

Chapter 9

BIBLIOGRAPHY

Abdullah, M. A., Mansur, M.R., Tamaldin, N. & Thanaraj, K. 2013. Development of formula varsity race car chassis. *2nd International Conference on Mechanical Engineering Research*.

Abrams, R. 2008. Formula SAE race car analysis: simulation & testing of the engine as a structural member. <http://www.fisita.com/education/congress/sc08papers/f2008sc005.pdf>
Date of access: 21 Jul. 2011.

Adams, H. 1993. Chassis engineering. Los Angeles: HP Books.

Aird, F. 2008. The race car chassis. 2nd ed. New York: HP Books.

Armstead, J.K. 2006. Chassis development for the formula SAE racer. Queensland: University of Queensland.

Ashby, M.F. 2005. Materials selection in mechanical design. 3rd ed. Burlington: Elsevier.

Baker, C.S. 2004. FoES formula SAE-A space frame chassis design. Queensland: University of Southern Queensland.

Boresi, A.P. & Schmidt, R.J. 2001. Engineering mechanics : statics. Pacific Grove: Brookes/Cole.

Charubhun, W. & Rodkwan, S. 1999. Design of the space frame racing car front clip and rear clip for torsional rigidity.
http://www.researchgate.net/publication/228731642_Design_of_the_Space_Frame_Racing_Car_Front_Clip_and_Rear_Clip_for_Torsional_Rigidity Date of access: 25 Jul. 2011.

Dally, J.W. & Riley, W.R. 1965. Experimental stress analysis. New York: McGraw-Hill.

De Jager, R. 2009. Formula SAE racing car chassis design. Potchefstroom: North-West University. (Mini-dissertation).

Devore, J. & Farnum, N. 2005. Applied statistics for engineers and scientists. Belmont: Brooks/Cole.

Dieter, G.E. 1988. Mechanical metallurgy. Singapore: McGraw-Hill.

Efunda. 2013. Strain rosette for strain measurement.
http://www.efunda.com/formulae/solid_mechanics/mat_mechanics/strain_gage_rosette.cfm
Date of access: 15 May. 2013.

F1network. 2006. The remarkable history of chassis R26-03.

<http://www.f1network.net/main/s208/st107994.htm> Date of access: 26 Aug. 2011.

Faieza, A., Sapuan, S., Ariffin, M., Baharudin, B. & Supeni, E. 2009. Design and fabrication of a student competition based racing car. *Scientific research and essay*, 4(5):361-366.

Fenner, R. T. 2013. Finite element methods for engineers. 2nd ed. London: Imperial College Press.

FSAE. 2013. Formula SAE. <http://www.fsae.com/> Date of access: 1 Feb. 2011.

Gaffney, E.F. & Salinas, A.R. 1997. Introduction to formula SAE suspension and frame design. <http://www.4x4brasil.com.br/forum/attachments/forum-geral-4x4-brasil/141181d1224865939-livros-de-engenharia-automotiva-introduction-formula-sae-suspension-frame-design.pdf> Date of access: 28 May 2011.

Gillespie, T.D. 1992. Fundamentals of vehicle dynamics. Warrendale: Society of Automotive Engineers.

Henningsgaard, A. & Yanchar, C. 1998. Carbon fiber reinforced steel spaceframe techniques. SAE conference proceedings. http://www.firearmz.com/user/SAE_983055.pdf Date of access: 12 Jul. 2011.

Hibbeler, R.C. 2005. Mechanics of materials. 6th ed. Upper Saddle River: Pearson Prentice Hall.

Hibbeler, R.C. 2004. Engineering mechanics : dynamics. Singapore: Pearson Prentice Hall.

Import meet. 2011. Formula SAE car

<http://www.importmeet.com/forum/viewtopic.php?f=80&t=580> Date of access: 5 Sep. 2011.

Janse van Rensburg, W. 2009. The design and fabrication of a suspension system for a formula SAE type race car. Potchefstroom: North-West University. (Mini-dissertation).

Katz, J. 2006. Race car aerodynamics : designing for speed. Cambridge: Bentley.

Kelly, K. M. 2009. Chassis development shifts focus. *Automotive design & production*:34-35.

Kim, H. Y., Jung, H. Y., Cho, J. R. & Bae, W. B. 2007. Finite element analysis on process improvement of the multi-forming for the motor-case of an automobile. *Journal of materials processing technology*, 187-188(2007):387-382.

Kurowski, P.M. 2012. Engineering analysis with SolidWorks simulation 2012. Mission: Schroff Development Corporation.

McBeath, S. 2006. Competition car aerodynamics. Sparkford: Haynes Publishers.

Michael, B. & Gilbert, T. 2009. Design, development and analysis of the NCSHFH.09 chassis. <http://www.mae.ncsu.edu/academics/duke-energy-research/pdfs/broad.pdf> Date of access: 29 May 2011.

Milliken, W.F. & Milliken, D.L. 2003. Race car vehicle dynamics : problems, answers, and experiments. Warrendale: SAE International.

Milliken, W.F. & Milliken, D.L. 1995. Race car vehicle dynamics. Warrendale: SAE International.

Milliken, W.F., Milliken, D.L. & Olley, M. 2002. Chassis design : principals and analysis. 1st ed. Warrendale: Society of Automotive Engineers.

National Instruments. 2013. Strain gauge configuration types. <http://www.ni.com/white-paper/4172/en/> Date of access: 20 Jul. 2013.

Pashley, T. 2008. How to build motorcycled engined racing cars. 2nd ed. Dorchester: Veloce Publishing.

Performance productions. 2011. Temporada 1981. <http://performersproductions.wordpress.com/2011/03/21/> Date of access: 24 Jul. 2011.

Rao, S.S. 2004. Mechanical vibrations. Upper Saddle River, N.J. : Pearson Prentice Hall.

Reddy, J.N. 1993. An introduction to the finite element method. New York: McGraw-Hill.

Riley, W.B. & George, A.R. 2002. Design, analysis and testing of a formula SAE car chassis. <http://www.theoryinpracticeengineering.com/resources/fsae/cornell%20design%20anal%20testing%20fsae.pdf> Date of access: 28 May. 2011.

SAE. 2012. Formula SAE rules. Washington: SAE International.

SAE. 2011. Formula SAE rules. Washington: SAE International.

SAE International. 2013. SAE formula SAE® series. <http://students.sae.org/cds/formulaseries/> Date of access: 2 Feb. 2010.

Seabright hot rods. 2013. '34 Ford coupe: details, part II. <http://www.seabrighthotrods.com/?p=287> Date of access: 24 Aug. 2011

Kalpakjian, S., Schmid, S. 2006. Manufacturing engineering and technology. 5th ed. Singapore: Person Prentice Hall.

Shigley, J.E. 2004. Mechanical engineering design. New York: McGraw-Hill.

Shih, R.H. 2012. Introduction to finite element analysis using SolidWorks simulation 2012. Mission, Kans: Schroff Development Corporation.

Siegler, B. P., Butler, A.J., Deakin, A.J. & Barton, D. C. 1999. The application of finite element analysis to composite racing chassis design. *Sports engineering*, 1999(2):245-252.

Smith, C. 1985. Engineer to win. Minneapolis: Motorbooks International.

Smith, C. 1978. Tune to win. 2nd ed. Minneapolis: Motorbooks International.

SolidWorks. 2013. Help - beams.

<http://help.solidworks.com/2012/English/SolidWorks/cworks/beams.htm?format=P> Date of access: 22 Jul. 2013.

SomersF1. 2013. Modern McLaren MP4/4 – part I.

<http://somersf1.blogspot.com/2013/03/modern-mclaren-mp44-part-1.html> Date of access: 12 Aug 2013.

Staniforth, A. 2006. Competition car suspension : a practical handbook. Sparkford: Haynes.

Thompson, L.L., Lampert, J.K. & Law, E.H. 1998. Design of a twist fixture to measure the torsional stiffness of a winston cup chassis. SAE conference proceedings.

<http://www.ces.clemson.edu/~lonny/pubs/conference/sae983054.pdf> Date of access: 14 Jun. 2011

Thompson, L.L., Raju, S. & Law, E.H. 1998. Design of a winston cup chassis for torsional stiffness. SAE conference proceedings.

http://www.researchgate.net/publication/2417241_Design_of_a_Winston_Cup_Chassis_for_Torsional_Stiffness Date of access: 14 Jun 2011.

Toyota 2000GT. 2005. Divers: Lotus Elan. <http://www.2000gt.net/Lotus/Elan.php> Date of access: 26 Jul. 2011.

Tremayne, D. 2006. The science of formula 1 design. Sparkford: Haynes Publishing.

Wakeham, K.J. 2009. Introduction to chassis design. St. John: Memorial University of Newfoundland And Labrador. (Mini-dissertation).

Virginmedia. 2013. McLaren's new road legal supercar.

<http://www.virginmedia.com/motoring/features/mclaren-mp4.php?ssid=3> Date of access: 19 Aug 2013.

WMU FSAE. 2009. FSAE manufacturing

<https://picasaweb.google.com/wmuformularacing/2009FSAEManufacturing02#> Date of access: 14 Jul. 2011.

Yucheng L., 2009. Development and evaluation of a finite element truck chassis crash model. *International journal of crashworthiness*, 15(1):107-113.

Zerotohundred. 2008. Ferrari ditches Marlboro logo on its cars – finally.

<http://www.zerotohundred.com/2008/auto-news/ferrari-ditches-marlboro-logo-on-its-cars-finally/> Date of access: 25 Jul. 2011.

Zienkiewicz, O. C., Taylor, R. L. 2000. The finite element method. 5th ed. Oxford: Butterworth-Heinemann.

Chapter 10

APPENDICES

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Appendix A

Formula SAE Rules

Appendix A contains the rules and regulations required for the Formula SAE (FSAE) vehicle chassis. It includes a descriptive table for all the chassis components with regards to materials and construction. The Appendix also includes extracted pages from the FSAE rules and regulations that are only applicable on the chassis of the entire vehicle. The complete set of rules can be found on the data DVD found in Appendix F.

Table A-1 Vehicle chassis component description

Component	Material & Dimensions	Construction
Main Hoop A roll bar located alongside or just behind the driver's torso.	Mild or Alloy Steel (min 1% C) Round 25.4 mm x 2.40 mm or Round 25.0 mm x 2.50 mm	Must extend from the lowest frame member on the one side, up, over and down the lowest frame member on the other side of the frame. In the side view of the vehicle, the portion of the main roll hoop that lies above its attachment point to the major structure of the frame must be within ten degrees of the vertical. In front view, vertical members must be 380 mm apart.
Front Hoop A roll bar located above the driver's legs, in proximity of the steering wheel.	Mild or Alloy Steel (min 1% C) Round 25.4 mm x 2.40 mm or Round 25.0 mm x 2.50 mm	Must extend from the lowest frame member on the one side, up, over and down the lowest frame member on the opposite side of the frame. With proper triangulation or gusseting, it may be constructed from more than one piece of tubing. The top-most surface of the front hoop must be no lower than the top of the steering wheel in any angular position. Front hoop must be no more than 250 mm forward of the steering wheel. From the side view, no part of the front hoop can be inclined at more than twenty degrees from the vertical.
Main Hoop Bracing The structure from the upper end of the roll hoop back to the frame structure.	Mild or Alloy Steel (min 1% C) Round 25.4 mm x 1.25 mm or Round 25.0 mm x 1.50 mm or Round 26.0 mm x 1.20 mm	The main hoop must be supported by two braces on both the left and right side of the hoop. These braces must be straight. The braces must be 160 mm from the top of the main hoop and must be at an angle of at least thirty degrees. Must be able to transmit loads.
Front Hoop Bracing The structure from the upper end of the roll hoop back to the frame structure.	Mild or Alloy Steel (min 1% C) Round 25.4 mm x 1.65 mm or Round 25.0 mm x 1.75 mm or Round 25.4 mm x 1.60 mm or Square 25.0 mm x 25.0 mm x 1.25 mm or Square 26.0 mm x 26.0 mm x 1.20 mm	The front hoop must be supported by two braces extending in the forward direction in both the left and right sides. Must be constructed such that it protects the driver's legs and must extend to the front bulkhead. The braces must be no more than 50.8 mm from the top of the front hoop. If the front hoop leans rearwards by more than ten degrees from the vertical, it must be supported by additional bracing from the rear.

Front Bulkhead Planar structure that defines the forward plane of the major structure of the frame and functions to protect the driver's feet.	Mild or Alloy Steel (min 1% C) Round 25.4 mm x 1.65 mm or Round 25.0 mm x 1.75 mm or Round 25.4 mm x 1.60 mm or Square 25.0 mm x 25.0 mm x 1.25 mm or Square 26.0 mm x 26.0 mm x 1.20 mm	The bulkhead must be located forward of all non-crushable objects. This excludes aerodynamic devices and body parts. The bulkhead must be located such that the soles of the driver's feet, when touching the pedals are rearward of the bulk plane.
Front Bulkhead Support	Mild or Alloy Steel (min 1% C) Round 25.4 mm x 1.25 mm or Round 25.0 mm x 1.50 mm or Round 26.0 mm x 1.20 mm	The front bulkhead must be securely integrated into the frame. The front bulkhead must be supported back to the front roll hoop by a minimum of three frame member on each side of the vehicle with one at the top (see front hoop bracing), one at the bottom, and one as a diagonal brace to provide triangulation. The triangulation must be node-to-node, with triangles being formed by the front bulkhead, the diagonal and one of the other two required front bulkhead support frame members.
Side Impact Members The area of the side of the car extending from the top of the floor to 350 mm above the ground and from the front hoop back to the main hoop.	Mild or Alloy Steel (min 1% C) Round 25.4 mm x 1.65 mm or Round 25.0 mm x 1.75 mm or Round 25.4 mm x 1.60 mm or Square 25.0 mm x 25.0 mm x 1.25 mm or Square 26.0 mm x 26.0 mm x 1.20 mm	The side impact structure must be comprised of at least three tubular members located on each side. The member locations are as follows: The <i>upper member</i> must connect the main hoop and the front hoop at a height between 300 mm and 350 mm above the ground. The <i>lower member</i> must connect the bottom of the main hoop and the bottom of the front hoop. The <i>diagonal member</i> must connect the upper and lower members forward of the main hoop and rearward of the front hoop.

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PART B – TECHNICAL REQUIREMENTS

ARTICLE 1: VEHICLE REQUIREMENTS & RESTRICTIONS

B1.1 Technical Inspection

The following requirements and restrictions will be enforced through technical inspection. Noncompliance must be corrected and the car re-inspected before the car is allowed to operate under power.

B1.2 Modifications and Repairs

- B1.2.1** Once the vehicle has been presented for judging in the Cost or Design Events, or submitted for Technical Inspection, and until the vehicle is approved to compete in the dynamic events, i.e. all the inspection stickers are awarded, the only modifications permitted to the vehicle are those directed by the Inspector(s) and noted on the Inspection Form.
- B1.2.2** Once the vehicle is approved to compete in the dynamic events, the **ONLY** modifications permitted to the vehicle are those listed below. They are also referenced in Part C of the Formula SAE Rules – Static Event Regulations.
- a. Adjustment of belts, chains and clutches
 - b. Adjustment of brake bias
 - c. Adjustment of the driver restraint system, head restraint, seat and pedal assembly
 - d. Substitution of the head restraint or seat insert for different drivers
 - e. Adjustment to engine operating parameters, e.g. fuel mixture and ignition timing
 - f. Adjustment of mirrors
 - g. Adjustment of the suspension where no part substitution is required, (except that springs, sway bars and shims may be changed)
 - h. Adjustment of tire pressure
 - i. Adjustment of wing angle, but not the location
 - j. Replenishment of fluids
 - k. Replacement of worn tires or brake pads
 - l. The changing of wheels and tires for “wet” or “damp” conditions as allowed in Part D of the FSAE Rules – Dynamic Event Regulations.
- B1.2.3** The vehicle must maintain all required specifications, e.g. ride height, suspension travel, braking capacity, sound level and wing location throughout the competition.
- B1.2.4** Once the vehicle is approved for competition, any damage to the vehicle that requires repair, e.g. crash damage, electrical or mechanical damage will void the Inspection Approval. Upon the completion of the repair and before re-entering into any dynamic competition, the vehicle **MUST** be re-submitted to Technical Inspection for re-approval.

ARTICLE 2: GENERAL DESIGN REQUIREMENTS

B2.1 Vehicle Configuration

The vehicle must be open-wheeled and open-cockpit (a formula style body) with four (4) wheels that are not in a straight line.

B2.2 Bodywork

There must be no openings through the bodywork into the driver compartment from the front of the vehicle back to the roll bar main hoop or firewall other than that required for the cockpit opening. Minimal openings around the front suspension components are allowed.

B2.3 Wheelbase

The car must have a wheelbase of at least 1525 mm (60 inches). The wheelbase is measured from the center of ground contact of the front and rear tires with the wheels pointed straight ahead.

B2.4 Vehicle Track

The smaller track of the vehicle (front or rear) must be no less than 75% of the larger track.

B2.5 Visible Access

All items on the Inspection Form must be clearly visible to the technical inspectors without using instruments such as endoscopes or mirrors. Visible access can be provided by removing body panels or by providing removable access panels.

ARTICLE 3: DRIVER'S CELL

B3.0 Vehicle Structure - 2 Options

Teams may, at their option, design their vehicle to comply with either of two (2) separate, but related, sets of requirements and restrictions. Specifically, teams may elect to comply with **either**:

- (1) Part B Article 3 "Drivers Cell" as defined below **or**
- (2) Part AF "Alternate Frame Rules" as found in Appendix AF and the FSAE website.

B3.0.1 Notice Requirement – Teams planning to use the Part AF "Alternate Frame Rules" must notify the Rules committee of their intent by November 1, 2011. The instructions for notification appear in Part AF. The Rules Committee will review the submission and notify the team if the request is granted. Part AF has significant analytical requirements and as it is still in development this application process will insure that the Committee can handle the workload and give teams the support they may require to show certification as well as insure the teams have the technical capability to analyze their design and prove compliance with the AF Rules.

B3.0.2 Alternate Frame Rules use requires the submission of the "Structural Requirements Certification Form (SRCF)" which **supersedes** the Rule B3.8 "Structural Equivalency Spreadsheet".

Teams submitting a Structural Requirements Certification Form (SRCF) **do not** have to submit a Structural Equivalency Spreadsheet (SES).

B3.1 General Requirements

Among other requirements, the vehicle's structure must include two roll hoops that are braced, a front bulkhead with support system and Impact Attenuator, and side impact structures.

B3.2 Definitions

The following definitions apply throughout the Rules document:

- Main Hoop - A roll bar located alongside or just behind the driver's torso.
- Front Hoop - A roll bar located above the driver's legs, in proximity to the steering wheel.
- Roll Hoops – Both the Front Hoop and the Main Hoop are classified as "Roll Hoops"

- Roll Hoop Bracing Supports – The structure from the lower end of the Roll Hoop Bracing back to the Roll Hoop(s).
- Frame Member - A minimum representative single piece of uncut, continuous tubing.
- Frame - The “Frame” is the fabricated structural assembly that supports all functional vehicle systems. This assembly may be a single welded structure, multiple welded structures or a combination of composite and welded structures.
- Primary Structure – The Primary Structure is comprised of the following Frame components: 1) Main Hoop, 2) Front Hoop, 3) Roll Hoop Braces and Supports, 4) Side Impact Structure, 5) Front Bulkhead, 6) Front Bulkhead Support System and 7) all Frame Members, guides and supports that transfer load from the Driver’s Restraint System into items 1 through 6.
- Major Structure of the Frame – The portion of the Frame that lies within the envelope defined by the Primary Structure. The upper portion of the Main Hoop and the Main Hoop *Bracing* are not included in defining this envelope.
- Front Bulkhead – A planar structure that defines the forward plane of the Major Structure of the Frame and functions to provide protection for the driver’s feet.
- Impact Attenuator – A deformable, energy absorbing device located forward of the Front Bulkhead.
- Side Impact Zone – The area of the side of the car extending from the top of the floor to 350 mm (13.8 inches) above the ground and from the Front Hoop back to the Main Hoop.

B3.3 Minimum Material Requirements

B3.3.1 Baseline Steel Material

The Primary Structure of the car must be constructed of:

Either: Round, mild or alloy, steel tubing (minimum 0.1% carbon) of the minimum dimensions specified in the following table,

Or: Approved alternatives per Rules B3.4, B.3.5, B3.6 and B3.7.

ITEM or APPLICATION	OUTSIDE <i>DIMENSION</i> X WALL THICKNESS
Main & Front Hoops, Shoulder Harness Mounting Bar	Round 1.0 inch (25.4 mm) x 0.095 inch (2.4 mm) or Round 25.0 mm x 2.50 mm metric
Side Impact Structure, Front Bulkhead, Roll Hoop Bracing, Driver’s Restraint Harness Attachment (except as noted above)	Round 1.0 inch (25.4 mm) x 0.065 inch (1.65 mm) or Round 25.0 mm x 1.75 mm metric or Round 25.4 mm x 1.60 mm metric or Square 1.00 inch x 1.00 inch x 0.049 inch or Square 25.0 mm x 25.0 mm x 1.25 mm metric or Square 26.0 mm x 26.0 mm x 1.2 mm metric
Front Bulkhead Support, Main Hoop Bracing Supports	Round 1.0 inch (25.4 mm) x 0.049 inch (1.25 mm) or Round 25.0 mm x 1.5 mm metric or Round 26.0 mm x 1.2 mm metric

Note 1: The use of alloy steel does not allow the wall thickness to be thinner than that used for mild steel.

