05
0.01488	-1.07E-05	5.36E-05	2.17E-05	-5.72E-05	-1.13E-05	6.87E-05	2.04E-05	-7.55E-05
0.0155	-1.07E-05	5.36E-05	2.20E-05	-5.75E-05	-1.20E-05	6.87E-05	2.00E-05	-7.56E-05
0.01612	-1.02E-05	5.38E-05	2.19E-05	-5.80E-05	-1.12E-05	6.86E-05	2.00E-05	-7.53E-05
0.01674	-1.04E-05	5.36E-05	2.21E-05	-5.73E-05	-1.08E-05	6.86E-05	2.00E-05	-7.52E-05
0.01736	-8.96E-06	5.45E-05	2.14E-05	-5.81E-05	-1.07E-05	6.81E-05	2.00E-05	-7.53E-05
0.01798	-8.41E-06	5.38E-05	2.15E-05	-5.76E-05	-1.03E-05	6.82E-05	1.98E-05	-7.50E-05
0.0186	-8.61E-06	5.38E-05	2.17E-05	-5.83E-05	-1.01E-05	6.82E-05	1.93E-05	-7.50E-05
0.01922	-8.96E-06	5.33E-05	2.16E-05	-5.86E-05	-1.04E-05	6.83E-05	2.01E-05	-7.52E-05
0.01984	-9.36E-06	5.28E-05	2.23E-05	-5.83E-05	-1.00E-05	6.83E-05	1.93E-05	-7.47E-05
0.02046	-1.06E-05	5.27E-05	2.24E-05	-5.80E-05	-8.87E-06	6.88E-05	1.91E-05	-7.46E-05
0.02108	-1.08E-05	5.26E-05	2.24E-05	-5.76E-05	-8.35E-06	6.81E-05	1.91E-05	-7.44E-05
0.0217	-1.13E-05	5.29E-05	2.25E-05	-5.71E-05	-7.79E-06	6.83E-05	1.93E-05	-7.45E-05
0.02232	-1.09E-05	5.24E-05	2.20E-05	-5.74E-05	-8.69E-06	6.77E-05	2.01E-05	-7.46E-05
0.02294	-1.19E-05	5.27E-05	2.26E-05	-5.68E-05	-9.45E-06	6.72E-05	2.04E-05	-7.41E-05
0.02356	-1.18E-05	5.27E-05	2.23E-05	-5.73E-05	-1.05E-05	6.68E-05	2.01E-05	-7.45E-05
0.02418	-1.23E-05	5.26E-05	2.31E-05	-5.66E-05	-1.09E-05	6.69E-05	2.02E-05	-7.49E-05
0.0248	-1.22E-05	5.28E-05	2.28E-05	-5.71E-05	-1.12E-05	6.73E-05	2.06E-05	-7.56E-05
0.02542	-1.23E-05	5.36E-05	2.30E-05	-5.68E-05	-1.15E-05	6.78E-05	2.04E-05	-7.60E-05
0.02604	-1.29E-05	5.34E-05	2.31E-05	-5.64E-05	-1.14E-05	6.76E-05	2.01E-05	-7.53E-05
0.02666	-1.29E-05	5.33E-05	2.20E-05	-5.66E-05	-1.20E-05	6.77E-05	1.98E-05	-7.58E-05
0.02728	-1.42E-05	5.28E-05	2.29E-05	-5.60E-05	-1.20E-05	6.77E-05	2.03E-05	-7.54E-05
0.0279	-1.46E-05	5.25E-05	2.33E-05	-5.58E-05	-1.24E-05	6.74E-05	2.02E-05	-7.56E-05
0.02852	-1.51E-05	5.33E-05	2.32E-05	-5.63E-05	-1.25E-05	6.71E-05	2.05E-05	-7.58E-05
0.02914	-1.46E-05	5.38E-05	2.31E-05	-5.63E-05	-1.23E-05	6.78E-05	2.06E-05	-7.58E-05
0.02976	-1.38E-05	5.37E-05	2.30E-05	-5.55E-05	-1.26E-05	6.76E-05	2.05E-05	-7.58E-05
0.03038	-1.32E-05	5.42E-05	2.27E-05	-5.59E-05	-1.41E-05	6.70E-05	2.09E-05	-7.61E-05