Note 2: For a specific application:

- Using tubing of the specified outside diameter but with greater wall thickness,
- **Or** of the specified wall thickness and a greater outside diameter,

- **Or** replacing round tubing with square tubing of the same or larger size to those listed above,

Are NOT rules deviation requiring approval.

Note 3: Except for inspection holes, any holes drilled in any regulated tubing require the submission of an SES.

Note 4: Baseline steel properties used for calculations to be submitted in an SES may not be lower than the following:

Bending and buckling strength calculations:

Young's Modulus (E) = 200 GPa (29,000 ksi)

Yield Strength (Sy) = 305 MPa (44.2 ksi)

Ultimate Strength (Su) = 365 MPa (52.9 ksi)

Welded monocoque attachment points or welded tube joint calculations:

Yield Strength (Sy) = 180 MPa (26ksi)

Ultimate Strength (Su) = 300 MPa (43.5 ksi)

Where welded tubing reinforcements are required (e.g. inserts for bolt holes or material to support suspension cutouts) the tubing **must** retain the baseline cold rolled strength while using the welded strength for the additional reinforcement material.

B3.4 Alternative Tubing and Material - General

B3.4.1 Alternative tubing geometry and/or materials may be used except that the Main Roll Hoop and Main Roll Hoop Bracing must be made from steel, i.e. the use of aluminum or titanium tubing or composites for these components is prohibited.

B3.4.2 Titanium or magnesium on which welding has been utilized may not be used for any part of the Primary Structure. This includes the attachment of brackets to the tubing or the attachment of the tubing to other components.

B3.4.3 If a team chooses to use alternative tubing and/or materials they must submit a "Structural Equivalency Spreadsheet" per Rule B3.8. The teams must submit calculations for the material they have chosen, demonstrating equivalence to the minimum requirements found in Section B3.3.1 for yield and ultimate strengths in bending, buckling and tension, for buckling modulus and for energy dissipation. (The Buckling Modulus is defined as EI, where, E = modulus of Elasticity, and I = area moment of inertia about the weakest axis.)

B3.4.4 Tubing cannot be of thinner wall thickness than listed in B3.5 or B3.6.

B3.4.5 *If a bent tube is used anywhere in the primary structure, other than the front and main roll hoops, an additional tube must be attached to support it. The attachment point must be the position along the tube where it deviates farthest from a straight line connecting both ends. The support tube must have the same diameter and thickness as the bent tube. The support tube must terminate at a node of the chassis.*

B3.5 Alternative Steel Tubing

Minimum Wall Thickness Allowed:

MATERIAL & APPLICATION	MINIMUM WALL THICKNESS
Steel Tubing for Front and Main Roll Hoops, and Shoulder Harness Mounting Bar	2.0 mm (0.079 inch)
Steel Tubing for Roll Hoop Bracing, Roll Hoop Bracing Supports, Side Impact Structure, Front Bulkhead, Front Bulkhead Support, and Driver's Harness Attachment (except as noted above)	1.2 mm (0.047 inch)

Note 1: All steel is treated equally - there is no allowance for alloy steel tubing, e.g. SAE 4130, to have a thinner wall thickness than that used with mild steel.

Note 2: To maintain EI with a thinner wall thickness than specified in B3.3.1, the outside diameter **MUST** be increased.

Note 3: To maintain the equivalent yield and ultimate tensile strength the same cross-sectional area of steel as the baseline tubing specified in B3.3.1 **MUST** be maintained.

B3.6 Aluminum Tubing Requirements

B3.6.1 Minimum Wall Thickness: Aluminum Tubing 3.0 mm (0.118 inch)

B3.6.2 The equivalent yield strength must be considered in the “as-welded” condition, (Reference: WELDING ALUMINUM (latest Edition) by the Aluminum Association, or THE WELDING HANDBOOK, Volume 4, 7th Ed., by The American Welding Society), unless the team demonstrates and shows proof that the frame has been properly solution heat treated and artificially aged.

B3.6.3 Should aluminum tubing be solution heat-treated and age hardened to increase its strength after welding; the team must supply sufficient documentation as to how the process was performed. This includes, but is not limited to, the heat-treating facility used, the process applied, and the fixturing used.

B3.7 Composite Materials

B3.7.1 If any composite or other material is used, the team must present documentation of material type, e.g. purchase receipt, shipping document or letter of donation, and of the material properties. Details of the composite lay-up technique as well as the structural material used (cloth type, weight, and resin type, number of layers, core material, and skin material if metal) must also be submitted. The team must submit calculations demonstrating equivalence of their composite structure to one of similar geometry made to the minimum requirements found in Section B3.3.1. Equivalency calculations must be submitted for energy dissipation, yield and ultimate strengths in bending, buckling, and tension. Submit the completed “Structural Equivalency Spreadsheet” per Section B3.8.

B3.7.2 Composite materials are not allowed for the Main Hoop or the Front Hoop.

B3.8 Structural Documentation – SES or SRCF Submission

All equivalency calculations must prove equivalency relative to steel grade SAE/AISI 1010.

- B3.8.1 All teams **MUST** submit either a STRUCTURAL EQUIVALENCY SPREADSHEET (SES) or a STRUCTURAL REQUIREMENTS CERTIFICATION FORM (SRCF).

Teams complying with the Part B Article 3 “Drivers Cell” rules **MUST** submit a Structural Equivalence Spreadsheet (SES), even if they are **NOT** planning to use alternative materials or tubing sizes to those specified in B3.3.1 Baseline Steel Materials.

Teams following the Part AF “Alternate Frame Rules” **MUST** submit a Structural Requirements Certification Form (SRCF). See Rule AF2.

- B3.8.2 The use of alternative materials or tubing sizes to those specified in B3.3.1 “Baseline Steel Material,” is allowed, provided they have been judged by a technical review to have equal or superior properties to those specified in B3.3.1.
- B3.8.3 Approval of alternative material or tubing sizes will be based upon the engineering judgment and experience of the chief technical inspector or his appointee.
- B3.8.4 The technical review is initiated by completing the “Structural Equivalency Spreadsheet” (SES) using the format given in Appendix B-1.
- B3.8.5 Structural Equivalency Spreadsheet – Submission
- a. Address – SESs must be submitted to the officials at the competition you are entering at the address shown in the Appendix or indicated on the competition website.
 - b. Due Date – SESs must be submitted no later than the date indicated on the competition website. Teams that submit their Structural Equivalency Spreadsheet after the due date for the competition will be penalized 10 points per day up to a maximum of 50 points, which will be taken off the team’s Total Score.
 - c. Acknowledgement – North America competitions – SESs submitted for vehicles entered into competitions held in North America will be acknowledged automatically by the fsaonline website.

Do Not Resubmit SES’s unless instructed to do so.

- B3.8.6 Vehicles completed under an approved SES must be fabricated in accordance with the materials and processes described in the SES.
- B3.8.7 Teams must bring a copy of the approved SES with them to Technical Inspection.

Comment - The resubmission of an SES that was written and submitted for a competition in a previous year is strongly discouraged. Each team is expected to perform their own tests and to submit SESs based on their original work. Understanding the engineering that justifies the equivalency is essential to discussing your work with the officials.

B3.9 Main and Front Roll Hoops – General Requirements

- B3.9.1 The driver’s head and hands must not contact the ground in any rollover attitude.
- B3.9.2 The Frame must include both a Main Hoop and a Front Hoop as shown in Figure 1.
- B3.9.3 When seated normally and restrained by the Driver’s Restraint System, the helmet of a 95th percentile male (anthropometrical data) and all of the team’s drivers must:

- a. Be a minimum of 50.8 mm (2 inches) from the straight line drawn from the top of the main hoop to the top of the front hoop. (Figure 1a)
- b. Be a minimum of 50.8 mm (2 inches) from the straight line drawn from the top of the main hoop to the lower end of the main hoop bracing if the bracing extends rearwards. (Figure 1b)
- c. Be no further rearwards than the rear surface of the main hoop if the main hoop bracing extends forwards. (Figure 1c)

95th Percentile Male Template Dimensions

A two dimensional template used to represent the 95th percentile male is made to the following dimensions:

- A circle of diameter 200 mm (7.87 inch) will represent the hips and buttocks.
- A circle of diameter 200 mm (7.87 inch) will represent the shoulder/cervical region.
- A circle of diameter 300 mm (11.81 inch) will represent the head (with helmet).
- A straight line measuring 490 mm (19.29 inch) will connect the centers of the two 200 mm circles.
- A straight line measuring 280 mm (11.02 inch) will connect the centers of the upper 200 mm circle and the 300 mm head circle.

B3.9.4 The 95th percentile male template will be positioned as follows: (See Figure 2.)

- The seat will be adjusted to the rearmost position,
- The bottom 200 mm circle will be placed at the junction of the seat back and the seat bottom, tangential to both.
- The middle 200 mm circle, representing the shoulders, will be positioned on the seat back.
- The upper 300 mm circle will be positioned no more than 25.4 mm (1 inch) away from the head restraint (i.e. where the driver's helmet would normally be located while driving).

B3.9.5 If the requirements of B3.9.3 are not met with the 95th percentile male template, the car will NOT receive a Technical Inspection Sticker and will not be allowed to compete in the dynamic events.

B3.9.6 Drivers who do not meet the helmet clearance requirements of B3.9.3 will not be allowed to drive in the competition.

B3.9.7 The minimum radius of any bend, measured at the tube centerline, must be at least three times the tube outside diameter. Bends must be smooth and continuous with no evidence of crimping or wall failure.

B3.9.8 The Main Hoop and Front Hoop must be securely integrated into the Primary Structure using gussets and/or tube triangulation.

B3.10 Main Hoop

B3.10.1 The Main Hoop must be constructed of a single piece of uncut, continuous, closed section steel tubing per Rule B3.3.1.

B3.10.2 The use of aluminum alloys, titanium alloys or composite materials for the Main Hoop is prohibited.

B3.10.3 The Main Hoop must extend from the lowest Frame Member on one side of the Frame, up, over and down the lowest Frame Member on the other side of the Frame.

B3.10.4 In the side view of the vehicle, the portion of the Main Roll Hoop that lies above its attachment point to the Major Structure of the Frame must be within ten degrees (10°) of the vertical.

B3.10.5 In the front view of the vehicle, the vertical members of the Main Hoop must be at least 380 mm (15 inch) apart (inside dimension) at the location where the Main Hoop is attached to the Major Structure of the Frame.

B3.11 Front Hoop

B3.11.1 The Front Hoop must be constructed of closed section metal tubing per Rule B3.3.1.

B3.11.2 The Front Hoop must extend from the lowest Frame Member on one side of the Frame, up, over and down to the lowest Frame Member on the other side of the Frame.

B3.11.3 With proper gusseting and/or triangulation, it is permissible to fabricate the Front Hoop from more than one piece of tubing.

B3.11.4 The top-most surface of the Front Hoop must be no lower than the top of the steering wheel in any angular position.

B3.11.5 The Front Hoop must be no more than 250 mms (9.8 inches) forward of the steering wheel. This distance shall be measured horizontally, on the vehicle centerline, from the rear surface of the Front Hoop to the forward most surface of the steering wheel rim with the steering in the straight-ahead position.

B3.11.6 In side view, no part of the Front Hoop can be inclined at more than twenty degrees (20°) from the vertical.

B3.12 Main Hoop Bracing

B3.12.1 Main Hoop braces must be constructed of closed section steel tubing per Rule B3.3.1.

B3.12.2 The Main Hoop must be supported by two braces extending in the forward or rearward direction on both the left and right sides of the Main Hoop.

B3.12.3 In the side view of the Frame, the Main Hoop and the Main Hoop braces must not lie on the same side of the vertical line through the top of the Main Hoop, i.e. if the Main Hoop leans forward, the braces must be forward of the Main Hoop, and if the Main Hoop leans rearward, the braces must be rearward of the Main Hoop.

B3.12.4 The Main Hoop braces must be attached as near as possible to the top of the Main Hoop but not more than 160 mm (6.3 in) below the top-most surface of the Main Hoop. The included angle formed by the Main Hoop and the Main Hoop braces must be at least thirty degrees (30°). See Figure 3.

B3.12.5 The Main Hoop braces must be straight, i.e. without any bends.

B3.12.6 The attachment of the Main Hoop braces must be capable of transmitting all loads from the Main Hoop into the Major Structure of the Frame without failing. From the lower end of the braces there must be a properly triangulated structure back to the lowest part of the Main Hoop and the node at which the upper side impact tube meets the Main Hoop. This structure must meet the minimum requirements for Main Hoop Bracing Supports (see Rule B3.3) or an SES approved alternative. Bracing loads must not be fed solely into the engine, transmission or differential, or through suspension components.

B3.12.7 If any item which is outside the envelope of the Primary Structure is attached to the Main Hoop braces, then additional bracing must be added to prevent bending loads in the braces in any rollover attitude.

B3.13 Front Hoop Bracing

B3.13.1 Front Hoop braces must be constructed of material per Rule B3.3.1.

B3.13.2 The Front Hoop must be supported by two braces extending in the forward direction on both the left and right sides of the Front Hoop.

B3.13.3 The Front Hoop braces must be constructed such that they protect the driver's legs and should extend to the structure in front of the driver's feet.

B3.13.4 The Front Hoop braces must be attached as near as possible to the top of the Front Hoop but not more than 50.8 mm (2 in) below the top-most surface of the Front Hoop. See Figure 3.

B3.13.5 If the Front Hoop leans rearwards by more than ten degrees (10°) from the vertical, it must be supported by additional bracing to the rear. This bracing must be constructed of material per Rule B3.3.1.

B3.14 Other Bracing Requirements

Where the braces are not welded to steel Frame Members, the braces must be securely attached to the Frame using 8 mm Metric Grade 8.8 (5/16 in SAE Grade 5), or stronger, bolts. Mounting plates welded to the Roll Hoop braces must be at least 2.0 mm (0.080 in) thick steel.

B3.15 Other Side Tube Requirements

If there is a Roll Hoop brace or other frame tube alongside the driver, at the height of the neck of any of the team's drivers, a metal tube or piece of sheet metal must be firmly attached to the Frame to prevent the drivers' shoulders from passing under the roll hoop brace or frame tube, and his/her neck contacting this brace or tube.

B3.16 Mechanically Attached Roll Hoop Bracing

B3.16.1 Roll Hoop bracing may be mechanically attached.

B3.16.2 Any non-permanent joint at either end must be either a double-lug joint as shown in Figures 4 and 5, or a sleeved butt joint as shown in Figure 6.

B3.16.3 The threaded fasteners used to secure non-permanent joints are considered critical fasteners and must comply with Article B14.

B3.16.4 No spherical rod ends are allowed.

B3.16.5 For double-lug joints, each lug must be at least 4.5 mm (0.177 in) thick steel, measure 25 mm (1.0 in) minimum perpendicular to the axis of the bracing and be as short as practical along the axis of the bracing.

B3.16.6 All double-lug joints, whether fitted at the top or bottom of the tube, must include a capping arrangement (Figures 4 & 5).

B3.16.7 In a double-lug joint the pin or bolt must be 10 mm Metric Grade 9.8 (3/8 in. SAE Grade 8) minimum. The attachment holes in the lugs and in the attached bracing must be a close fit with the pin or bolt.

B3.16.8 For sleeved butt joints (Figure 6), the sleeve must have a minimum length of 76 mm (3 inch); 38 mm (1.5 inch) either side of the joint, and be a close-fit around the base tubes. The wall thickness of the sleeve must be at least that of the base tubes. The bolts must be 6 mm Metric Grade 9.8 (1/4 inch SAE Grade 8) minimum. The holes in the sleeves and tubes must be a close-fit with the bolts.

B3.17 Frontal Impact Structure

B3.17.1 The driver's feet must be completely contained within the Major Structure of the Frame. While the driver's feet are touching the pedals, in side and front views no part of the driver's feet can extend above or outside of the Major Structure of the Frame.

B3.17.2 Forward of the Front Bulkhead must be an energy-absorbing Impact Attenuator.

B3.18 Bulkhead

B3.18.1 The Front Bulkhead must be constructed of closed section tubing per Rule B3.3.1.

B3.18.2 Except as allowed by B3.22.2, The Front Bulkhead must be located forward of all non-crushable objects, e.g. batteries, master cylinders, hydraulic reservoirs.

B3.18.3 The Front Bulkhead must be located such that the soles of the driver's feet, when touching but not applying the pedals, are rearward of the bulkhead plane. (This plane is defined by the forward-most surface of the tubing.) Adjustable pedals must be in the forward most position.

B3.19 Front Bulkhead Support

B3.19.1 The Front Bulkhead must be securely integrated into the Frame.

B3.19.2 The Front Bulkhead must be supported back to the Front Roll Hoop by a minimum of three (3) Frame Members on each side of the vehicle with one at the top (within 50.8 mm (2 inches) of its top-most surface), one (1) at the bottom, and one (1) as a diagonal brace to provide triangulation.

B3.19.3 The triangulation must be node-to-node, with triangles being formed by the Front Bulkhead, the diagonal and one of the other two required Front Bulkhead Support Frame Members.

B3.19.4 All the Frame Members of the Front Bulkhead Support system listed above must be constructed of closed section tubing per Section B3.3.1.

B3.20 Impact Attenuator

B3.20.1 The Impact Attenuator must be:

- a. Installed forward of the Front Bulkhead.
- b. At least 200 mm (7.8 in) long, with its length oriented along the fore/aft axis of the Frame.
- c. At least 100 mm (3.9 in) high and 200 mm (7.8 in) wide for a minimum distance of 200 mm (7.8 in) forward of the Front Bulkhead.
- d. Such that it cannot penetrate the Front Bulkhead in the event of an impact.
- e. Attached securely and directly to the Front Bulkhead and not by being part of non-structural bodywork.

- B3.20.2 The attachment of the Impact Attenuator must be constructed to provide an adequate load path for transverse and vertical loads in the event of off-center and off-axis impacts.
- B3.20.3 The attachment of the Impact Attenuator to a monocoque structure requires an approved “Structural Equivalency Spreadsheet” per Article B3.8 that shows equivalency to a minimum of four (4) 8 mm Grade 8.8 (5/16 inch Grade 5) bolts.
- B3.20.4 On all cars, a 1.5 mm (0.060 in) solid steel or 4.0 mm (0.157 in) solid aluminum “anti-intrusion plate” must be integrated into the Impact Attenuator. If the IA plate is bolted to the Front Bulkhead, it must be the same size as the outside dimensions of the Front Bulkhead. If it is welded to the Front Bulkhead, it must extend at least to the centerline of the Front Bulkhead tubing.
- B3.20.5 If the anti-intrusion is not integral with the frame, i.e. welded, a minimum of four (4) 8 mm Metric Grade 8.8 (5/16 inch SAE Grade 5) bolts must attach the Impact Attenuator to the Front Bulkhead.
- B3.20.6 Alternative designs of the anti-intrusion plate required by B3.20.4 that do not comply with the minimum specifications given above require an approved “Structural Equivalency Spreadsheet” per Article B3.8. Equivalency must also be proven for perimeter shear strength of the proposed design.

B3.21 Impact Attenuator Data Requirement

- B3.21.1 The team must submit test data to show that their Impact Attenuator, when mounted on the front of a vehicle with a total mass of 300 kgs (661 lbs) and run into a solid, non-yielding impact barrier with a velocity of impact of 7.0 meters/second (23.0 ft/sec), would give an average deceleration of the vehicle not to exceed 20 g’s, with a peak deceleration less than or equal to 40 g’s. Total energy absorbed must meet or exceed 7350 Joules.

Note: These are the attenuator functional requirements not test requirements. Quasi-static testing is allowed.

- B3.21.2 When using acceleration data, the average deceleration must be calculated based on the raw data. The peak deceleration can be assessed based on the raw data, and if peaks above the 40g limit are apparent in the data, it can then be filtered with a Channel Filter Class (CFC) 60 (100 Hz) filter per SAE Recommended Practice J211 “Instrumentation for Impact Test”, or a 100 Hz, 3rd order, lowpass Butterworth (-3dB at 100 Hz) filter.
- B3.21.3 A schematic of the test method must be supplied along with photos of the attenuator before and after testing.
- B3.21.4 The test piece must be presented at technical inspection for comparison to the photographs and the attenuator fitted to the vehicle.
- B3.21.5 The test data and calculations must be submitted electronically in Adobe Acrobat ® format (*.pdf file) to the address and by the date provided in the Action Deadlines provided on the relevant competition website. This material must be a single file (text, drawings, data or whatever you are including).
- B3.21.6 The Impact Attenuator Data must be named as follows: carnumber_schoolname_competition code_IAD.pdf using the assigned car number, the complete school name and competition code [Example: 087_University of SAE_FSAEM_IAD.pdf]

Competition Codes are listed in Rule A.2.6

- B3.21.7 Teams that submit their Impact Attenuator Data Report after the due date will be penalized 10 points per day up to a maximum of 50 points, which will be taken off the team's Total Score.
- B3.21.8 Impact Attenuator Reports will be evaluated by the organizers and the evaluations will be passed to the Design Event Captain for consideration in that event.
- B3.21.9 During the test, the attenuator must be attached to the anti-intrusion plate using the intended vehicle attachment method. The anti-intrusion plate must be spaced at least 50 mm (2 inches) from any rigid surface. No part of the anti-intrusion plate may permanently deflect more than 25.1 mm (1 inch) beyond the position of the anti-intrusion plate before the test.

Note: The 25.4 mm (1 inch) spacing represents the front bulkhead support and insures that the plate does not intrude excessively into the cockpit

- B3.21.10 Dynamic testing (sled, pendulum, drop tower, etc.) of the impact attenuator may only be done at a dedicated test facility. The test facility may be part of the University but must be supervised by professional staff or University faculty. Teams are not allowed to construct their own dynamic test apparatus. Quasi-static testing may be performed by teams using their universities facilities/equipment, but teams are advised to exercise due care when performing all tests.
- B3.21.11 Standard Attenuator – An officially approved impact attenuator can be found at <http://www.fsaeonline.com/home/page.aspx?pageid=193613e4-fff1-4ea9-97ec-eb1c07fbe3c0> . Teams may choose to use that style of impact attenuator and need not submit test data with their IAD Report. The other requirements of the IAD Report must still be submitted including, but not limited to, photos of the team's actual attenuator with evidence that it meets the design criteria given on the website.

B3.22 Non-Crushable Objects

- B3.22.1 Except as allowed by B3.22.2, all non-crushable objects (e.g. batteries, master cylinders, hydraulic reservoirs) must be rearward of the bulkhead. No non-crushable objects are allowed in the impact attenuator zone.
- B3.22.2 The front wing and wing supports may be forward of the Front Bulkhead, but may NOT be located in or pass through the Impact Attenuator. If the wing supports are in front of the Front Bulkhead, the supports must be included in the test of the Impact Attenuator for B.3.21.

B3.23 Front Bodywork

- B3.23.1 Sharp edges on the forward facing bodywork or other protruding components are prohibited.
- B3.23.2 All forward facing edges on the bodywork that could impact people, e.g. the nose, must have forward facing radii of at least 38 mm (1.5 inches). This minimum radius must extend to at least forty-five degrees (45°) relative to the forward direction, along the top, sides and bottom of all affected edges.

B3.24 Side Impact Structure for Tube Frame Cars

The Side Impact Structure must meet the requirements listed below.

- B3.24.1 The Side Impact Structure for tube frame cars must be comprised of at least three (3) tubular members located on each side of the driver while seated in the normal driving position, as shown in Figure 7.
- B3.24.2 The three (3) required tubular members must be constructed of material per Section B.3.3.1.

B3.24.3 The locations for the three (3) required tubular members are as follows:

- The upper Side Impact Structural member must connect the Main Hoop and the Front Hoop. With a 77kg (170 pound) driver seated in the normal driving position *all of the member must be at a height between 300 mm (11.8 inches) and 350 mm (13.8 inches) above the ground.* The upper frame rail may be used as this member if it meets the height, diameter and thickness requirements.
- The lower Side Impact Structural member must connect the bottom of the Main Hoop and the bottom of the Front Hoop. The lower frame rail/frame member may be this member if it meets the diameter and wall thickness requirements.
- The diagonal Side Impact Structural member must connect the upper and lower Side Impact Structural members forward of the Main Hoop and rearward of the Front Hoop.

B3.24.4 With proper gusseting and/or triangulation, it is permissible to fabricate the Side Impact Structural members from more than one piece of tubing.

B3.24.5 Alternative geometry that does not comply with the minimum requirements given above requires an approved “Structural Equivalency Spreadsheet” per Rule B3.8.

B3.25 Inspection Holes

B3.25.1 The Technical Inspectors may check the compliance of all tubes. This may be done by the use of ultra-sonic testing or by the drilling of inspection holes at the inspector’s request.

B3.26 Monocoque General Requirements

All equivalency calculations must prove equivalency relative to steel grade SAE/AISI 1010.

B3.26.1 All sections of the rules apply to monocoque structures except for the following sections which supplement or supersede other rule sections.

B3.26.2 Monocoque construction requires an approved Structural Equivalency Spreadsheet, per Section B3.8. The form must demonstrate that the design is equivalent to a welded frame in terms of energy dissipation, yield and ultimate strengths in bending, buckling and tension. Information must include: material type(s), cloth weights, resin type, fiber orientation, number of layers, core material, and lay-up technique. The 3 point bend test and shear test data and pictures must also be included as per B3.28 Monocoque Laminate Testing. The Structural Equivalency must address each of the items below. Data from the laminate testing results must be used as the basis for any strength or stiffness calculations.

B3.26.3 Composite and metallic monocoques have the same requirements.

B3.26.4 Composite monocoques must meet the materials requirements in Rule B3.7 Composite Materials.

B3.27 Monocoque Buckling Modulus – Equivalent Flat Panel Calculation

When specified in the rules, the EI of the monocoque must be calculated as the EI of a flat panel with the same composition as the monocoque about the neutral axis of the laminate. The curvature of the panel and geometric cross section of the monocoque must be ignored for these calculations.

Note: Calculations of EI that do not reference B3.27 may take into account the actual geometry of the monocoque.

B3.28 Monocoque Laminate Testing

Teams must build a representative section of the monocoque side impact zone (defined in B3.31) side as a flat panel and perform a 3 point bending test on this panel. They must prove by physical test that a section 200mm (7.9 inches) x 500 mm (19.7 inches) has at least the same properties as a baseline steel side impact tube (See B3.3.1 “Baseline Steel Materials”) for bending stiffness and two side impact tubes for yield and ultimate strength. The data from these tests and pictures of the test samples must be included in the SES. The test specimen must be presented at technical inspection. If the test specimen does not meet these requirements then the monocoque side impact zone must be strengthened appropriately.

Note: Teams are advised to make an equivalent test with the base line steel tubes such that any compliance in the test rig can be accounted for.

B3.29 Monocoque Front Bulkhead

See Rule B3.26 for general requirements that apply to all aspects of the monocoque. In addition when modeled as a flat plate the EI of the front bulkhead about both vertical and lateral axis must be equivalent to that of the tubes specified for the front bulkhead under B3.18. Furthermore any front bulkhead which supports the IA plate must have a perimeter shear strength equivalent to a 1.5 mm thick steel plate.

B3.30 Monocoque Front Bulkhead Support

B3.30.1 In addition to proving that the strength of the monocoque is adequate, the monocoque must have equivalent EI to the sum of the EI of the six (6) baseline steel tubes that it replaces.

B3.30.2 The EI of the vertical side of the front bulkhead support structure must be equivalent to at least the EI of one baseline steel tube that it replaces when calculated as per rule B3.27 Monocoque Buckling Modulus.

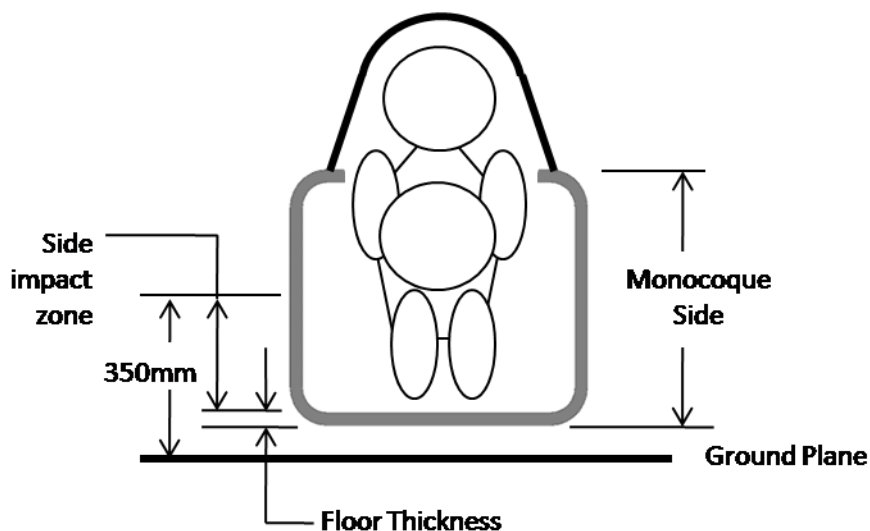
B3.30.3 The perimeter shear strength of the monocoque laminate in the front bulkhead support structure should be at least 4kN (880 pounds) for a section with a diameter of 25 mm (1 inch). This must be proven by a physical test by measuring the force required to pull or push a 25mm (1 inch) diameter object through a sample of laminate and the results include in the SES

B3.31 Monocoque Side Impact

B3.31.1 In addition to proving that the strength of the monocoque is adequate, the side of the monocoque must have equivalent EI to the sum of the EI of the three (3) baseline steel tubes that it replaces.

B3.31.2 The side of the monocoque between the upper surface of the floor and 350 mm (13.8 inches) above the ground (Side Impact Zone) must have an EI of at least 50% of the sum of the EI of the three (3) baseline steel tubes that it replaces when calculated as per Rule B3.27 Monocoque Buckling Modulus.

B3.31.3 The perimeter shear strength of the monocoque laminate should be at least 7.5 kN (1700 pounds) for a section with a diameter of 25 mm (1 inch). This must be proven by physical test by measuring the force required to pull or push a 25 mm (1 inch) diameter object through a sample of laminate and the results included in the SES.



B3.32 Monocoque Main Hoop

- B3.32.1 The Main Hoop must be constructed of a single piece of uncut, continuous, closed section steel tubing per B3.3.1 and extend down to the bottom of the monocoque.
- B3.32.2 The Main Hoop must be mechanically attached at the top and bottom of the monocoque and at intermediate locations as needed to show equivalency.
- B3.32.3 Mounting plates welded to the Roll Hoop shall be at least 2.0 mm (0.080 inch) thick steel.
- B3.32.4 Attachment of the Main Hoop to the monocoque must comply with B3.37.

B3.33 Monocoque Front Hoop

- B3.33.1 Composite materials are not allowed for the front hoop. See Rule B3.26 for general requirements that apply to all aspects of the monocoque.
- B3.33.2 Attachment of the Front Hoop to the monocoque must comply with Rule B3.37.

B3.34 Monocoque Front and Main Hoop Bracing

- B3.34.1 See Rule B3.26 for general requirements that apply to all aspects of the monocoque.
- B3.34.2 Attachment of tubular Front or Main Hoop Bracing to the monocoque must comply with Rule B3.37.

B3.35 Monocoque Impact Attenuator Attachment

The attachment of the Impact Attenuator to a monocoque structure requires an approved "Structural Equivalency Spreadsheet" per Rule B3.8 that shows the equivalency to a minimum of four (4) 8 mm Metric Grade 8.8 (5/16 inch SAE Grade 5) bolts.

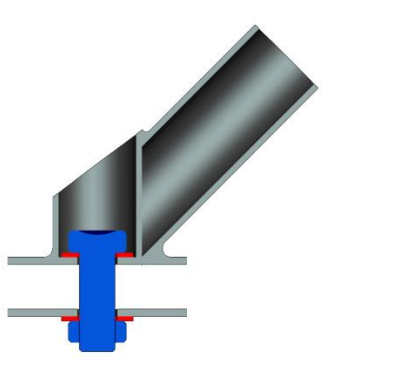
B3.36 Monocoque Impact Attenuator Anti-intrusion Plate

See Rule B3.26 for general requirements that apply to all aspects of the monocoque and Rule B3.20.6 for alternate anti-intrusion plate designs.

B3.37 Monocoque Attachments

- B3.37.1 In any direction, each attachment point between the monocoque and the other primary structure must be able to carry a load of 30kN.

- B3.37.2 The laminate, mounting plates, backing plates and inserts must have sufficient shear area, weld area and strength to carry the specified 30kN load in any direction. Data obtained from the laminate perimeter shear strength test (B3.31.3) should be used to prove adequate shear area is provided
- B3.37.3 Each attachment point requires a minimum of two (2) 8 mm Metric Grade 8.8 (5/16 inch SAE Grade 5) bolts
- B3.37.4 Each attachment point requires steel backing plates with a minimum thickness of 2 mm. Alternate materials may be used for backing plates if equivalency is approved.
- B3.37.5 The Front Hoop Bracing, Main Hoop Bracing and Main Hoop Bracing Supports only may use one (1) 10 mm Metric Grade 8.8 (3/8 inch SAE Grade 5) bolt as an alternative to B3.37.3 if the bolt is on the centerline of tube similar to the figure below.



- B3.37.6 No crushing of the core is permitted
- B3.37.7 Main Hoop bracing attached to a monocoque (i.e. not welded to a rear space frame) is always considered “mechanically attached” and must comply with Rule B3.16.
- B3.38 Monocoque Driver’s Harness Attachment Points**
- B3.38.1 The monocoque attachment points for the shoulder and lap belts must support a load of 13 kN (~3000 pounds) before failure.
- B3.38.2 The monocoque attachment points for the ant-submarine belts must support a load of 6.5 kN (~1500 pounds) before failure.
- B3.38.3 If the lap belts and anti-submarine belts are attached to the same attachment point, then this point must support a load of 19.5 kN (~4500 pounds) before failure.
- B3.38.4 The strength of lap belt attachment and shoulder belt attachment must be proven by physical test where the required load is applied to a representative attachment point where the proposed layup and attachment bracket is used.

ARTICLE 4: COCKPIT

B4.1 Cockpit Opening

- B4.1.1 In order to ensure that the opening giving access to the cockpit is of adequate size, a template shown in Figure 8 will be inserted into the cockpit opening. It will be held horizontally and inserted vertically until it has passed below the top bar of the Side Impact Structure (or until it is 350 mm (13.8 inches)

above the ground for monocoque cars). No fore and aft translation of the template will be permitted during insertion.

- B4.1.2 During this test, the steering wheel, steering column, seat and all padding may be removed. The firewall may not be moved or removed.

B4.2 Cockpit Internal Cross Section:

- B4.2.1 A free vertical cross section, which allows the template shown in Figure 9 to be passed horizontally through the cockpit to a point 100 mm (4 inches) rearwards of the face of the rearmost pedal when in the inoperative position, must be maintained over its entire length. If the pedals are adjustable, they will be put in their most forward position.
- B4.2.2 The template, with maximum thickness of 7mm (0.275 inch), will be held vertically and inserted into the cockpit opening rearward of the Front Roll Hoop, as close to the Front Roll Hoop as the car's design will allow.
- B4.2.3 The only items that may be removed for this test are the steering wheel, and any padding required by Rule B5.7 "Driver's Leg Protection" that can be easily removed without the use of tools with the driver in the seat. The seat may NOT be removed.
- B4.2.4 Teams whose cars do not comply with B4.1 or B4.2 will not be given a Technical Inspection Sticker and will NOT be allowed to compete in the dynamic events.

Note: Cables, wires, hoses, tubes, etc. must not impede the passage of the templates required by B4.1 and B4.2.

B4.3 Driver's Seat

- B.4.3.1 The lowest point of the driver's seat must be no lower than the bottom surface of the lower frame rails or by having a longitudinal tube (or tubes) that meets the requirements for Side Impact tubing, passing underneath the lowest point of the seat.
- B.4.3.2 When seated in the normal driving position, adequate heat insulation must be provided to ensure that the driver will not contact any metal or other materials which may become heated to a surface temperature above sixty degrees C (60°C). The insulation may be external to the cockpit or incorporated with the driver's seat or firewall. The design must show evidence of addressing all three (3) types of heat transfer, namely conduction, convection and radiation, with the following between the heat source, e.g. an exhaust pipe or coolant hose/tube and the panel that the driver could contact, e.g. the seat or floor:
 - a. Conduction Isolation by:
 - i. No direct contact between the heat source and the panel, or
 - ii. A heat resistant, conduction isolation material with a minimum thickness of 8 mm (0.3 in) between the heat source and the panel.
 - b. Convection Isolation by a minimum air gap of 25 mm (1 inch) between the heat source and the panel
 - c. Radiation Isolation by:
 - i. A solid metal heat shield with a minimum thickness of 0.4 mm (0.015 in) or
 - ii. Reflective foil or tape when combined with a.ii above.

B4.4 Floor Close-out

All vehicles must have a floor closeout made of one or more panels, which separate the driver from the pavement. If multiple panels are used, gaps between panels are not to exceed 3 mm (1/8 inch). The

closeout must extend from the foot area to the firewall and prevent track debris from entering the car. The panels must be made of a solid, non-brittle material.

B4.5 Firewall

- B4.5.1 A firewall must separate the driver compartment from all components of the fuel supply, the engine oil and the liquid cooling systems. It must protect the neck of the tallest driver. It must extend sufficiently far upwards and/or rearwards such that any point less than 100 mm (4 ins.) above the bottom of the helmet of the tallest driver shall not be in direct line of sight with any part of the fuel system, the cooling system or the engine oil system.
- B4.5.2 The firewall must be a non-permeable surface made from a rigid, fire resistant material.
- B4.5.3 Any firewall must seal completely against the passage of fluids, especially at the sides and the floor of the cockpit, i.e. there can be no holes in a firewall through which seat belts pass.
- B4.5.4 Pass-throughs for wiring, cables, etc. are allowable if grommets are used to seal the pass-throughs. Also, multiple panels may be used to form the firewall but must be sealed at the joints.

B4.6 Accessibility of Controls

All vehicle controls, including the shifter, must be operated from inside the cockpit without any part of the driver, e.g. hands, arms or elbows, being outside the planes of the Side Impact Structure defined in Rule B3.24 and B3.31.

B4.7 Driver Visibility

B4.7.1 General Requirement

The driver must have adequate visibility to the front and sides of the car. With the driver seated in a normal driving position he/she must have a minimum field of vision of two hundred degrees (200°) (a minimum one hundred degrees (100°) to either side of the driver). The required visibility may be obtained by the driver turning his/her head and/or the use of mirrors.

B4.7.2 Mirrors

If mirrors are required to meet Rule B4.7.1, they must remain in place and adjusted to enable the required visibility throughout all dynamic events.

B4.8 Driver Egress

All drivers must be able to exit to the side of the vehicle in no more than 5 seconds. Egress time begins with the driver in the fully seated position, hands in driving position on the connected steering wheel and wearing the required driver equipment. Egress time will stop when the driver has both feet on the pavement.

ARTICLE 5: DRIVERS EQUIPMENT (BELTS AND COCKPIT PADDING)

B5.1 Belts - General

B5.1.1 Definitions

- a. A 5-point system – consists of a 76 mm (3 inch) wide lap belt, approximately 76 mm (3 inch) wide shoulder straps and a single approximately 51 mm (2 inch) wide anti-submarine strap. The single anti-submarine strap must have a metal-to-metal connection with the single release common to the lap belt and shoulder harness.
- b. A 6-point system – consists of a 76 mm (3 inch) wide lap belt, approximately 76 mm (3 inch) wide shoulder straps and two (2) approximately 51 mm (2 inch) wide leg or anti-submarine straps.

TECHNICAL DRAWINGS

The figures referenced in Part B “Technical Requirements” follow this page.