0.031	-1.18E-05	5.45E-05	2.22E-05	-5.68E-05	-1.44E-05	6.77E-05	2.14E-05	-7.62E-05
0.03162	-1.21E-05	5.43E-05	2.19E-05	-5.71E-05	-1.44E-05	6.74E-05	2.06E-05	-7.65E-05
0.03224	-1.17E-05	5.44E-05	2.27E-05	-5.69E-05	-1.42E-05	6.83E-05	2.05E-05	-7.63E-05
0.03286	-1.12E-05	5.46E-05	2.24E-05	-5.70E-05	-1.29E-05	6.85E-05	2.02E-05	-7.60E-05
0.03348	-1.11E-05	5.43E-05	2.23E-05	-5.73E-05	-1.27E-05	6.90E-05	2.04E-05	-7.60E-05
0.0341	-1.08E-05	5.37E-05	2.18E-05	-5.74E-05	-1.19E-05	6.90E-05	2.01E-05	-7.58E-05
0.03472	-1.07E-05	5.36E-05	2.27E-05	-5.73E-05	-1.20E-05	6.89E-05	1.96E-05	-7.57E-05
0.03534	-1.02E-05	5.35E-05	2.22E-05	-5.78E-05	-1.11E-05	6.90E-05	2.00E-05	-7.54E-05
0.03596	-1.04E-05	5.37E-05	2.26E-05	-5.74E-05	-1.14E-05	6.87E-05	1.99E-05	-7.54E-05
0.03658	-1.06E-05	5.37E-05	2.24E-05	-5.73E-05	-1.06E-05	6.84E-05	2.02E-05	-7.56E-05
0.0372	-9.03E-06	5.47E-05	2.17E-05	-5.79E-05	-1.06E-05	6.87E-05	2.02E-05	-7.55E-05
0.03782	-8.97E-06	5.46E-05	2.15E-05	-5.81E-05	-1.07E-05	6.83E-05	1.95E-05	-7.53E-05
0.03844	-8.09E-06	5.38E-05	2.18E-05	-5.84E-05	-1.06E-05	6.84E-05	2.01E-05	-7.51E-05
0.03906	-8.69E-06	5.33E-05	2.19E-05	-5.81E-05	-1.04E-05	6.85E-05	1.96E-05	-7.47E-05
0.03968	-9.40E-06	5.29E-05	2.21E-05	-5.81E-05	-1.01E-05	6.83E-05	1.94E-05	-7.53E-05
0.0403	-1.00E-05	5.26E-05	2.25E-05	-5.76E-05	-8.50E-06	6.93E-05	1.92E-05	-7.45E-05
0.04092	-1.05E-05	5.23E-05	2.25E-05	-5.80E-05	-8.61E-06	6.85E-05	1.94E-05	-7.44E-05
0.04154	-1.11E-05	5.25E-05	2.21E-05	-5.78E-05	-8.63E-06	6.80E-05	1.95E-05	-7.46E-05
0.04216	-1.16E-05	5.25E-05	2.20E-05	-5.70E-05	-8.64E-06	6.81E-05	1.98E-05	-7.43E-05
0.04278	-1.14E-05	5.31E-05	2.32E-05	-5.74E-05	-9.62E-06	6.76E-05	1.99E-05	-7.49E-05
0.0434	-1.17E-05	5.27E-05	2.26E-05	-5.69E-05	-9.68E-06	6.69E-05	2.01E-05	-7.44E-05
0.04402	-1.19E-05	5.27E-05	2.32E-05	-5.71E-05	-1.05E-05	6.75E-05	2.06E-05	-7.56E-05
0.04464	-1.21E-05	5.28E-05	2.34E-05	-5.72E-05	-1.06E-05	6.73E-05	2.01E-05	-7.51E-05
0.04526	-1.33E-05	5.28E-05	2.30E-05	-5.65E-05	-1.11E-05	6.68E-05	2.02E-05	-7.49E-05
0.04588	-1.30E-05	5.35E-05	2.32E-05	-5.66E-05	-1.16E-05	6.72E-05	2.02E-05	-7.51E-05