HELMET CLEARANCE

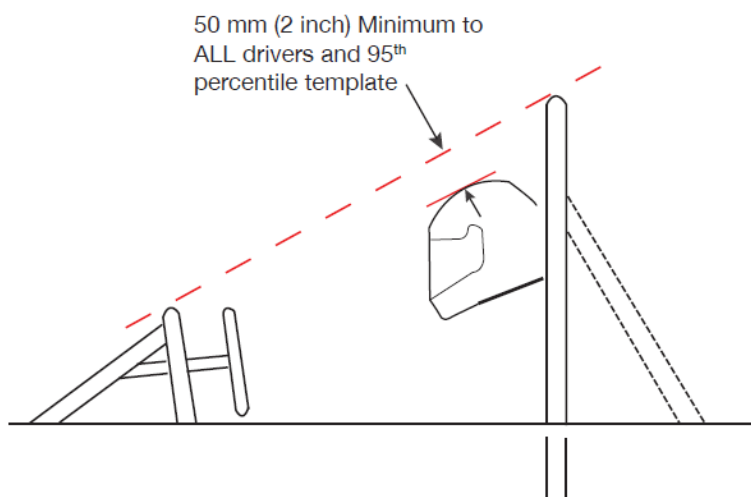


FIGURE 1a

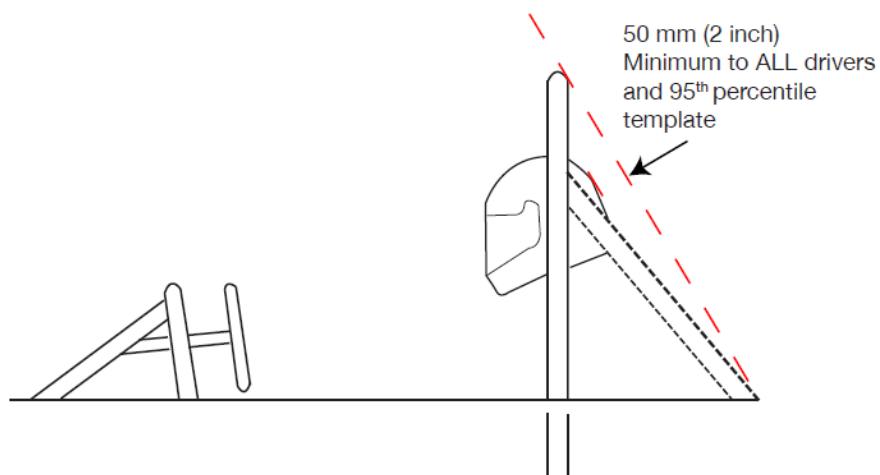


FIGURE 1b

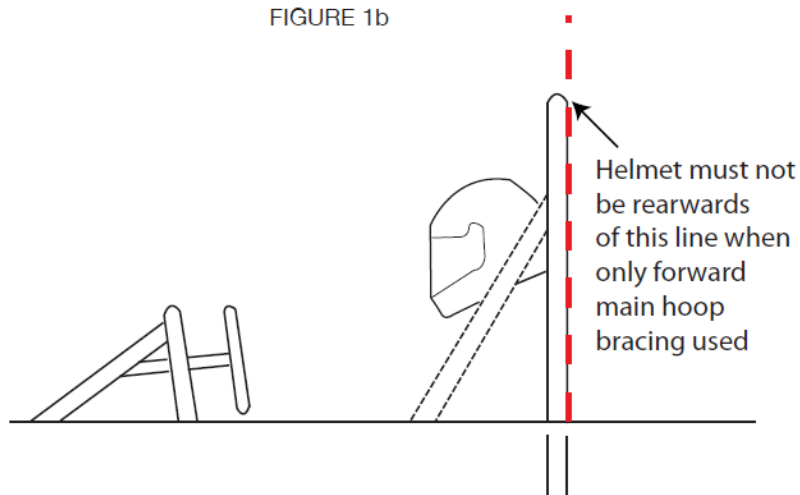
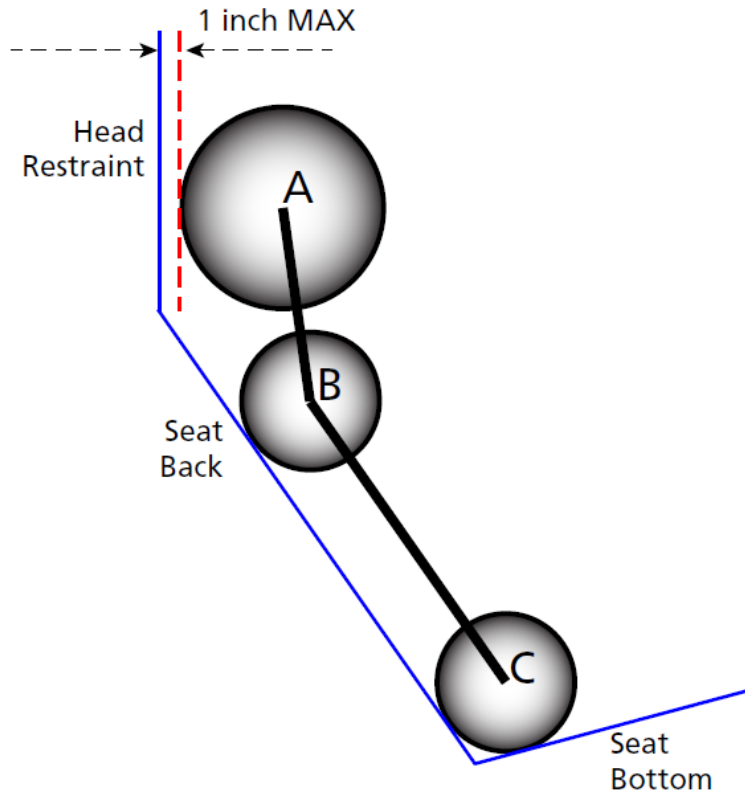


FIGURE 1c

"Percy" – 95th Percentile Male with Helmet



Circle A = Head with helmet – 300 mm diameter

Circle B = Shoulders – 200 mm diameter

Circle C = Hips and buttocks – 200 mm diameter

Line A-B = 280 mm from centerpoint to centerpoint

Line B-C = 490 mm from centerpoint to centerpoint

FIGURE 2

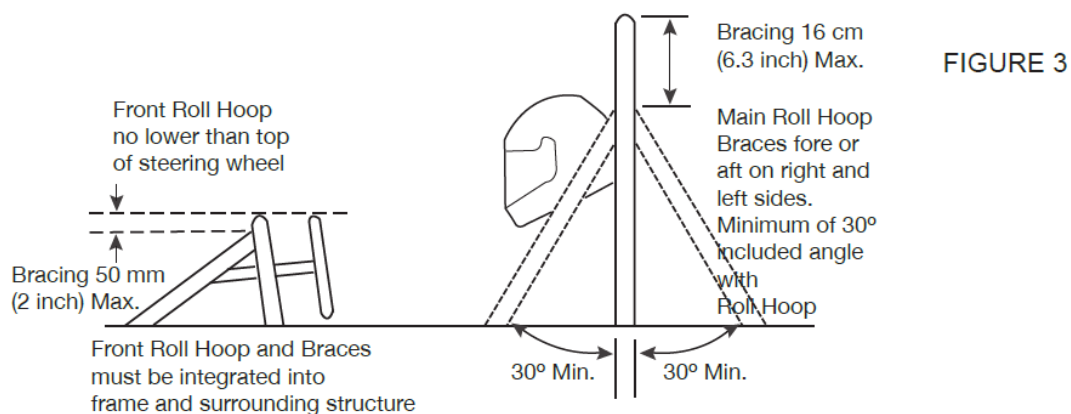


FIGURE 3

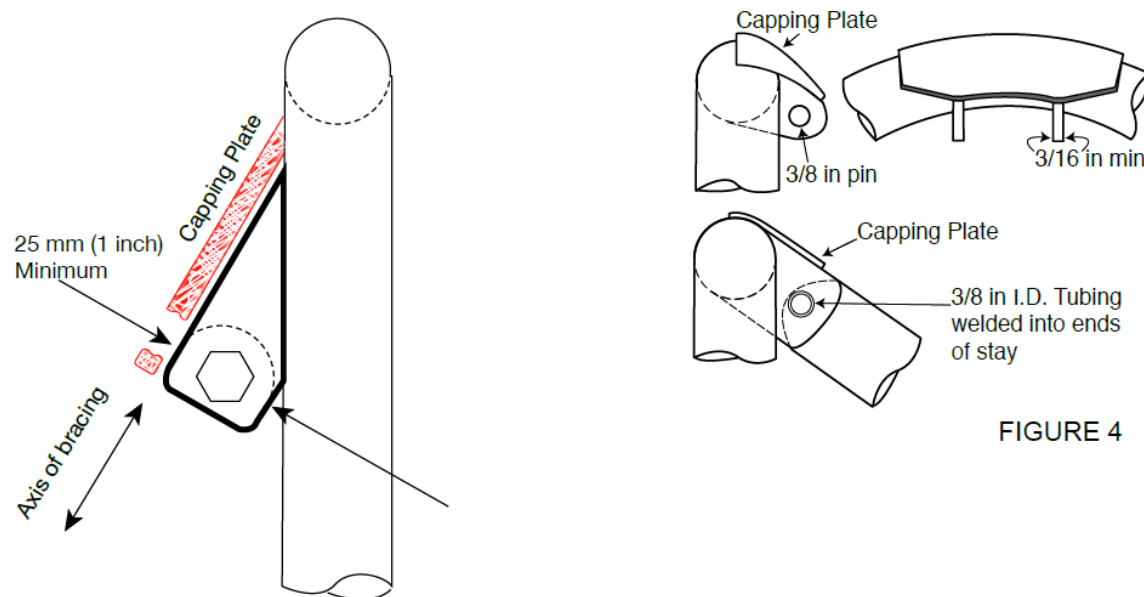


FIGURE 4

FIGURE 5

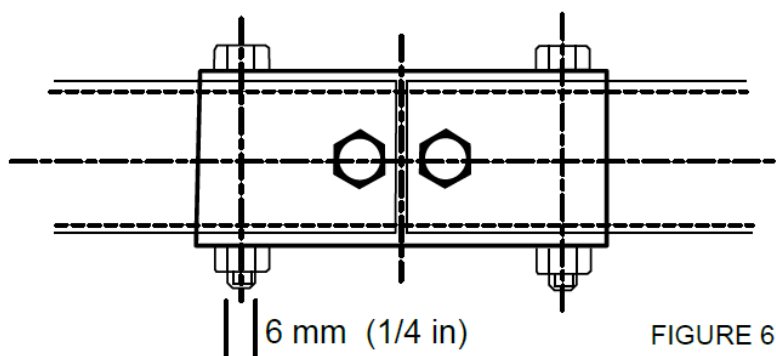


FIGURE 6

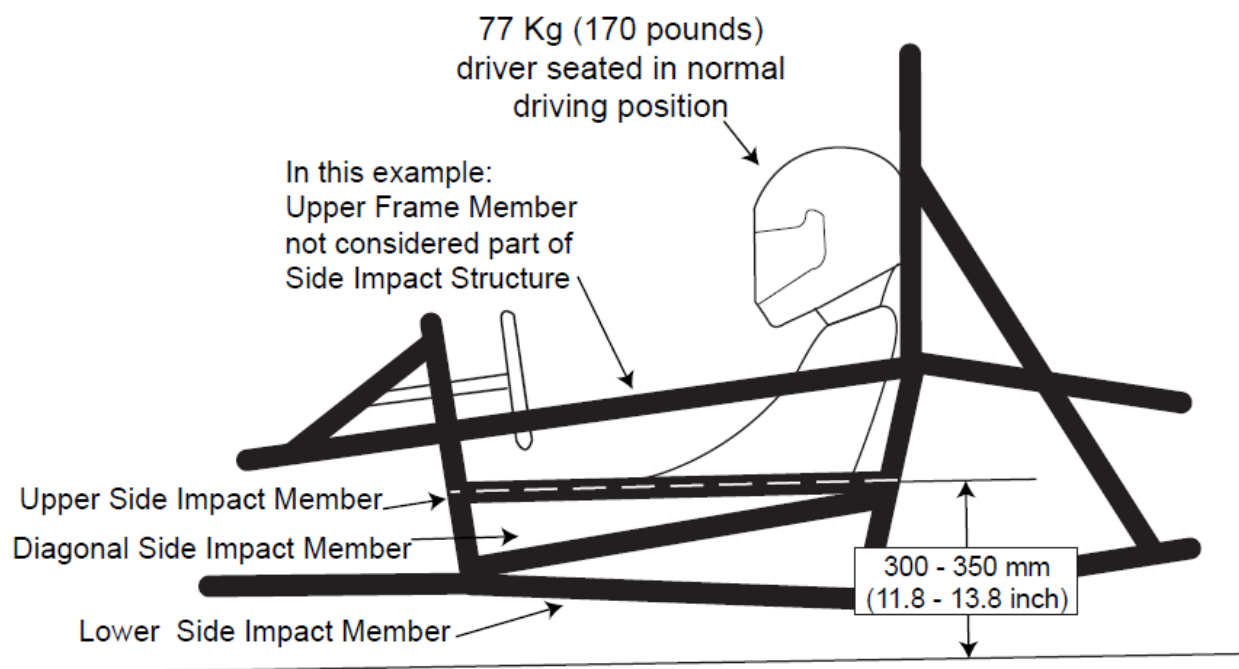


FIGURE 7

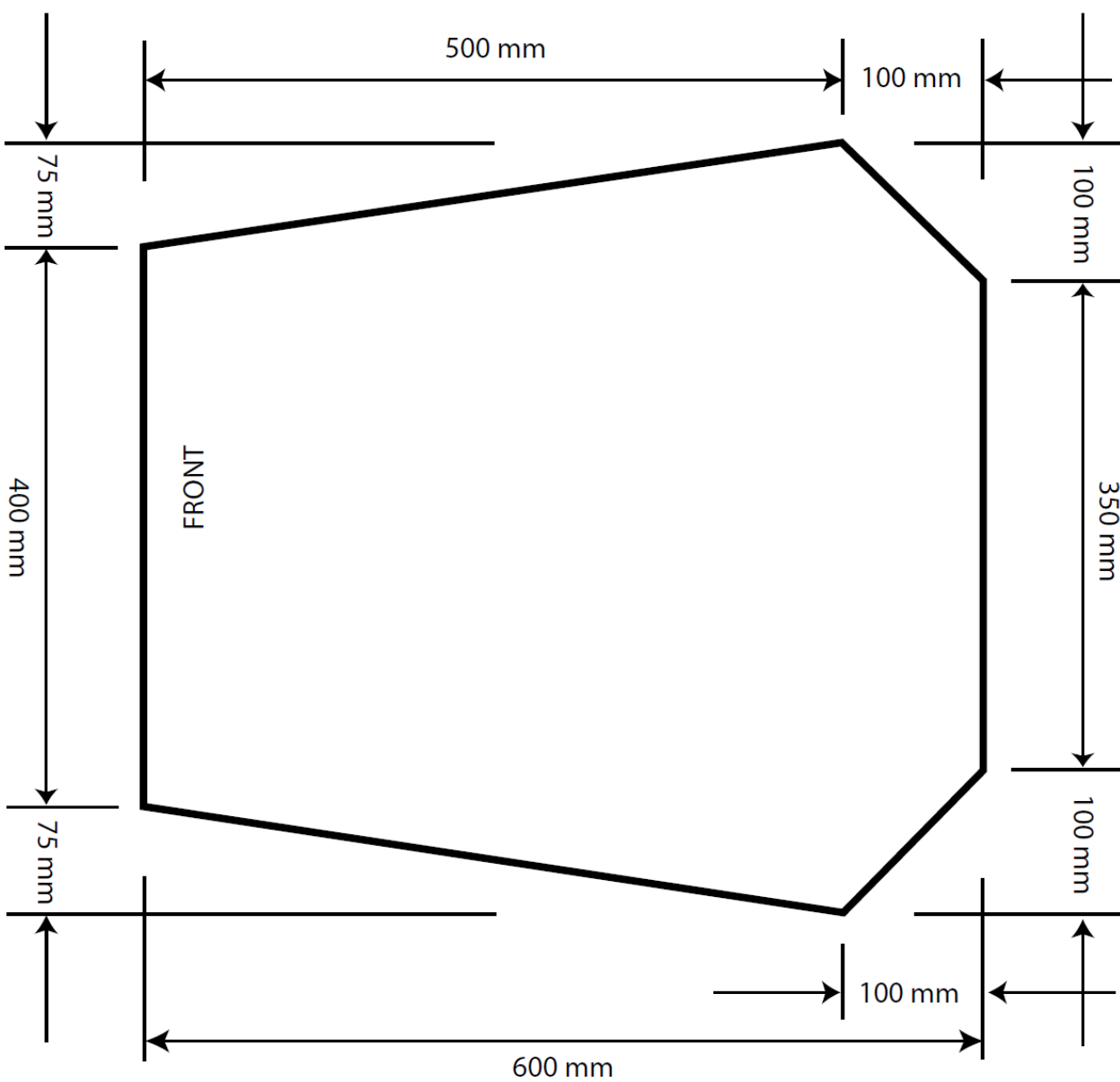


FIGURE 8

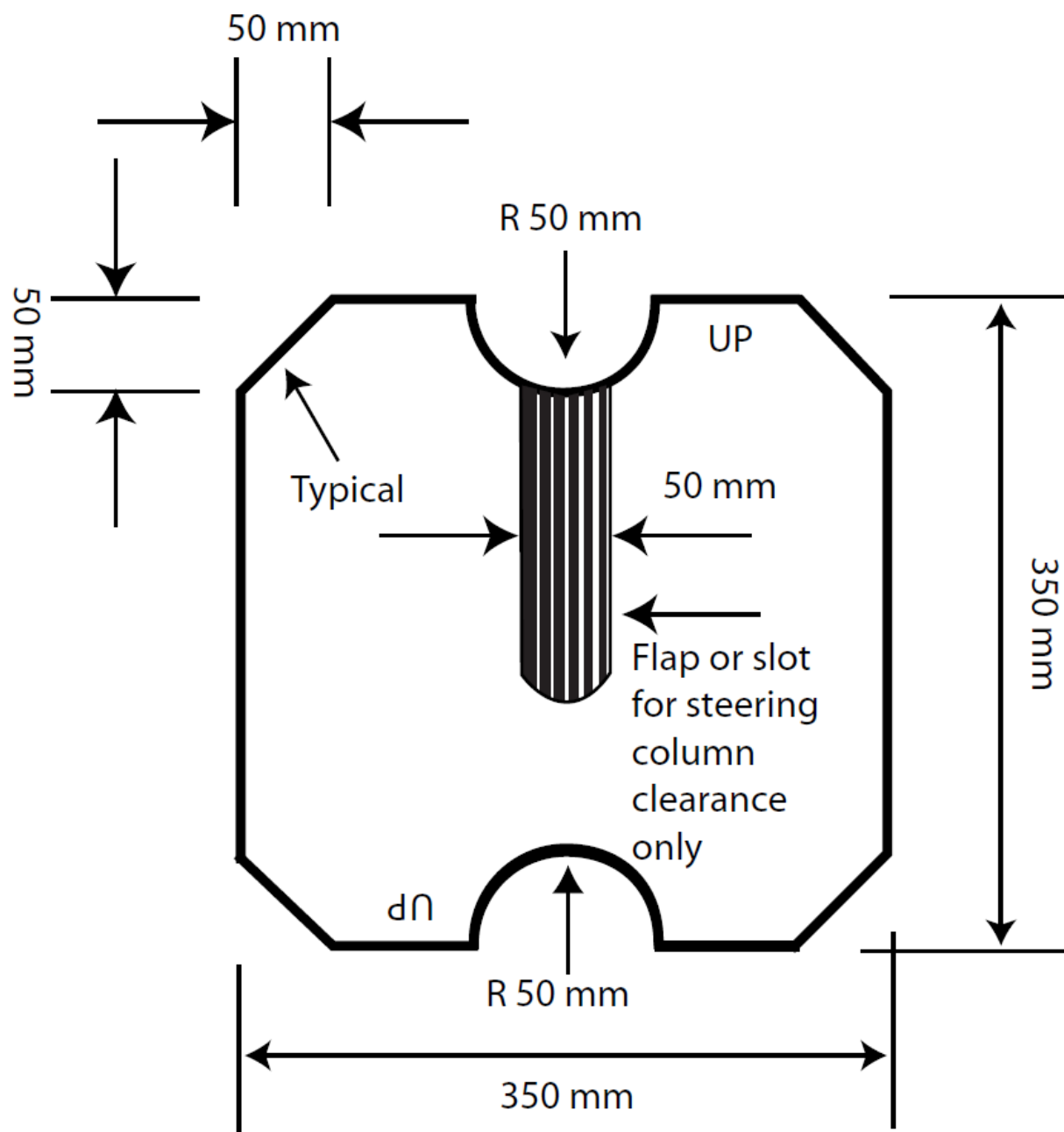


FIGURE 9

FIGURE 10

Lap Belt Angle

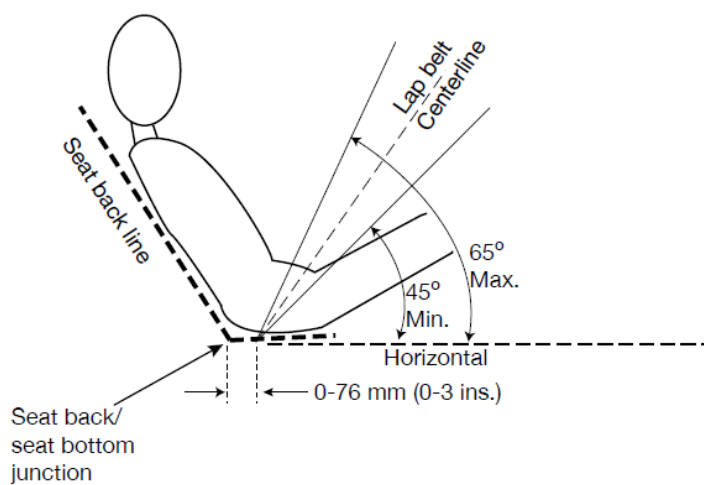


FIGURE 11

Shoulder Harness Mounting Points

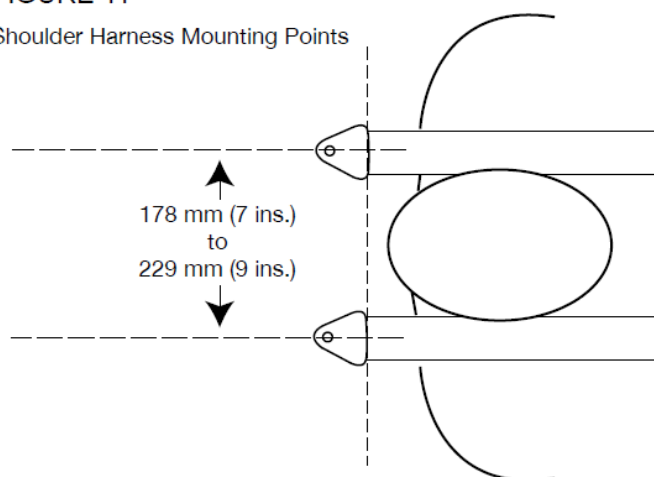
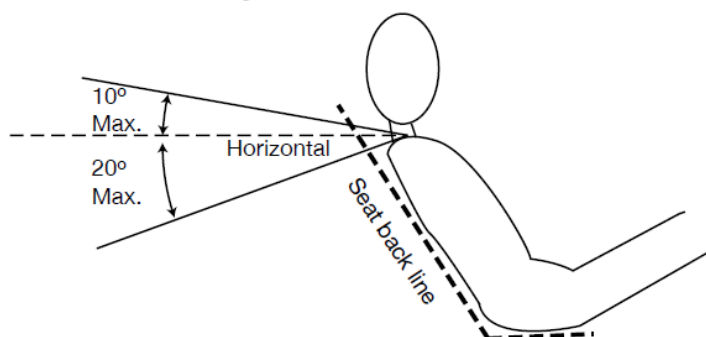


FIGURE 12

Shoulder Harness Angle



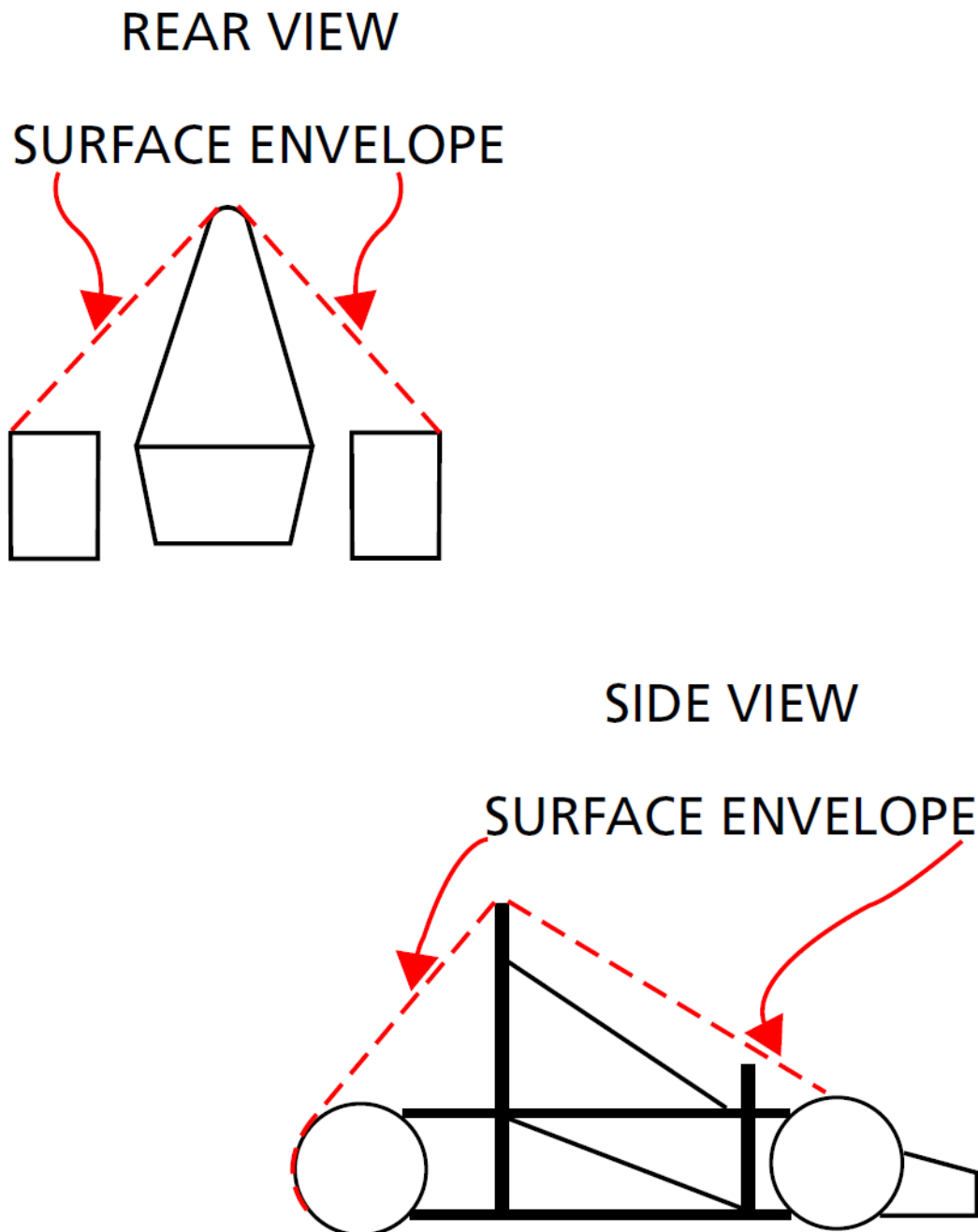


FIGURE 13

Appendix B

Wheatstone bridge

Appendix B briefly describes the Wheatstone bridge and the application of the circuit in conjunction with strain gauges. It explains the technique that was used in this study, together with the accompanying formula.

The Wheatstone bridge

The Wheatstone bridge is an electrical circuit that is used to determine the change in resistance when a strain gauge is subjected to strain. The bridge allows the output voltage to be measured which is then related to strain. Wheatstone bridges are available for a variety of strain gauge measurements and applications. The bridge circuit (Figure B-) consists of a network of four resistors. Sensing elements can be used in one or more of the resistors (Dally & Riley, 1965).

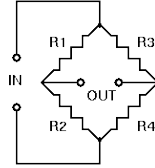


Figure B-1: Schematic illustration of a Wheatstone bridge

The Wheatstone bridge concept is used for sensing physical phenomena such as strain and temperature variations. It is very useful for measuring small variations in resistance. Strain gauge configurations are generally integrated in Wheatstone bridges. Three types of strain gauge configurations are commonly used with the Wheatstone bridge, namely a quarter-bridge, half-bridge and full-bridge. The number of active elements in a bridge defines the bridge configuration. (National Instruments, 2013)

Table B-1: Wheatstone bridge configurations

Configuration	Active Elements
Quarter-bridge	1
Half-bridge	2
Full-bridge	4

Because of the equipment available in this study, the quarter bridge was used. This implies that only one strain gauge was used in each Wheatstone bridge as seen in Figure B-2.

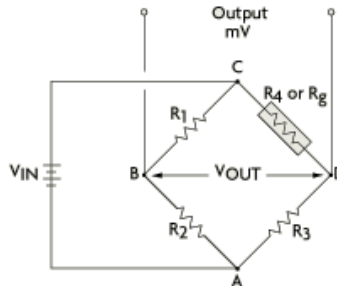


Figure B-2: Illustration of a strain gauge within a quarter Wheatstone bridge configuration

Four Wheatstone bridges were used for the cluster of strain gauges, with each strain gauge having its own channel. The voltage-strain relationship for this configuration is given by

$$\frac{U_{out}}{U_{EXC}} = \frac{k \cdot \varepsilon}{4000}$$

where U_{out}/U_{EXC} is the measured voltage signal; k is the strain gauge factor and ε the strain.

Appendix C

Strain gauge certificate

Appendix C includes the strain gauge certificate of the strain gauge used in this study. The certificate contains values and parameters required for the experimental calculations.



**Dehnmessstreifen
Strain gages
Jauges d'extensométrie**

Bestellnummer
Order No.
No. de référence

1-EDUCATION-GAGE

Typ
Type
Type

6/350 LY41

Stückzahl
Contents
Quantité

100

Temperaturkoeffizient
des k-Faktors
Temperature coefficient
of gage factor
Coefficient de température
du facteur k

$0 \pm 0 [10^{-6} / ^\circ\text{C}]$

(0)

Folienlos
Lot
Lot de la feuille

For education

Herstellungslos
Batch
Lot de fabrication

812050451

$\alpha = 0,0 [10^{-6} / ^\circ\text{C}]$

Widerstand
Resistance
Résistance

$350 \Omega \pm 0,30 \%$

k-Faktor
Gage factor
Facteur k

$2,03 \pm 1,0 \%$

Querempfindlichkeit
Transverse sensitivity
Sensibilité transverse

$-0,4 \%$

Temperaturkompensation: Angepasst für
Temperature compensation: Compensated for
Compensation de température: Compensation pour

Ferritischen Stahl mit
steel with
acier avec

Daten / Data / Données

Alle technischen Daten nach OIML IR 62, bei Beachtung der abweichenden Toleranzangaben auch nach VDI/VDE 2635. Geben Sie bei Rückfragen bitte Bestellnummer und Herstellungs-Los an.

All specifications in accordance with OIML IR 62, also compliant with VDI/VDE 2635 if deviating tolerances are observed. In case of further inquiries please indicate order no. and batch number.

Toutes caractéristiques techniques selon OIML IR 62 et VDI/VDE 2635 pour les indications différentes de tolérance. Pour toutes questions, indiquer le no. de référence ainsi que le lot de fabrication.

Kopfdaten / Header / Titre



Protokoll zur DMS-Installation
Report on strain gage installation
Rapport d'installation de jauges

Installation ausgeführt:

Installation done by:

Installation réalisée par :

Datum:

Date:

Date :

Messobjekt:

Measuring object:

Objet équipé :

Installationsbedingungen:

Conditions of installation:

Conditions d'installation des jauges :

Klebstoff:

Adhesive:

Adhésif :

Verschaltung:

Electrical connection:

Raccordement électrique :

Optische Messstellenprüfung:

Optical inspection of the installation:

Contrôle optique de l'installation :

Elektrische Messstellenprüfung:

Electrical inspection of the
installation:

Contrôle électrique de
l'installation :

Isolationswiderstand:

Insulation resistance:

Résistance d'isolement :

Durchgangswiderstand:

Current-flow resistance:

Résistance actuelle :

Schutzabdeckung:

Protective coating:

Produit de protection :

Bemerkungen:

Comments:

Commentaires :

Hottinger Baldwin Messtechnik GmbH

Im Tiefen See 45 · D-64293 Darmstadt · Germany
Tel.: +49 6151 8030 · Fax: +49 6151 803 9100
E-Mail: info@hbm.com · www.hbm.com

measure and predict with confidence



Appendix D

Simulation and experimental data

Appendix D comprises of all the generated data of the simulation and experimental procedures. Numerous tests were carried out for each experiment, which include the data of the weight, longitudinal centre of gravity, torsional stiffness and the chassis stress tests.

Chassis weight and centre of gravity

Simulation data

Chassis weight [kg]	33.075
Longitudinal centre of gravity [mm]	1269.50

Experimental data

Weight [kg]	
Run 1	33.35
Run 2	33.32
Run 3	33.30
Run 4	33.38
Run 5	33.37
Run 6	33.37
Run 7	33.40
Run 8	33.40
Run 9	33.37
Run 10	33.40
Average	33.37

Longitudinal centre of gravity [mm]	
Run 1	1255.60
Run 2	1255.70
Run 3	1255.65
Run 4	1255.71
Run 5	1255.64
Run 6	1255.62
Run 7	1255.70
Run 8	1255.68
Run 9	1255.68
Run 10	1255.67
Average	1255.67

Chassis torsional stiffness

Simulation data

Torsion T [N.m]	y_1 [mm]	y_2 [mm]	Angular Disp. θ [degrees]	Stiffness K _T [N.m/deg]
34.335	0.2459	-0.1973	0.07255	473.242
68.670	0.4918	-0.3947	0.14512	473.189
103.005	0.7376	-0.5920	0.21766	473.244
137.340	0.9835	-0.7893	0.29021	473.245
171.675	1.2290	-0.9866	0.36269	473.333
206.010	1.4750	-1.1840	0.43528	473.286
240.345	1.7210	-1.3810	0.50779	473.315
274.680	1.9670	-1.5790	0.58047	473.204
309.015	2.2130	-1.7760	0.65298	473.238
343.350	2.4590	-1.9730	0.72549	473.267
377.685	2.7050	-2.1710	0.79816	473.194
412.020	2.9510	-2.3680	0.87067	473.224
446.355	3.1960	-2.5650	0.94300	473.333
480.690	3.4420	-2.7630	1.01567	473.276
515.025	3.6880	-2.9600	1.08816	473.298
549.360	3.9340	-3.1570	1.16065	473.319
583.695	4.1800	-3.3550	1.23331	473.277
618.030	4.4260	-3.5520	1.30579	473.300
652.365	4.6720	-3.7490	1.37827	473.321
686.700	4.9180	-3.9470	1.45091	473.289
721.035	5.1640	-4.1440	1.52338	473.312

Experimental test data

RUN 1		CHASSIS ANGULAR DISPLACEMENT										
Weight [kg]	Torsion [N.m]	y_1 [mm] FRONT	y_2 [mm] FRONT	x_1 [mm] REAR	x_2 [mm] REAR	y_delta [mm]	Angular Disp. [radians] (y_delta)	Angular Disp. [degrees] FRONT	x_delta [mm]	Angular Disp. [radians] (x_delta)	Angular Disp. [degrees] REAR	Angular Disp. [degrees] (TOTAL)
2.5	24.53	0.09	-0.05	0.015	-0.015	0.14	0.00037	0.02111	0.03	0.00004	0.00246	0.0187
6.25	61.31	0.235	-0.25	0.04	-0.04	0.49	0.00128	0.07313	0.08	0.00011	0.00655	0.0666
10	98.10	0.38	-0.42	0.08	-0.08	0.80	0.00211	0.12062	0.16	0.00023	0.01310	0.1075
15	147.15	0.58	-0.64	0.14	-0.12	1.22	0.00321	0.18395	0.26	0.00037	0.02128	0.1627
20	196.20	0.96	-0.91	0.28	-0.25	1.87	0.00492	0.28195	0.53	0.00076	0.04338	0.2386
25	245.25	1.15	-1.23	0.53	-0.5	2.38	0.00626	0.35885	1.03	0.00147	0.08431	0.2745
30	294.30	1.455	-1.5	0.755	-0.705	2.96	0.00778	0.44554	1.46	0.00209	0.11950	0.3260
35	343.35	1.8	-1.91	1.02	-0.95	3.71	0.00976	0.55937	1.97	0.00281	0.16125	0.3981
40	392.40	2.18	-2.3	1.25	-1.24	4.48	0.01179	0.67546	2.49	0.00356	0.20381	0.4716
42.5	416.93	2.34	-2.47	1.45	-1.38	4.81	0.01266	0.72521	2.83	0.00404	0.23164	0.4936
45	441.45	2.53	-2.67	1.61	-1.53	5.20	0.01368	0.78400	3.14	0.00449	0.25701	0.5270
47.5	465.98	2.73	-2.89	1.8	-1.71	5.62	0.01479	0.84731	3.51	0.00501	0.28730	0.5600
50	490.50	2.9	-3.06	1.94	-1.85	5.96	0.01568	0.89857	3.79	0.00541	0.31021	0.5884

RUN 2		CHASSIS ANGULAR DISPLACEMENT										
Weight [kg]	Torsion, T [N.m]	y_1 [mm] FRONT	y_2 [mm] FRONT	x_1 [mm] REAR	x_2 [mm] REAR	y_delta [mm]	Angular Disp. [radians] (y_delta)	Angular Disp. [degrees] FRONT	x_delta [mm]	Angular Disp. [radians] (x_delta)	Angular Disp. [degrees] REAR	Angular Disp. [degrees] (TOTAL)
2.5	24.53	0.09	-0.11	0.015	-0.01	0.20	0.00053	0.03016	0.025	0.00004	0.00205	0.0281
6.25	61.31	0.23	-0.28	0.045	-0.04	0.51	0.00134	0.07690	0.085	0.00012	0.00696	0.0699
10	98.10	0.37	-0.48	0.08	-0.07	0.85	0.00224	0.12816	0.15	0.00021	0.01228	0.1159
15	147.15	0.58	-0.685	0.14	-0.12	1.27	0.00333	0.19073	0.26	0.00037	0.02128	0.1695
20	196.20	0.85	-0.98	0.31	-0.28	1.83	0.00482	0.27592	0.59	0.00084	0.04829	0.2276
25	245.25	1.14	-1.29	0.53	-0.51	2.43	0.00639	0.36639	1.04	0.00149	0.08513	0.2813
30	294.30	1.46	-1.64	0.77	-0.71	3.10	0.00816	0.46740	1.48	0.00211	0.12114	0.3463
35	343.35	1.79	-1.975	1.01	-0.94	3.77	0.00991	0.56766	1.95	0.00279	0.15961	0.4081
40	392.40	2.12	-2.325	1.27	-1.22	4.45	0.01170	0.67018	2.49	0.00356	0.20381	0.4664
42.5	416.93	2.3	-2.53	1.42	-1.34	4.83	0.01271	0.72822	2.76	0.00394	0.22591	0.5023
45	441.45	2.475	-2.7	1.56	-1.47	5.18	0.01362	0.78023	3.03	0.00433	0.24801	0.5322
47.5	465.98	2.67	-2.9	1.74	-1.65	5.57	0.01466	0.83978	3.39	0.00484	0.27747	0.5623
50	490.50	2.85	-3.09	1.89	-1.8	5.94	0.01563	0.89555	3.69	0.00527	0.30203	0.5935

Experimental test data (continued)

RUN 3		CHASSIS ANGULAR DISPLACEMENT										
Weight [kg]	Torsion, T [N.m]	y_1 [mm] FRONT	y_2 [mm] FRONT	x_1 [mm] REAR	x_2 [mm] REAR	y_delta [mm]	Angular Disp. [radians] (y_delta)	Angular Disp. [degrees] FRONT	x_delta [mm]	Angular Disp. [radians] (x_delta)	Angular Disp. [degrees] REAR	Angular Disp. [degrees] (TOTAL)
2.5	24.53	0.1	-0.12	0.02	-0.02	0.22	0.00058	0.03317	0.04	0.00006	0.00327	0.0299
6.25	61.31	0.24	-0.28	0.05	-0.05	0.52	0.00137	0.07840	0.1	0.00014	0.00819	0.0702
10	98.10	0.38	-0.43	0.08	-0.08	0.81	0.00213	0.12213	0.16	0.00023	0.01310	0.1090
15	147.15	0.59	-0.66	0.14	-0.12	1.25	0.00329	0.18847	0.26	0.00037	0.02128	0.1672
20	196.20	0.84	-0.92	0.28	-0.26	1.76	0.00463	0.26537	0.54	0.00077	0.04420	0.2212
25	245.25	1.12	-1.22	0.48	-0.45	2.34	0.00616	0.35282	0.93	0.00133	0.07612	0.2767
30	294.30	1.47	-1.6	0.77	-0.71	3.07	0.00808	0.46288	1.48	0.00211	0.12114	0.3417
35	343.35	1.8	-1.925	1.01	-0.94	3.73	0.00980	0.56163	1.95	0.00279	0.15961	0.4020
40	392.40	2.13	-2.27	1.26	-1.18	4.40	0.01158	0.66340	2.44	0.00349	0.19972	0.4637
42.5	416.93	2.315	-2.44	1.38	-1.3	4.76	0.01251	0.71691	2.68	0.00383	0.21936	0.4976
45	441.45	2.465	-2.625	1.53	-1.45	5.09	0.01339	0.76742	2.98	0.00426	0.24391	0.5235
47.5	465.98	2.65	-2.81	1.7	-1.61	5.46	0.01437	0.82319	3.31	0.00473	0.27093	0.5523
50	490.50	2.85	-3.02	1.88	-1.81	5.87	0.01545	0.88500	3.69	0.00527	0.30203	0.5830

RUN 4		CHASSIS ANGULAR DISPLACEMENT										
Weight [kg]	Torsion, T [N.m]	y_1 [mm] FRONT	y_2 [mm] FRONT	x_1 [mm] REAR	x_2 [mm] REAR	y_delta [mm]	Angular Disp. [radians] (y_delta)	Angular Disp. [degrees] FRONT	x_delta [mm]	Angular Disp. [radians] (x_delta)	Angular Disp. [degrees] REAR	Angular Disp. [degrees] (TOTAL)
2.5	24.53	0.06	-0.105	0.02	-0.01	0.17	0.00043	0.02488	0.03	0.00004	0.00246	0.0224
6.25	61.31	0.2	-0.27	0.05	-0.04	0.47	0.00124	0.07087	0.09	0.00013	0.00737	0.0635
10	98.10	0.35	-0.43	0.08	-0.07	0.78	0.00205	0.11761	0.15	0.00021	0.01228	0.1053
15	147.15	0.565	-0.67	0.16	-0.14	1.24	0.00325	0.18621	0.3	0.00043	0.02456	0.1617
20	196.20	0.85	-0.97	0.36	-0.34	1.82	0.00479	0.27441	0.7	0.00100	0.05730	0.2171
25	245.25	1.13	-1.26	0.555	-0.52	2.39	0.00629	0.36036	1.075	0.00154	0.08799	0.2724
30	294.30	1.48	-1.62	0.815	-0.77	3.10	0.00816	0.46740	1.585	0.00226	0.12973	0.3377
35	343.35	1.96	-1.81	1.08	-1.01	3.77	0.00992	0.56842	2.09	0.00299	0.17107	0.3973
40	392.40	2.14	-2.31	1.33	-1.25	4.45	0.01171	0.67093	2.58	0.00369	0.21117	0.4598
42.5	416.93	2.32	-2.49	1.47	-1.41	4.81	0.01266	0.72521	2.88	0.00411	0.23573	0.4895
45	441.45	2.5	-2.675	1.615	-1.54	5.18	0.01362	0.78023	3.155	0.00451	0.25824	0.5220
47.5	465.98	2.69	-2.87	1.79	-1.7	5.56	0.01463	0.83827	3.49	0.00499	0.28566	0.5526
50	490.50	2.88	-3.06	1.95	-1.85	5.94	0.01563	0.89555	3.8	0.00543	0.31103	0.5845

Experimental test data (continued)