0.0465	-1.25E-05	5.30E-05	2.27E-05	-5.68E-05	-1.18E-05	6.74E-05	2.03E-05	-7.52E-05
0.04712	-1.37E-05	5.27E-05	2.31E-05	-5.66E-05	-1.24E-05	6.75E-05	2.07E-05	-7.60E-05
0.04774	-1.51E-05	5.27E-05	2.26E-05	-5.61E-05	-1.25E-05	6.69E-05	2.04E-05	-7.56E-05
0.04836	-1.47E-05	5.30E-05	2.34E-05	-5.62E-05	-1.24E-05	6.75E-05	2.06E-05	-7.57E-05
0.04898	-1.48E-05	5.35E-05	2.28E-05	-5.62E-05	-1.25E-05	6.76E-05	2.05E-05	-7.51E-05
0.0496	-1.42E-05	5.37E-05	2.28E-05	-5.63E-05	-1.24E-05	6.77E-05	1.99E-05	-7.60E-05
0.05022	-1.31E-05	5.44E-05	2.25E-05	-5.64E-05	-1.39E-05	6.71E-05	2.02E-05	-7.62E-05
0.05084	-1.25E-05	5.40E-05	2.24E-05	-5.65E-05	-1.45E-05	6.72E-05	2.10E-05	-7.67E-05
0.05146	-1.25E-05	5.42E-05	2.25E-05	-5.69E-05	-1.48E-05	6.81E-05	2.13E-05	-7.64E-05
0.05208	-1.18E-05	5.41E-05	2.20E-05	-5.69E-05	-1.46E-05	6.81E-05	2.13E-05	-7.67E-05
0.0527	-1.12E-05	5.40E-05	2.28E-05	-5.75E-05	-1.32E-05	6.81E-05	2.02E-05	-7.67E-05
0.05332	-1.11E-05	5.40E-05	2.18E-05	-5.69E-05	-1.26E-05	6.87E-05	2.05E-05	-7.64E-05
0.05394	-1.14E-05	5.44E-05	2.24E-05	-5.75E-05	-1.22E-05	6.88E-05	1.98E-05	-7.56E-05
0.05456	-1.09E-05	5.41E-05	2.23E-05	-5.75E-05	-1.22E-05	6.85E-05	1.95E-05	-7.56E-05
0.05518	-1.05E-05	5.36E-05	2.19E-05	-5.78E-05	-1.18E-05	6.89E-05	2.02E-05	-7.57E-05
0.0558	-1.03E-05	5.38E-05	2.23E-05	-5.79E-05	-1.11E-05	6.91E-05	1.95E-05	-7.56E-05
0.05642	-1.08E-05	5.34E-05	2.21E-05	-5.74E-05	-1.14E-05	6.82E-05	1.97E-05	-7.53E-05
0.05704	-1.00E-05	5.44E-05	2.20E-05	-5.85E-05	-1.09E-05	6.84E-05	1.99E-05	-7.50E-05
0.05766	-8.50E-06	5.45E-05	2.16E-05	-5.86E-05	-1.04E-05	6.83E-05	1.95E-05	-7.54E-05
0.05828	-8.79E-06	5.39E-05	2.14E-05	-5.84E-05	-1.03E-05	6.80E-05	1.93E-05	-7.46E-05
0.0589	-8.58E-06	5.37E-05	2.16E-05	-5.81E-05	-1.03E-05	6.86E-05	1.98E-05	-7.52E-05
0.05952	-9.33E-06	5.31E-05	2.24E-05	-5.79E-05	-9.93E-06	6.80E-05	2.00E-05	-7.52E-05
0.06014	-1.02E-05	5.31E-05	2.24E-05	-5.83E-05	-9.25E-06	6.86E-05	1.94E-05	-7.41E-05
0.06076	-1.12E-05	5.24E-05	2.31E-05	-5.78E-05	-7.93E-06	6.88E-05	1.94E-05	-7.48E-05
0.06138	-1.09E-05	5.23E-05	2.24E-05	-5.69E-05	-8.19E-06	6.85E-05	1.94E-05	-7.43E-05
	-1.15E-05	5.34E-05	2.24E-05	-5.72E-05	-1.13E-05	6.80E-05	2.00618E-05	-7.54E-05