RUN 5		CHASSIS ANGULAR DISPLACEMENT										
Weight [kg]	Torsion, T [N.m]	y_1 [mm] FRONT	y_2 [mm] FRONT	x_1 [mm] REAR	x_2 [mm] REAR	y_delta [mm]	Angular Disp. [radians] (y_delta)	Angular Disp. [degrees] FRONT	x_delta [mm]	Angular Disp. [radians] (x_delta)	Angular Disp. [degrees] REAR	Angular Disp. [degrees] (TOTAL)
2.5	24.53	0.1	-0.1	0.02	-0.01	0.20	0.00053	0.03016	0.03	0.00004	0.00246	0.0277
6.25	61.31	0.24	-0.26	0.04	-0.04	0.50	0.00132	0.07539	0.08	0.00011	0.00655	0.0688
10	98.10	0.38	-0.41	0.07	-0.06	0.79	0.00208	0.11911	0.13	0.00019	0.01064	0.1085
15	147.15	0.58	-0.63	0.12	-0.11	1.21	0.00318	0.18244	0.23	0.00033	0.01883	0.1636
20	196.20	0.85	-0.91	0.29	-0.27	1.76	0.00463	0.26537	0.56	0.00080	0.04584	0.2195
25	245.25	1.49	-1.58	0.76	-0.7	3.07	0.00808	0.46288	1.46	0.00209	0.11950	0.3434
30	294.30	1.8	-1.89	1.005	-0.925	3.69	0.00971	0.55635	1.93	0.00276	0.15797	0.3984
35	343.35	1.8	-1.89	1.005	-0.925	3.69	0.00971	0.55635	1.93	0.00276	0.15797	0.3984
40	392.40	2.12	-2.23	1.245	-1.16	4.35	0.01145	0.65586	2.405	0.00344	0.19685	0.4590
42.5	416.93	2.32	-2.435	1.41	-1.34	4.76	0.01251	0.71691	2.75	0.00393	0.22509	0.4918
45	441.45	2.48	-2.6	1.53	-1.48	5.08	0.01337	0.76591	3.01	0.00430	0.24637	0.5195
47.5	465.98	2.69	-2.81	1.795	-1.64	5.50	0.01447	0.82922	3.435	0.00491	0.28116	0.5481
50	490.50	2.87	-2.99	1.88	-1.79	5.86	0.01542	0.88349	3.67	0.00524	0.30039	0.5831

RUN 6		CHASSIS ANGULAR DISPLACEMENT										
Weight [kg]	Torsion, T [N.m]	y_1 [mm] FRONT	y_2 [mm] FRONT	x_1 [mm] REAR	x_2 [mm] REAR	y_delta [mm]	Angular Disp. [radians] (y_delta)	Angular Disp. [degrees] FRONT	x_delta [mm]	Angular Disp. [radians] (x_delta)	Angular Disp. [degrees] REAR	Angular Disp. [degrees] (TOTAL)
2.5	24.53	0.09	-0.1	0.01	-0.02	0.19	0.00050	0.02865	0.03	0.00004	0.00246	0.0262
6.25	61.31	0.23	-0.335	0.03	-0.04	0.57	0.00149	0.08519	0.07	0.00010	0.00573	0.0795
10	98.10	0.37	-0.42	0.06	-0.07	0.79	0.00208	0.11911	0.13	0.00019	0.01064	0.1085
15	147.15	0.57	-0.64	0.11	0.11	1.21	0.00318	0.18244	0	0.00000	0.00000	0.1824
20	196.20	0.815	-0.905	0.25	-0.24	1.72	0.00453	0.25934	0.49	0.00070	0.04011	0.2192
25	245.25	1.11	-1.2	0.46	-0.44	2.31	0.00608	0.34829	0.9	0.00129	0.07367	0.2746
30	294.30	1.47	-1.59	0.745	-0.7	3.06	0.00805	0.46137	1.445	0.00206	0.11827	0.3431
35	343.35	1.76	-1.89	0.95	-0.89	3.65	0.00960	0.55032	1.84	0.00263	0.15061	0.3997
40	392.40	1.92	-2.22	1.195	-1.13	4.14	0.01089	0.62420	2.325	0.00332	0.19030	0.4339
42.5	416.93	2.265	-2.41	1.34	-1.26	4.68	0.01230	0.70485	2.6	0.00371	0.21281	0.4920
45	441.45	2.45	-2.6	1.5	-1.43	5.05	0.01329	0.76139	2.93	0.00419	0.23982	0.5216
47.5	465.98	2.63	-2.78	1.65	-1.57	5.41	0.01424	0.81566	3.22	0.00460	0.26356	0.5521
50	490.50	2.83	-2.98	1.82	-1.74	5.81	0.01529	0.87595	3.56	0.00509	0.29139	0.5846

Experimental test data (continued)

RUN 7		CHASSIS ANGULAR DISPLACEMENT										
Weight [kg]	Torsion, T [N.m]	y_1 [mm] FRONT	y_2 [mm] FRONT	x_1 [mm] REAR	x_2 [mm] REAR	y_delta [mm]	Angular Disp. [radians] (y_delta)	Angular Disp. [degrees] FRONT	x_delta [mm]	Angular Disp. [radians] (x_delta)	Angular Disp. [degrees] REAR	Angular Disp. [degrees] (TOTAL)
2.5	24.53	0.09	-0.11	0.01	-0.01	0.20	0.00053	0.03016	0.02	0.00003	0.00164	0.0285
6.25	61.31	0.23	-0.27	0.04	-0.4	0.50	0.00132	0.07539	0.44	0.00063	0.03601	0.0394
10	98.10	0.37	-0.42	0.07	-0.65	0.79	0.00208	0.11911	0.72	0.00103	0.05893	0.0602
15	147.15	0.57	-0.645	0.13	-0.11	1.22	0.00320	0.18320	0.24	0.00034	0.01964	0.1636
20	196.20	0.84	-0.92	0.3	-0.27	1.76	0.00463	0.26537	0.57	0.00081	0.04666	0.2187
25	245.25	1.12	-1.21	0.5	-0.46	2.33	0.00613	0.35131	0.96	0.00137	0.07858	0.2727
30	294.30	1.435	-1.55	0.74	-0.68	2.99	0.00786	0.45006	1.42	0.00203	0.11623	0.3338
35	343.35	1.75	-1.88	0.98	-0.91	3.63	0.00955	0.54731	1.89	0.00270	0.15470	0.3926
40	392.40	2.1	-2.23	1.245	-1.155	4.33	0.01139	0.65284	2.4	0.00343	0.19644	0.4564
42.5	416.93	2.28	-2.42	1.39	-1.3	4.70	0.01237	0.70862	2.69	0.00384	0.22018	0.4884
45	441.45	2.45	-2.6	1.535	-1.44	5.05	0.01329	0.76139	2.975	0.00425	0.24351	0.5179
47.5	465.98	2.64	-2.785	1.69	-1.59	5.43	0.01428	0.81792	3.28	0.00469	0.26847	0.5494
50	490.50	2.85	-2.995	1.89	-1.79	5.85	0.01538	0.88123	3.68	0.00526	0.30121	0.5800

RUN 8		CHASSIS ANGULAR DISPLACEMENT										
Weight [kg]	Torsion, T [N.m]	y_1 [mm] FRONT	y_2 [mm] FRONT	x_1 [mm] REAR	x_2 [mm] REAR	y_delta [mm]	Angular Disp. [radians] (y_delta)	Angular Disp. [degrees] FRONT	x_delta [mm]	Angular Disp. [radians] (x_delta)	Angular Disp. [degrees] REAR	Angular Disp. [degrees] (TOTAL)
2.5	24.53	0.08	-0.12	0.015	-0.02	0.20	0.00053	0.03016	0.035	0.00005	0.00286	0.0273
6.25	61.31	0.23	-0.28	0.04	-0.04	0.51	0.00134	0.07690	0.08	0.00011	0.00655	0.0703
10	98.10	0.37	-0.43	0.07	-0.06	0.80	0.00211	0.12062	0.13	0.00019	0.01064	0.1100
15	147.15	0.57	-0.65	0.12	-0.11	1.22	0.00321	0.18395	0.23	0.00033	0.01883	0.1651
20	196.20	0.84	-0.93	0.29	-0.27	1.77	0.00466	0.26688	0.56	0.00080	0.04584	0.2210
25	245.25	1.12	-1.22	0.5	-0.46	2.34	0.00616	0.35282	0.96	0.00137	0.07858	0.2742
30	294.30	1.44	-1.55	0.725	-0.67	2.99	0.00787	0.45082	1.395	0.00199	0.11418	0.3366
35	343.35	1.76	-1.89	0.99	-0.92	3.65	0.00960	0.55032	1.91	0.00273	0.15634	0.3940
40	392.40	2.1	-2.25	1.24	-1.15	4.35	0.01145	0.65586	2.39	0.00341	0.19562	0.4602
42.5	416.93	2.325	-2.425	1.38	-1.295	4.75	0.01250	0.71616	2.675	0.00382	0.21895	0.4972
45	441.45	2.44	-2.6	1.51	-1.42	5.04	0.01326	0.75988	2.93	0.00419	0.23982	0.5201
47.5	465.98	2.64	-2.8	1.685	-1.59	5.44	0.01431	0.82018	3.275	0.00468	0.26806	0.5521
50	490.50	2.82	-2.975	1.84	-1.74	5.80	0.01525	0.87369	3.58	0.00511	0.29302	0.5807

Experimental test data (continued)

RUN 9		CHASSIS ANGULAR DISPLACEMENT										
Weight [kg]	Torsion, T [N.m]	y_1 [mm] FRONT	y_2 [mm] FRONT	x_1 [mm] REAR	x_2 [mm] REAR	y_delta [mm]	Angular Disp. [radians] (y_delta)	Angular Disp. [degrees] FRONT	x_delta [mm]	Angular Disp. [radians] (x_delta)	Angular Disp. [degrees] REAR	Angular Disp. [degrees] (TOTAL)
2.5	24.53	0.09	-0.11	0.01	-0.015	0.20	0.00053	0.03016	0.025	0.00004	0.00205	0.0281
6.25	61.31	0.24	-0.27	0.04	-0.04	0.51	0.00134	0.07690	0.08	0.00011	0.00655	0.0703
10	98.10	0.37	-0.42	0.06	-0.06	0.79	0.00208	0.11911	0.12	0.00017	0.00982	0.1093
15	147.15	0.575	-0.645	0.12	-0.11	1.22	0.00321	0.18395	0.23	0.00033	0.01883	0.1651
20	196.20	0.85	-0.93	0.3	-0.28	1.78	0.00468	0.26838	0.58	0.00083	0.04747	0.2209
25	245.25	1.14	-1.23	0.51	-0.52	2.37	0.00624	0.35734	1.03	0.00147	0.08431	0.2730
30	294.30	1.44	-1.55	0.72	-0.68	2.99	0.00787	0.45082	1.4	0.00200	0.11459	0.3362
35	343.35	1.78	-1.9	0.99	-0.93	3.68	0.00968	0.55485	1.92	0.00274	0.15715	0.3977
40	392.40	2.13	-2.255	1.26	-1.19	4.39	0.01154	0.66113	2.45	0.00350	0.20053	0.4606
42.5	416.93	2.3	-2.44	1.39	-1.32	4.74	0.01247	0.71465	2.71	0.00387	0.22182	0.4928
45	441.45	2.48	-2.63	1.55	-1.53	5.11	0.01345	0.77043	3.08	0.00440	0.25210	0.5183
47.5	465.98	2.66	-2.81	1.69	-1.61	5.47	0.01439	0.82470	3.3	0.00471	0.27011	0.5546
50	490.50	2.85	-3	1.86	-1.78	5.85	0.01539	0.88198	3.64	0.00520	0.29794	0.5840

RUN 10		CHASSIS ANGULAR DISPLACEMENT										
Weight [kg]	Torsion, T [N.m]	y_1 [mm] FRONT	y_2 [mm] FRONT	x_1 [mm] REAR	x_2 [mm] REAR	y_delta [mm]	Angular Disp. [radians] (y_delta)	Angular Disp. [degrees] FRONT	x_delta [mm]	Angular Disp. [radians] (x_delta)	Angular Disp. [degrees] REAR	Angular Disp. [degrees] (TOTAL)
2.5	24.53	0.1	-0.115	0.015	-0.2	0.22	0.00057	0.03242	0.215	0.00031	0.01760	0.0148
6.25	61.31	0.23	-0.27	0.03	-0.03	0.50	0.00132	0.07539	0.06	0.00009	0.00491	0.0705
10	98.10	0.37	-0.43	0.06	-0.06	0.80	0.00211	0.12062	0.12	0.00017	0.00982	0.1108
15	147.15	0.57	-0.645	0.12	-0.1	1.22	0.00320	0.18320	0.22	0.00031	0.01801	0.1652
20	196.20	0.84	-0.93	0.29	-0.27	1.77	0.00466	0.26688	0.56	0.00080	0.04584	0.2210
25	245.25	1.14	-1.23	0.51	-0.47	2.37	0.00624	0.35734	0.98	0.00140	0.08021	0.2771
30	294.30	1.46	-1.575	0.76	-0.71	3.04	0.00799	0.45760	1.47	0.00210	0.12032	0.3373
35	343.35	1.77	-1.89	0.97	-0.91	3.66	0.00963	0.55183	1.88	0.00269	0.15388	0.3980
40	392.40	2.09	-2.22	1.22	-1.14	4.31	0.01134	0.64983	2.36	0.00337	0.19317	0.4567
42.5	416.93	2.27	-2.41	1.37	-1.31	4.68	0.01232	0.70561	2.68	0.00383	0.21936	0.4862
45	441.45	2.44	-2.59	1.51	-1.44	5.03	0.01324	0.75837	2.95	0.00421	0.24146	0.5169
47.5	465.98	2.625	-2.77	1.66	-1.85	5.40	0.01420	0.81339	3.51	0.00501	0.28730	0.5261
50	490.50	2.8	-2.945	1.81	-1.72	5.75	0.01512	0.86616	3.53	0.00504	0.28893	0.5772

Chassis Stresses

Simulation data

	CP 1(a)		CP 1(b)		CP 2		RS		FS	
Torsion, T [N.m]	STR _{MAX} Stress [Pa]	STR _{MAX} Strain [Micro]	STR _{MAX} Stress [Pa]	STR _{MAX} Strain [Micro]	STR _{MAX} Stress [Pa]	STR _{MAX} Strain [Micro]	STR _{MAX} Stress [Pa]	STR _{MAX} Strain [Micro]	STR _{MAX} Stress [Pa]	STR _{MAX} Strain [Micro]
34.335	1773724.8	8.86862	2256786.5	11.28393	1776863.1	8.88432	2994471.0	14.97236	2037106.1	10.18553
68.670	3306119.0	16.53060	4271979.5	21.35990	3310858.8	16.55429	5359825.0	26.79913	4074212.3	20.37106
103.005	5321174.0	26.60587	6407969.0	32.03985	5330589.0	26.65295	8983413.0	44.91707	6111318.5	30.55659
137.340	6612238.0	33.06119	8543959.0	42.71980	7107452.5	35.53726	10719650.0	53.59825	8148424.5	40.74212
171.675	8265298.0	41.32649	11283933.0	56.41967	8884316.0	44.42158	13399562.0	66.99781	10185531.0	50.92766
206.010	9918357.0	49.59179	12815938.0	64.07969	10661178.0	53.30589	16079474.0	80.39737	12222637.0	61.11319
240.345	11571417.0	57.85709	14951928.0	74.75964	12438042.0	62.19021	18759388.0	93.79694	14259744.0	71.29872
274.680	13224476.0	66.12238	17087918.0	85.43959	13243435.0	66.21718	21439300.0	107.19650	16296849.0	81.48425
309.015	14877536.0	74.38768	19223908.0	96.11954	15991768.0	79.95884	26950240.0	134.75120	18333956.0	91.66978
343.350	16530596.0	82.65298	21359898.0	106.79949	16554294.0	82.77147	29944710.0	149.72355	20371062.0	101.85531
377.685	18183656.0	90.91828	23495888.0	117.47944	18209724.0	91.04862	29479036.0	147.39518	22408166.0	112.04083
412.020	19836714.0	99.18357	25631876.0	128.15938	21322356.0	106.61178	35933652.0	179.66826	24445274.0	122.22637
446.355	21489776.0	107.44888	27767868.0	138.83934	23099222.0	115.49611	34838864.0	174.19432	26482380.0	132.41190
480.690	23142834.0	115.71417	29903856.0	149.51928	24876084.0	124.38042	37518776.0	187.59388	28519488.0	142.59744
515.025	24795894.0	123.97947	33851800.0	169.25900	24831440.0	124.15720	40198688.0	200.99344	30556594.0	152.78297
549.360	26448952.0	132.24476	36108584.0	180.54292	26937838.0	134.68919	42878600.0	214.39300	32593698.0	162.96849
583.695	28102012.0	140.51006	36311828.0	181.55914	30206672.0	151.03336	45558512.0	227.79256	34630804.0	173.15402
618.030	29755072.0	148.77536	38447816.0	192.23908	31983536.0	159.91768	48238424.0	241.19212	36667912.0	183.33956
652.365	31408132.0	157.04066	40583808.0	202.91904	31453158.0	157.26579	50918336.0	254.59168	38705020.0	193.52510
686.700	33061192.0	165.30596	42719796.0	213.59898	33108588.0	165.54294	53598248.0	267.99124	40742124.0	203.71062
721.035	34714252.0	173.57126	44855788.0	224.27894	37314128.0	186.57064	56278164.0	281.39082	42779232.0	213.89616

Experimental test data

RUN 1		COCKPIT STRUCTURE 1 (a) [CS1(a)]													
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]	
2.5	24.53	-0.001	-0.001	-0.002	-0.003	-1.9704	-1.9704	-3.9409	-5.9113	3.4483	2.2030	5.6513	1130259.7	1.130	
6.25	61.31	-0.004	-0.002	-0.005	-0.007	-7.8818	-3.9409	-9.8522	-13.7931	8.8670	5.0237	13.8907	2778131.9	2.778	
10	98.10	-0.006	-0.004	-0.009	-0.011	-11.8227	-7.8818	-17.7340	-21.6749	14.7783	7.5032	22.2815	4456310.0	4.456	
15	147.15	-0.009	-0.006	-0.013	-0.017	-17.7340	-11.8227	-25.6158	-33.4975	22.1675	11.5317	33.6992	6739842.3	6.740	
20	196.20	-0.012	-0.008	-0.018	-0.022	-23.6453	-15.7635	-35.4680	-43.3498	29.5567	15.0064	44.5631	8912619.9	8.913	
25	245.25	-0.015	-0.01	-0.022	-0.028	-29.5567	-19.7044	-43.3498	-55.1724	36.9458	19.0278	55.9736	11194720.8	11.195	
30	294.30	-0.019	-0.012	-0.027	-0.035	-37.4384	-23.6453	-53.2020	-68.9655	45.8128	23.9917	69.8045	13960904.7	13.961	
35	343.35	-0.022	-0.013	-0.032	-0.04	-43.3498	-25.6158	-63.0542	-78.8177	52.7094	28.3669	81.0762	16215243.4	16.215	
37.5	367.88	-0.024	-0.014	-0.034	-0.044	-47.2906	-27.5862	-66.9951	-86.6995	57.1429	31.1554	88.2983	17659660.4	17.660	
42.5	416.93	-0.027	-0.016	-0.038	-0.049	-53.2020	-31.5271	-74.8768	-96.5517	64.0394	34.2710	98.3104	19662079.7	19.662	
47.5	465.98	-0.031	-0.018	-0.044	-0.056	-61.0837	-35.4680	-86.6995	-110.3448	73.3990	39.5686	112.9677	22593531.3	22.594	
52.5	515.03	-0.034	-0.02	-0.048	-0.063	-66.9951	-39.4089	-94.5813	-124.1379	81.2808	44.5534	125.8342	25166832.8	25.167	
55	539.55	0	0	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.000	
57.5	564.08	0	0	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.000	
60	588.60	0	0	0	0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0	0.000	

RUN 2		COCKPIT STRUCTURE 1 (a) [CS1(a)]													
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]	
2.5	24.53	0.001	0.001	0.002	0.002	1.9704	1.9704	3.9409	3.9409	2.9557	1.3933	4.3490	869795.8	0.870	
6.25	61.31	0.002	0.002	0.004	0.006	3.9409	3.9409	7.8818	11.8227	6.8966	4.4060	11.3026	2260519.4	2.261	
10	98.10	0.004	0.003	0.008	0.01	7.8818	5.9113	15.7635	19.7044	12.3153	7.9431	20.2584	4051676.4	4.052	
15	147.15	0.008	0.006	0.012	0.015	15.7635	11.8227	23.6453	29.5567	20.1970	9.7033	29.9004	5980070.5	5.980	
20	196.20	0.01	0.007	0.016	0.021	19.7044	13.7931	31.5271	41.3793	26.6010	15.0064	41.6074	8321486.9	8.321	
25	245.25	0.012	0.009	0.021	0.027	23.6453	17.7340	41.3793	53.2020	33.9901	19.8272	53.8174	10763470.3	10.763	
30	294.30	0.017	0.012	0.026	0.034	33.4975	23.6453	51.2315	66.9951	43.8424	23.4185	67.2608	13452163.3	13.452	
35	343.35	0.019	0.014	0.031	0.041	37.4384	27.5862	61.0837	80.7882	51.7241	29.1099	80.8341	16166812.5	16.167	
37.5	367.88	0.021	0.015	0.033	0.045	41.3793	29.5567	65.0246	88.6700	56.1576	31.8335	87.9911	17598224.4	17.598	
42.5	416.93	0.024	0.016	0.037	0.051	47.2906	31.5271	72.9064	100.4926	63.0542	36.7845	99.8387	19967745.7	19.968	
47.5	465.98	0.027	0.018	0.043	0.058	53.2020	35.4680	84.7291	114.2857	71.9212	42.4446	114.3658	22873166.2	22.873	
52.5	515.03	0.029	0.02	0.047	0.065	57.1429	39.4089	92.6108	128.0788	79.3103	47.7502	127.0606	25412114.9	25.412	
55	539.55	0.031	0.021	0.05	0.069	61.0837	41.3793	98.5222	135.9606	84.2365	50.8607	135.0972	27019436.1	27.019	
57.5	564.08	0.033	0.022	0.053	0.073	65.0246	43.3498	104.4335	143.8424	89.1626	53.9718	143.1344	28626873.6	28.627	
60	588.60	0.032	0.023	0.054	0.077	63.0542	45.3202	106.4039	151.7241	91.6256	57.4478	149.0734	29814683.5	29.815	