APPENDIX E

Asia-Pacific Automotive Engineering Conference-17th, Challenger Impact, Bangkok, April 1-4, 2013
Title:

An Overview for Design of Wheel Force Transducer on Multipurpose Agricultural Truck

Abstract

Movement of vehicle is a result of force effect made by ground and wheels. Once correlated the road load data generated from these cycles reinforces whole vehicle development process ensuring design, simulation, validation; which will be representative of intended market to ensure a high quality and reliable product. An overview for design of an appropriate Wheel force transducer (WFT) that determines road load data with respect to X and Z axis (SAE Coordinates system) for Thai multipurpose agricultural truck is the kernel of this paper. An entire new system for WFT with shear strain gauge based on wireless communication and analogue data acquisition system integrating National Instrument and easily available hardware has been designed. A shear stress based load cell with aluminium 7075 has been designed with four radially extended thin walled hollow beams. A unique structure for load-cell and its adapters has been designed to meet functions as per vehicle requirements. Design and analysis of optimum structure for wheel force transducer has been performed on "SolidWorks" and "ANSYS" CAD/CAE software respectively, while electronic signal transmissions have been carried out on LabView. Moreover, for rim dimensional inspection "GOM Inspect"; a rapid prototyping 3D scanner has been employed.

Keywords: wheel force transducer, road load data, optimum structure analysis, wireless data acquisition

Preceding of the 3rd TSME International Conference on Mechanical Engineering, Chang- Rai , October 24-26, 2012,page 47.
Title:

Structural and Optimum Design of Two Dimensional Wheel Force Transducer for Road Load Data on Multipurpose Agriculture Truck

Abstract

Real time road load data plays a vital role for the design and development of a vehicle before analysis and developing a prototype, which can be obtained by wheel force transducer. The theme of this paper is to define the structural and optimum design of the two dimensional wheel force transducer for real time road load data on multipurpose agriculture truck in Thailand, developed by NSTDA. Structure selection and optimum design are keys to successful data acquisition at mechanical design phase. Wheel force transducer is mounted between the spindle and wheel rim, where a load cell is fixed by the help of wheel hub adaptor and rim adaptor. Structure based on the shear stress has been designed and optimized for the load cell. Different thin- wall structures, i.e. circular, square, hexagonal and octagonal with circular hollow with constant length together and constant cross-sectional area along with volume were considered for analysis. These structures have been analysed in a computer aided engineering program, "ANSYS", for their shear stress. The thin walled square and the thin walled circular structures have been selected for this specific determination. After the numerical analysis of square thin walled optimum structure has been obtained from ANSYS for the manufacturing compatibility. Finally, a complete numerical analysis of wheel force transducer structure has been archived for the optimum design of the whole structure before developing prototype.

Keywords: *Road load data, Wheel force transducer, Load cell, Numerical analysis*

Preceding of the 8th International Conference on Automotive Engineering, Challenger Impact, Bangkok, April 2-5, 2012, page 25
Title:

Beam Selection and Sensor Placement for Road Load Data on Agriculture Truck

Road load data, which plays a vital role in design process for automotive dynamic condition before testing and analysis at different terrains: city, highway, and off-road, can be obtained by wheel force transducer (WFT). The kernel of this paper is the beam selection and sensor placement for road load data to the sustainable development of agriculture truck, based upon shear stress analysis on load cell beams of WFT. Hollow rectangular and circular patterns were selected and were modified to obtain maximum shear stress between them. The point with maximum shear stress and minimum bending moment has been identified for the placement of the sensor. This sensor location on load cell makes WFT more precise and sensitive to road load which is independent of bending moment. Road load data obtained will be used for design and optimization of this agriculture truck parts such as: chassis, suspension, body etc., durability test, noise vibration