Experimental test data (continued)

RUN 3		COCKPIT STRUCTURE 1 (a) [CS1(a)]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.002	0.001	0.002	0.003	3.9409	1.9704	3.9409	5.9113	3.9409	1.9704	5.9113	1182266.0	1.182
6.25	61.31	0.005	0.003	0.007	0.007	9.8522	5.9113	13.7931	13.7931	10.8374	4.4060	15.2435	3048696.7	3.049
10	98.10	0.007	0.005	0.01	0.011	13.7931	9.8522	19.7044	21.6749	16.2562	6.6091	22.8652	4573045.1	4.573
15	147.15	0.01	0.007	0.014	0.016	19.7044	13.7931	27.5862	31.5271	23.1527	9.7033	32.8560	6571203.5	6.571
20	196.20	0.014	0.009	0.019	0.022	27.5862	17.7340	37.4384	43.3498	31.5271	13.7226	45.2496	9049928.7	9.050
25	245.25	0.017	0.011	0.023	0.028	33.4975	21.6749	45.3202	55.1724	38.9163	17.7613	56.6776	11335518.5	11.336
30	294.30	0.021	0.013	0.028	0.035	41.3793	25.6158	55.1724	68.9655	47.7833	22.7456	70.5289	14105772.0	14.106
35	343.35	0.024	0.015	0.032	0.041	47.2906	29.5567	63.0542	80.7882	55.1724	26.8009	81.9733	16394668.2	16.395
37.5	367.88	0.026	0.017	0.035	0.044	51.2315	33.4975	68.9655	86.6995	60.0985	28.0399	88.1384	17627684.5	17.628
42.5	416.93	0.031	0.019	0.04	0.05	61.0837	37.4384	78.8177	98.5222	68.9655	31.8030	100.7685	20153699.5	20.154
47.5	465.98	0.034	0.02	0.045	0.057	66.9951	39.4089	88.6700	112.3153	76.8473	38.0301	114.8774	22975471.6	22.975
52.5	515.03	0.036	0.023	0.05	0.064	70.9360	45.3202	98.5222	126.1084	85.2217	42.6841	127.9058	25581154.3	25.581
55	539.55	0.037	0.023	0.051	0.068	72.9064	45.3202	100.4926	133.9901	88.1773	46.4310	134.6084	26921672.3	26.922
57.5	564.08	0.038	0.023	0.054	0.071	74.8768	45.3202	106.4039	139.9015	91.6256	49.8487	141.4743	28294865.5	28.295
60	588.60	0.04	0.024	0.056	0.074	78.8177	47.2906	110.3448	145.8128	95.5665	51.7218	147.2883	29457658.9	29.458

RUN 4		COCKPIT STRUCTURE 1 (a) [CS1(a)]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.001	0.001	0.002	0.003	1.9704	1.9704	3.9409	5.9113	3.4483	2.2030	5.6513	1130259.7	1.130
6.25	61.31	0.003	0.002	0.005	0.007	5.9113	3.9409	9.8522	13.7931	8.3744	5.3056	13.6800	2735993.1	2.736
10	98.10	0.005	0.004	0.008	0.011	9.8522	7.8818	15.7635	21.6749	13.7931	7.5032	21.2963	4259265.6	4.259
15	147.15	0.008	0.006	0.012	0.017	15.7635	11.8227	23.6453	33.4975	21.1823	11.5317	32.7140	6542798.0	6.543
20	196.20	0.012	0.008	0.017	0.022	23.6453	15.7635	33.4975	43.3498	29.0640	14.6464	43.7104	8742082.5	8.742
25	245.25	0.014	0.01	0.022	0.028	27.5862	19.7044	43.3498	55.1724	36.4532	19.4066	55.8598	11171963.7	11.172
30	294.30	0.018	0.012	0.026	0.035	35.4680	23.6453	51.2315	68.9655	44.8276	23.9917	68.8193	13763860.4	13.764
35	343.35	0.022	0.014	0.031	0.041	43.3498	27.5862	61.0837	80.7882	53.2020	28.0399	81.2419	16248374.2	16.248
37.5	367.88	0.023	0.015	0.033	0.045	45.3202	29.5567	65.0246	88.6700	57.1429	31.1554	88.2983	17659660.4	17.660
42.5	416.93	0.025	0.016	0.037	0.05	49.2611	31.5271	72.9064	98.5222	63.0542	35.5227	98.5769	19715372.0	19.715
47.5	465.98	0.029	0.018	0.043	0.057	57.1429	35.4680	84.7291	112.3153	72.4138	40.8243	113.2381	22647625.4	22.648
52.5	515.03	0.032	0.02	0.047	0.064	63.0542	39.4089	92.6108	126.1084	80.2956	45.7996	126.0951	25219026.0	25.219
55	539.55	0.034	0.021	0.05	0.068	66.9951	41.3793	98.5222	133.9901	85.2217	48.9150	134.1367	26827343.1	26.827
57.5	564.08	0.036	0.022	0.052	0.072	70.9360	43.3498	102.4631	141.8719	89.6552	51.7218	141.3770	28275392.9	28.275
60	588.60	0.038	0.023	0.055	0.075	74.8768	45.3202	108.3744	147.7833	94.0887	53.8998	147.9885	29597698.0	29.598

Experimental test data (continued)

RUN 5		COCKPIT STRUCTURE 1 (a) [CS1(a)]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.002	0.001	0.002	0.003	3.9409	1.9704	3.9409	5.9113	3.9409	1.9704	5.9113	1182266.0	1.182
6.25	61.31	0.005	0.003	0.006	0.007	9.8522	5.9113	11.8227	13.7931	10.3448	4.0622	14.4070	2881400.1	2.881
10	98.10	0.007	0.005	0.009	0.011	13.7931	9.8522	17.7340	21.6749	15.7635	6.2311	21.9946	4398927.2	4.399
15	147.15	0.011	0.008	0.014	0.017	21.6749	15.7635	27.5862	33.4975	24.6305	9.3466	33.9772	6795435.1	6.795
20	196.20	0.015	0.01	0.019	0.023	29.5567	19.7044	37.4384	45.3202	33.0049	13.4005	46.4054	9281077.9	9.281
25	245.25	0.018	0.012	0.023	0.029	35.4680	23.6453	45.3202	57.1429	40.3941	17.4582	57.8523	11570452.2	11.570
30	294.30	0.021	0.013	0.027	0.035	41.3793	25.6158	53.2020	68.9655	47.2906	22.4665	69.7572	13951430.2	13.951
35	343.35	0.024	0.016	0.033	0.041	47.2906	31.5271	65.0246	80.7882	56.1576	26.1780	82.3356	16467125.2	16.467
37.5	367.88	0.026	0.016	0.035	0.045	51.2315	31.5271	68.9655	88.6700	60.0985	29.9157	90.0142	18002847.9	18.003
42.5	416.93	0.029	0.019	0.039	0.05	57.1429	37.4384	76.8473	98.5222	67.4877	32.0916	99.5793	19915861.1	19.916
47.5	465.98	0.032	0.02	0.044	0.058	63.0542	39.4089	86.6995	114.2857	75.8621	39.2608	115.1229	23024574.9	23.025
52.5	515.03	0.036	0.022	0.049	0.065	70.9360	43.3498	96.5517	128.0788	84.7291	44.2583	128.9873	25797468.9	25.797
55	539.55	0.038	0.023	0.052	0.068	74.8768	45.3202	102.4631	133.9901	89.1626	46.4310	135.5936	27118716.6	27.119
57.5	564.08	0.039	0.024	0.054	0.071	76.8473	47.2906	106.4039	139.9015	92.6108	48.6065	141.2173	28243465.1	28.243
60	588.60	0.042	0.026	0.058	0.074	82.7586	51.2315	114.2857	145.8128	98.5222	49.8487	148.3709	29674175.9	29.674

RUN 6		COCKPIT STRUCTURE 1 (a) [CS1(a)]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.002	0.001	0.002	0.003	3.9409	1.9704	3.9409	5.9113	3.9409	1.9704	5.9113	1182266.0	1.182
6.25	61.31	0.005	0.003	0.006	0.007	9.8522	5.9113	11.8227	13.7931	10.3448	4.0622	14.4070	2881400.1	2.881
10	98.10	0.008	0.006	0.01	0.011	15.7635	11.8227	19.7044	21.6749	17.2414	5.3056	22.5470	4509392.1	4.509
15	147.15	0.011	0.008	0.015	0.017	21.6749	15.7635	29.5567	33.4975	25.1232	9.7033	34.8265	6965292.2	6.965
20	196.20	0.014	0.009	0.018	0.023	27.5862	17.7340	35.4680	45.3202	31.5271	14.3450	45.8721	9174427.5	9.174
25	245.25	0.018	0.012	0.024	0.029	35.4680	23.6453	47.2906	57.1429	40.8867	17.7613	58.6480	11729607.2	11.730
30	294.30	0.022	0.014	0.029	0.035	43.3498	27.5862	57.1429	68.9655	49.2611	21.8088	71.0699	14213979.0	14.214
35	343.35	0.026	0.016	0.034	0.041	51.2315	31.5271	66.9951	80.7882	57.6355	25.8609	83.4964	16699272.8	16.699
37.5	367.88	0.027	0.016	0.035	0.045	53.2020	31.5271	68.9655	88.6700	60.5911	29.6386	90.2298	18045954.3	18.046
42.5	416.93	0.03	0.018	0.039	0.05	59.1133	35.4680	76.8473	98.5222	67.4877	32.7503	100.2380	20047594.1	20.048
47.5	465.98	0.034	0.021	0.045	0.058	66.9951	41.3793	88.6700	114.2857	77.8325	38.0301	115.8626	23172515.9	23.173
52.5	515.03	0.038	0.023	0.05	0.064	74.8768	45.3202	98.5222	126.1084	86.2069	42.0887	128.2956	25659117.0	25.659
55	539.55	0.039	0.024	0.052	0.067	76.8473	47.2906	102.4631	132.0197	89.6552	44.2583	133.9135	26782690.6	26.783
57.5	564.08	0.04	0.024	0.054	0.071	78.8177	47.2906	106.4039	139.9015	93.1034	48.3161	141.4195	28283901.3	28.284
60	588.60	0.043	0.025	0.057	0.074	84.7291	49.2611	112.3153	145.8128	98.0296	50.2077	148.2372	29647442.2	29.647

Experimental test data (continued)

RUN 7		COCKPIT STRUCTURE 1 (a) [CS1(a)]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.002	0.001	0.002	0.003	3.9409	1.9704	3.9409	5.9113	3.9409	1.9704	5.9113	1182266.0	1.182
6.25	61.31	0.003	0.002	0.005	0.007	5.9113	3.9409	9.8522	13.7931	8.3744	5.3056	13.6800	2735993.1	2.736
10	98.10	0.006	0.005	0.009	0.011	11.8227	9.8522	17.7340	21.6749	15.2709	6.6091	21.8800	4376000.8	4.376
15	147.15	0.009	0.007	0.014	0.017	17.7340	13.7931	27.5862	33.4975	23.1527	11.0151	34.1678	6833564.5	6.834
20	196.20	0.013	0.009	0.018	0.023	25.6158	17.7340	35.4680	45.3202	31.0345	14.6464	45.6809	9136171.2	9.136
25	245.25	0.016	0.011	0.023	0.029	31.5271	21.6749	45.3202	57.1429	38.9163	19.0278	57.9440	11588809.4	11.589
30	294.30	0.02	0.013	0.028	0.035	39.4089	25.6158	55.1724	68.9655	47.2906	23.0634	70.3541	14070817.7	14.071
35	343.35	0.024	0.016	0.033	0.041	47.2906	31.5271	65.0246	80.7882	56.1576	26.1780	82.3356	16467125.2	16.467
37.5	367.88	0.025	0.016	0.035	0.045	49.2611	31.5271	68.9655	88.6700	59.6059	30.2224	89.8283	17965659.8	17.966
42.5	416.93	0.027	0.017	0.039	0.051	53.2020	33.4975	76.8473	100.4926	66.0099	35.5227	101.5325	20306505.0	20.307
47.5	465.98	0.031	0.02	0.045	0.058	61.0837	39.4089	88.6700	114.2857	75.8621	39.8984	115.7605	23152101.2	23.152
52.5	515.03	0.035	0.022	0.05	0.065	68.9655	43.3498	98.5222	128.0788	84.7291	44.8682	129.5972	25919446.3	25.919
55	539.55	0.037	0.023	0.052	0.068	72.9064	45.3202	102.4631	133.9901	88.6700	46.7332	135.4031	27080623.6	27.081
57.5	564.08	0.038	0.024	0.054	0.072	74.8768	47.2906	106.4039	141.8719	92.6108	49.8487	142.4595	28491909.9	28.492
60	588.60	0.04	0.025	0.057	0.075	78.8177	49.2611	112.3153	147.7833	97.0443	52.0305	149.0749	29814972.2	29.815

RUN 8		COCKPIT STRUCTURE 1 (a) [CS1(a)]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.001	0.001	0.002	0.003	1.9704	1.9704	3.9409	5.9113	3.4483	2.2030	5.6513	1130259.7	1.130
6.25	61.31	0.004	0.003	0.005	0.007	7.8818	5.9113	9.8522	13.7931	9.3596	4.0622	13.4218	2684355.8	2.684
10	98.10	0.005	0.004	0.008	0.012	9.8522	7.8818	15.7635	23.6453	14.2857	8.4177	22.7035	4540690.4	4.541
15	147.15	0.01	0.006	0.013	0.017	19.7044	11.8227	25.6158	33.4975	22.6601	11.2333	33.8934	6778670.8	6.779
20	196.20	0.013	0.008	0.018	0.023	25.6158	15.7635	35.4680	45.3202	30.5419	15.5777	46.1196	9223918.9	9.224
25	245.25	0.016	0.01	0.022	0.029	31.5271	19.7044	43.3498	57.1429	37.9310	19.6304	57.5614	11512287.5	11.512
30	294.30	0.021	0.013	0.028	0.036	41.3793	25.6158	55.1724	70.9360	48.2759	23.6863	71.9622	14392439.5	14.392
35	343.35	0.024	0.015	0.033	0.042	47.2906	29.5567	65.0246	82.7586	56.1576	28.0399	84.1975	16839507.2	16.840
37.5	367.88	0.026	0.016	0.036	0.046	51.2315	31.5271	70.9360	90.6404	61.0837	31.1554	92.2392	18447837.8	18.448
42.5	416.93	0.029	0.017	0.038	0.052	57.1429	33.4975	74.8768	102.4631	66.9951	35.6046	102.5996	20519925.5	20.520
47.5	465.98	0.032	0.019	0.044	0.058	63.0542	37.4384	86.6995	114.2857	75.3695	40.2014	115.5708	23114169.8	23.114
52.5	515.03	0.036	0.021	0.049	0.065	70.9360	41.3793	96.5517	128.0788	84.2365	45.2022	129.4387	25887739.7	25.888
55	539.55	0.037	0.022	0.051	0.069	72.9064	43.3498	100.4926	135.9606	88.1773	48.3161	136.4934	27298679.7	27.299
57.5	564.08	0.039	0.024	0.055	0.072	76.8473	47.2906	108.3744	141.8719	93.5961	49.8487	143.4448	28688954.2	28.689
60	588.60	0.041	0.024	0.057	0.076	80.7882	47.2906	112.3153	149.7537	97.5369	53.6019	151.1388	30227760.0	30.228

Experimental test data (continued)

RUN 9		COCKPIT STRUCTURE 1 (a) [CS1(a)]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.002	0.001	0.003	0.002	3.9409	1.9704	5.9113	3.9409	3.9409	1.3933	5.3342	1066840.1	1.067
6.25	61.31	0.004	0.002	0.005	0.007	7.8818	3.9409	9.8522	13.7931	8.8670	5.0237	13.8907	2778131.9	2.778
10	98.10	0.006	0.006	0.008	0.011	11.8227	11.8227	15.7635	21.6749	15.2709	5.3056	20.5765	4115303.4	4.115
15	147.15	0.009	0.007	0.013	0.017	17.7340	13.7931	25.6158	33.4975	22.6601	10.6112	33.2713	6654252.1	6.654
20	196.20	0.013	0.008	0.017	0.022	25.6158	15.7635	33.4975	43.3498	29.5567	14.3450	43.9017	8780338.9	8.780
25	245.25	0.016	0.009	0.021	0.029	31.5271	17.7340	41.3793	57.1429	36.9458	20.3109	57.2567	11451335.6	11.451
30	294.30	0.019	0.011	0.027	0.035	37.4384	21.6749	53.2020	68.9655	45.3202	24.9244	70.2446	14048910.6	14.049
35	343.35	0.024	0.014	0.032	0.041	47.2906	27.5862	63.0542	80.7882	54.6798	27.7441	82.4239	16484779.4	16.485
37.5	367.88	0.025	0.015	0.034	0.045	49.2611	29.5567	66.9951	88.6700	58.6207	30.8580	89.4787	17895747.7	17.896
42.5	416.93	0.028	0.018	0.039	0.05	55.1724	35.4680	76.8473	98.5222	66.5025	33.3378	99.8402	19968049.0	19.968
47.5	465.98	0.032	0.019	0.044	0.057	63.0542	37.4384	86.6995	112.3153	74.8768	39.2608	114.1377	22827530.6	22.828
52.5	515.03	0.035	0.02	0.048	0.064	68.9655	39.4089	94.5813	126.1084	82.2660	45.2022	127.4683	25493651.0	25.494
55	539.55	0.037	0.022	0.051	0.068	72.9064	43.3498	100.4926	133.9901	87.6847	47.3727	135.0574	27011480.0	27.011
57.5	564.08	0.038	0.022	0.054	0.071	74.8768	43.3498	106.4039	139.9015	91.1330	50.7843	141.9173	28383467.2	28.383
60	588.60	0.041	0.024	0.057	0.074	80.7882	47.2906	112.3153	145.8128	96.5517	51.7218	148.2735	29654703.2	29.655

RUN 10		COCKPIT STRUCTURE 1 (a) [CS1(a)]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.002	0.001	0.002	0.003	3.9409	1.9704	3.9409	5.9113	3.9409	1.9704	5.9113	1182266.0	1.182
6.25	61.31	0.004	0.002	0.005	0.007	7.8818	3.9409	9.8522	13.7931	8.8670	5.0237	13.8907	2778131.9	2.778
10	98.10	0.007	0.004	0.009	0.011	13.7931	7.8818	17.7340	2.1675	10.3941	3.4707	13.8648	2772962.2	2.773
15	147.15	0.011	0.006	0.014	0.016	21.6749	11.8227	27.5862	31.5271	23.1527	10.2860	33.4387	6687745.1	6.688
20	196.20	0.014	0.008	0.018	0.022	27.5862	15.7635	35.4680	43.3498	30.5419	14.3450	44.8869	8977383.2	8.977
25	245.25	0.016	0.01	0.023	0.028	31.5271	19.7044	45.3202	55.1724	37.9310	19.0278	56.9588	11391765.1	11.392
30	294.30	0.02	0.013	0.028	0.035	39.4089	25.6158	55.1724	68.9655	47.2906	23.0634	70.3541	14070817.7	14.071
35	343.35	0.024	0.014	0.032	0.041	47.2906	27.5862	63.0542	80.7882	54.6798	27.7441	82.4239	16484779.4	16.485
37.5	367.88	0.025	0.016	0.035	0.045	49.2611	31.5271	68.9655	88.6700	59.6059	30.2224	89.8283	17965659.8	17.966
42.5	416.93	0.028	0.017	0.039	0.05	55.1724	33.4975	76.8473	98.5222	66.0099	34.2710	100.2808	20056168.3	20.056
47.5	465.98	0.033	0.02	0.045	0.058	65.0246	39.4089	88.6700	114.2857	76.8473	39.2608	116.1081	23221619.2	23.222
52.5	515.03	0.036	0.022	0.05	0.064	70.9360	43.3498	98.5222	126.1084	84.7291	43.6176	128.3467	25669337.4	25.669
55	539.55	0.037	0.022	0.053	0.068	72.9064	43.3498	104.4335	133.9901	88.6700	47.9834	136.6534	27330676.4	27.331
57.5	564.08	0.039	0.023	0.055	0.071	76.8473	45.3202	108.3744	139.9015	92.6108	49.8487	142.4595	28491909.9	28.492
60	588.60	0.041	0.025	0.058	0.075	80.7882	49.2611	114.2857	147.7833	98.0296	52.0305	150.0601	30012016.5	30.012

Experimental test data (continued)

RUN 1		COCKPIT STRUCTURE 1 (b) [CS1(b)]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	-0.002	-0.001	-0.004	-0.005	-3.9409	-1.9704	-7.8818	-9.8522	5.9113	4.4060	10.3174	2063475.1	2.063
6.25	61.31	-0.005	-0.005	-0.012	-0.011	-9.8522	-9.8522	-23.6453	-21.6749	16.2562	9.0833	25.3395	5067890.5	5.068
10	98.10	-0.007	-0.007	-0.016	-0.015	-13.7931	-13.7931	-31.5271	-29.5567	22.1675	11.8636	34.0311	6806225.5	6.806
15	147.15	-0.011	-0.01	-0.021	-0.021	-21.6749	-19.7044	-41.3793	-41.3793	31.0345	14.6464	45.6809	9136171.2	9.136
20	196.20	-0.014	-0.013	-0.027	-0.027	-27.5862	-25.6158	-53.2020	-53.2020	39.9015	18.8226	58.7241	11744822.3	11.745
25	245.25	-0.016	-0.014	-0.034	-0.035	-31.5271	-27.5862	-66.9951	-68.9655	48.7685	27.2499	76.0184	15203671.6	15.204
30	294.30	-0.02	-0.015	-0.039	-0.041	-39.4089	-29.5567	-76.8473	-80.7882	56.6502	31.7266	88.3768	17675366.4	17.675
35	343.35	-0.023	-0.019	-0.046	-0.049	-45.3202	-37.4384	-90.6404	-96.5517	67.4877	37.2435	104.7311	20946229.8	20.946
37.5	367.88	-0.025	-0.019	-0.05	-0.053	-49.2611	-37.4384	-98.5222	-104.4335	72.4138	41.5782	113.9920	22798403.1	22.798
42.5	416.93	-0.027	-0.021	-0.055	-0.059	-53.2020	-41.3793	-108.3744	-116.2562	79.8030	46.5041	126.3071	25261417.7	25.261
47.5	465.98	-0.031	-0.023	-0.061	-0.066	-61.0837	-45.3202	-120.1970	-130.0493	89.1626	51.6561	140.8186	28163725.5	28.164
52.5	515.03	-0.034	-0.025	-0.068	-0.074	-66.9951	-49.2611	-133.9901	-145.8128	99.0148	58.7592	157.7740	31554796.1	31.555
55	539.55	-0.036	-0.027	-0.071	-0.077	-70.9360	-53.2020	-139.9015	-151.7241	103.9409	60.1308	164.0717	32814340.5	32.814
57.5	564.08	-0.037	-0.028	-0.075	-0.08	-72.9064	-55.1724	-147.7833	-157.6355	108.3744	63.4532	171.8276	34365511.1	34.366
60	588.60	-0.04	-0.03	-0.079	-0.085	-78.8177	-59.1133	-155.6650	-167.4877	115.2709	66.4276	181.6986	36339710.6	36.340

RUN 2		COCKPIT STRUCTURE 1 (b) [CS1(b)]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	-0.004	-0.003	-0.006	-0.005	-7.8818	-5.9113	-11.8227	-9.8522	8.8670	2.7866	11.6536	2330724.6	2.331
6.25	61.31	-0.006	-0.007	-0.012	-0.011	-11.8227	-13.7931	-23.6453	-21.6749	17.7340	7.1045	24.8385	4967704.9	4.968
10	98.10	-0.009	-0.008	-0.016	-0.015	-17.7340	-15.7635	-31.5271	-29.5567	23.6453	9.7532	33.3985	6679703.4	6.680
15	147.15	-0.013	-0.012	-0.023	-0.021	-25.6158	-23.6453	-45.3202	-41.3793	33.9901	13.2548	47.2449	9448990.0	9.449
20	196.20	-0.014	-0.013	-0.027	-0.028	-27.5862	-25.6158	-53.2020	-55.1724	40.3941	19.5561	59.9502	11990036.1	11.990
25	245.25	-0.017	-0.015	-0.032	-0.034	-33.4975	-29.5567	-63.0542	-66.9951	48.2759	23.8497	72.1256	14425110.7	14.425
30	294.30	-0.019	-0.017	-0.038	-0.04	-37.4384	-33.4975	-74.8768	-78.8177	56.1576	29.3920	85.5496	17109924.7	17.110
35	343.35	-0.023	-0.019	-0.045	-0.048	-45.3202	-37.4384	-88.6700	-94.5813	66.5025	35.8626	102.3651	20473014.7	20.473
37.5	367.88	-0.025	-0.018	-0.051	-0.054	-49.2611	-35.4680	-100.4926	-106.4039	72.9064	43.7509	116.6573	23331469.3	23.331
42.5	416.93	-0.027	-0.02	-0.054	-0.06	-53.2020	-39.4089	-106.4039	-118.2266	79.3103	47.5465	126.8569	25371372.2	25.371
47.5	465.98	-0.031	-0.024	-0.061	-0.065	-61.0837	-47.2906	-120.1970	-128.0788	89.1626	50.0528	139.2153	27843062.7	27.843
52.5	515.03	-0.035	-0.028	-0.067	-0.072	-68.9655	-55.1724	-132.0197	-141.8719	99.5074	53.6019	153.1092	30621848.7	30.622
55	539.55	-0.036	-0.027	-0.07	-0.076	-70.9360	-53.2020	-137.9310	-149.7537	102.9557	58.7592	161.7149	32342973.4	32.343
57.5	564.08	-0.038	-0.029	-0.074	-0.081	-74.8768	-57.1429	-145.8128	-159.6059	109.3596	62.3109	171.6705	34334099.2	34.334
60	588.60	-0.04	-0.029	-0.077	-0.084	-78.8177	-57.1429	-151.7241	-165.5172	113.3005	65.3076	178.6081	35721626.3	35.722

Experimental test data (continued)

RUN 3		COCKPIT STRUCTURE 1 (b) [CS1(b)]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	-0.005	-0.002	-0.004	-0.005	-9.8522	-3.9409	-7.8818	-9.8522	7.8818	3.1155	10.9973	2199463.6	2.199
6.25	61.31	-0.01	-0.005	-0.011	-0.01	-19.7044	-9.8522	-21.6749	-19.7044	17.7340	5.0237	22.7577	4551530.9	4.552
10	98.10	-0.012	-0.008	-0.015	-0.015	-23.6453	-15.7635	-29.5567	-29.5567	24.6305	7.5032	32.1338	6426753.3	6.427
15	147.15	-0.015	-0.011	-0.021	-0.021	-29.5567	-21.6749	-41.3793	-41.3793	33.4975	11.4896	44.9871	8997419.5	8.997
20	196.20	-0.017	-0.014	-0.024	-0.025	-33.4975	-27.5862	-47.2906	-49.2611	39.4089	12.8457	52.2546	10450917.2	10.451
25	245.25	-0.02	-0.016	-0.033	-0.033	-39.4089	-31.5271	-65.0246	-65.0246	50.2463	21.0847	71.3310	14266194.0	14.266
30	294.30	-0.024	-0.017	-0.039	-0.041	-47.2906	-33.4975	-76.8473	-80.7882	59.6059	27.8837	87.4896	17497919.9	17.498
35	343.35	-0.026	-0.019	-0.046	-0.048	-51.2315	-37.4384	-90.6404	-94.5813	68.4729	34.7072	103.1801	20636025.6	20.636
37.5	367.88	-0.027	-0.021	-0.048	-0.051	-53.2020	-41.3793	-94.5813	-100.4926	72.4138	36.0785	108.4923	21698456.5	21.698
42.5	416.93	-0.029	-0.022	-0.055	-0.058	-57.1429	-43.3498	-108.3744	-114.2857	80.7882	43.7509	124.5391	24907824.0	24.908
47.5	465.98	-0.031	-0.026	-0.061	-0.064	-61.0837	-51.2315	-120.1970	-126.1084	89.6552	47.6994	137.3546	27470911.1	27.471
52.5	515.03	-0.032	-0.027	-0.067	-0.072	-63.0542	-53.2020	-132.0197	-141.8719	97.5369	56.1663	153.7032	30740644.6	30.741
55	539.55	-0.03	-0.029	-0.069	-0.076	-59.1133	-57.1429	-135.9606	-149.7537	100.4926	60.1712	160.6638	32132753.9	32.133
57.5	564.08	-0.027	-0.03	-0.072	-0.078	-53.2020	-59.1133	-141.8719	-153.6946	101.9704	64.8228	166.7932	33358647.6	33.359
60	588.60	-0.028	-0.032	-0.077	-0.082	-55.1724	-63.0542	-151.7241	-161.5764	107.8818	68.9726	176.8543	35370865.5	35.371

RUN 4		COCKPIT STRUCTURE 1 (b) [CS1(b)]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	-0.002	-0.002	-0.005	-0.005	-3.9409	-3.9409	-9.8522	-9.8522	6.8966	4.1799	11.0765	2215298.7	2.215
6.25	61.31	-0.006	-0.006	-0.012	-0.01	-11.8227	-11.8227	-23.6453	-19.7044	16.7488	7.1045	23.8533	4770660.6	4.771
10	98.10	-0.009	-0.009	-0.015	-0.014	-17.7340	-17.7340	-29.5567	-27.5862	23.1527	7.6948	30.8475	6169507.3	6.170
15	147.15	-0.012	-0.012	-0.022	-0.021	-23.6453	-23.6453	-43.3498	-41.3793	33.0049	13.2548	46.2597	9251945.6	9.252
20	196.20	-0.015	-0.015	-0.028	-0.027	-29.5567	-29.5567	-55.1724	-53.2020	41.8719	17.4304	59.3023	11860454.4	11.860
25	245.25	-0.017	-0.016	-0.033	-0.034	-33.4975	-31.5271	-65.0246	-66.9951	49.2611	23.7273	72.9884	14597672.7	14.598
30	294.30	-0.02	-0.018	-0.04	-0.041	-39.4089	-35.4680	-78.8177	-80.7882	58.6207	30.0291	88.6498	17729951.0	17.730
35	343.35	-0.024	-0.022	-0.047	-0.047	-47.2906	-43.3498	-92.6108	-92.6108	68.9655	33.4685	102.4341	20486812.9	20.487
37.5	367.88	-0.025	-0.023	-0.051	-0.052	-49.2611	-45.3202	-100.4926	-102.4631	74.3842	38.3731	112.7573	22551464.9	22.551
42.5	416.93	-0.029	-0.026	-0.056	-0.057	-57.1429	-51.2315	-110.3448	-112.3153	82.7586	40.5021	123.2607	24652139.8	24.652
47.5	465.98	-0.032	-0.027	-0.062	-0.064	-63.0542	-53.2020	-122.1675	-126.1084	91.1330	46.9301	138.0631	27612615.1	27.613
52.5	515.03	-0.035	-0.029	-0.068	-0.071	-68.9655	-57.1429	-133.9901	-139.9015	100.0000	52.6241	152.6241	30524823.9	30.525
55	539.55	-0.036	-0.029	-0.071	-0.075	-70.9360	-57.1429	-139.9015	-147.7833	103.9409	56.9472	160.8881	32177612.6	32.178
57.5	564.08	-0.038	-0.031	-0.074	-0.078	-74.8768	-61.0837	-145.8128	-153.6946	108.8670	58.3281	167.1951	33439022.8	33.439
60	588.60	-0.039	-0.032	-0.077	-0.081	-76.8473	-63.0542	-151.7241	-159.6059	112.8079	61.0917	173.8996	34779914.1	34.780

Experimental test data (continued)

RUN 5		COCKPIT STRUCTURE 1 (b) [CS1(b)]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	-0.002	-0.001	-0.004	-0.005	-3.9409	-1.9704	-7.8818	-9.8522	5.9113	4.4060	10.3174	2063475.1	2.063
6.25	61.31	-0.001	-0.005	-0.011	-0.01	-1.9704	-9.8522	-21.6749	-19.7044	13.3005	11.0151	24.3156	4863121.2	4.863
10	98.10	-0.006	-0.009	-0.016	-0.017	-11.8227	-17.7340	-31.5271	-33.4975	23.6453	12.6170	36.2623	7252462.8	7.252
15	147.15	-0.009	-0.011	-0.022	-0.022	-17.7340	-21.6749	-43.3498	-43.3498	31.5271	16.7777	48.3048	9660962.8	9.661
20	196.20	-0.012	-0.017	-0.029	-0.028	-23.6453	-33.4975	-57.1429	-55.1724	42.3645	19.9492	62.3138	12462750.1	12.463
25	245.25	-0.019	-0.022	-0.034	-0.032	-37.4384	-43.3498	-66.9951	-63.0542	52.7094	17.7613	70.4707	14094139.2	14.094
30	294.30	-0.021	-0.021	-0.041	-0.041	-41.3793	-41.3793	-80.7882	-80.7882	61.0837	27.8663	88.9500	17790004.2	17.790
35	343.35	-0.026	-0.023	-0.046	-0.047	-51.2315	-45.3202	-90.6404	-92.6108	69.9507	30.7793	100.7300	20146009.6	20.146
37.5	367.88	-0.03	-0.024	-0.049	-0.051	-59.1133	-47.2906	-96.5517	-100.4926	75.8621	32.5272	108.3893	21677861.7	21.678
42.5	416.93	-0.036	-0.027	-0.056	-0.058	-70.9360	-53.2020	-110.3448	-114.2857	87.1921	36.3465	123.5387	24707730.7	24.708
47.5	465.98	-0.039	-0.03	-0.062	-0.064	-76.8473	-59.1133	-122.1675	-126.1084	96.0591	40.4421	136.5012	27300246.6	27.300
52.5	515.03	-0.042	-0.032	-0.067	-0.07	-82.7586	-63.0542	-132.0197	-137.9310	103.9409	44.8141	148.7549	29750987.5	29.751
55	539.55	-0.044	-0.031	-0.07	-0.075	-86.6995	-61.0837	-137.9310	-147.7833	108.3744	50.3524	158.7268	31745365.4	31.745
57.5	564.08	-0.048	-0.035	-0.074	-0.077	-94.5813	-68.9655	-145.8128	-151.7241	115.2709	48.6664	163.9373	32787459.3	32.787
60	588.60	-0.05	-0.036	-0.078	-0.082	-98.5222	-70.9360	-153.6946	-161.5764	121.1823	53.0558	174.2381	34847615.4	34.848

RUN 6		COCKPIT STRUCTURE 1 (b) [CS1(b)]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	-0.001	-0.002	-0.004	-0.004	-1.9704	-3.9409	-7.8818	-7.8818	5.4187	3.5523	8.9710	1794197.3	1.794
6.25	61.31	-0.004	-0.004	-0.01	-0.01	-7.8818	-7.8818	-19.7044	-19.7044	13.7931	8.3599	22.1530	4430597.3	4.431
10	98.10	-0.006	-0.007	-0.016	-0.015	-11.8227	-13.7931	-31.5271	-29.5567	21.6749	12.6170	34.2919	6858374.1	6.858
15	147.15	-0.009	-0.01	-0.021	-0.021	-17.7340	-19.7044	-41.3793	-41.3793	30.0493	16.0382	46.0875	9217501.6	9.218
20	196.20	-0.012	-0.013	-0.027	-0.027	-23.6453	-25.6158	-53.2020	-53.2020	38.9163	20.2151	59.1313	11826263.0	11.826
25	245.25	-0.015	-0.015	-0.032	-0.033	-29.5567	-29.5567	-63.0542	-65.0246	46.7980	24.3929	71.1910	14238194.4	14.238
30	294.30	-0.018	-0.016	-0.038	-0.04	-35.4680	-31.5271	-74.8768	-78.8177	55.1724	30.7793	85.9517	17190344.6	17.190
35	343.35	-0.021	-0.018	-0.044	-0.047	-41.3793	-35.4680	-86.6995	-92.6108	64.0394	36.4665	100.5059	20101184.4	20.101
37.5	367.88	-0.022	-0.019	-0.047	-0.051	-43.3498	-37.4384	-92.6108	-100.4926	68.4729	40.0078	108.4807	21696134.2	21.696
42.5	416.93	-0.025	-0.022	-0.053	-0.057	-49.2611	-43.3498	-104.4335	-112.3153	77.3399	44.1595	121.4994	24299875.8	24.300
47.5	465.98	-0.029	-0.024	-0.06	-0.064	-57.1429	-47.2906	-118.2266	-126.1084	87.1921	49.8584	137.0506	27410113.0	27.410
52.5	515.03	-0.033	-0.027	-0.066	-0.071	-65.0246	-53.2020	-130.0493	-139.9015	97.0443	54.1872	151.2315	30246305.4	30.246
55	539.55	-0.034	-0.028	-0.069	-0.075	-66.9951	-55.1724	-135.9606	-147.7833	101.4778	57.7343	159.2122	31842431.8	31.842
57.5	564.08	-0.035	-0.028	-0.072	-0.078	-68.9655	-55.1724	-141.8719	-153.6946	104.9261	61.2821	166.2082	33241632.7	33.242
60	588.60	-0.037	-0.03	-0.075	-0.081	-72.9064	-59.1133	-147.7833	-159.6059	109.8522	62.6604	172.5126	34502525.0	34.503

Experimental test data (continued)

RUN 7		COCKPIT STRUCTURE 1 (b) [CS1(b)]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	-0.002	-0.002	-0.005	-0.005	-3.9409	-3.9409	-9.8522	-9.8522	6.8966	4.1799	11.0765	2215298.7	2.215
6.25	61.31	-0.005	-0.006	-0.011	-0.01	-9.8522	-11.8227	-21.6749	-19.7044	15.7635	7.1045	22.8681	4573616.3	4.574
10	98.10	-0.008	-0.009	-0.017	-0.016	-15.7635	-17.7340	-33.4975	-31.5271	24.6305	11.2333	35.8638	7172759.5	7.173
15	147.15	-0.011	-0.012	-0.022	-0.022	-21.6749	-23.6453	-43.3498	-43.3498	33.0049	14.6464	47.6513	9530259.9	9.530
20	196.20	-0.015	-0.015	-0.028	-0.027	-29.5567	-29.5567	-55.1724	-53.2020	41.8719	17.4304	59.3023	11860454.4	11.860
25	245.25	-0.018	-0.016	-0.034	-0.035	-35.4680	-31.5271	-66.9951	-68.9655	50.7389	24.4724	75.2113	15042263.0	15.042
30	294.30	-0.021	-0.019	-0.04	-0.041	-41.3793	-37.4384	-78.8177	-80.7882	59.6059	28.6393	88.2452	17649041.1	17.649
35	343.35	-0.024	-0.02	-0.046	-0.048	-47.2906	-39.4089	-90.6404	-94.5813	67.9803	35.0827	103.0630	20612608.4	20.613
37.5	367.88	-0.026	-0.022	-0.05	-0.052	-51.2315	-43.3498	-98.5222	-102.4631	73.8916	37.8510	111.7426	22348521.3	22.349
42.5	416.93	-0.028	-0.024	-0.055	-0.058	-55.1724	-47.2906	-108.3744	-114.2857	81.2808	42.7750	124.0558	24811150.1	24.811
47.5	465.98	-0.032	-0.027	-0.062	-0.066	-63.0542	-53.2020	-122.1675	-130.0493	92.1182	48.4765	140.5947	28118947.5	28.119
52.5	515.03	-0.035	-0.029	-0.068	-0.073	-68.9655	-57.1429	-133.9901	-143.8424	100.9852	54.1872	155.1724	31034482.8	31.034
55	539.55	-0.037	-0.03	-0.071	-0.076	-72.9064	-59.1133	-139.9015	-149.7537	105.4187	56.3561	161.7748	32354955.4	32.355
57.5	564.08	-0.038	-0.031	-0.074	-0.079	-74.8768	-61.0837	-145.8128	-155.6650	109.3596	59.1133	168.4729	33694581.3	33.695
60	588.60	-0.04	-0.032	-0.078	-0.084	-78.8177	-63.0542	-153.6946	-165.5172	115.2709	63.4532	178.7241	35744821.4	35.745

RUN 8		COCKPIT STRUCTURE 1 (b) [CS1(b)]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	-0.002	-0.003	-0.005	-0.005	-3.9409	-5.9113	-9.8522	-9.8522	7.3892	3.5523	10.9414	2188286.0	2.188
6.25	61.31	-0.004	-0.006	-0.012	-0.011	-7.8818	-11.8227	-23.6453	-21.6749	16.2562	9.2946	25.5507	5110144.1	5.110
10	98.10	-0.008	-0.008	-0.017	-0.016	-15.7635	-15.7635	-33.4975	-31.5271	24.1379	11.8636	36.0016	7200314.2	7.200
15	147.15	-0.011	-0.012	-0.023	-0.022	-21.6749	-23.6453	-45.3202	-43.3498	33.4975	15.3897	48.8872	9777438.3	9.777
20	196.20	-0.014	-0.013	-0.029	-0.029	-27.5862	-25.6158	-57.1429	-57.1429	41.8719	21.6076	63.4795	12695903.9	12.696
25	245.25	-0.017	-0.016	-0.035	-0.035	-33.4975	-31.5271	-68.9655	-68.9655	50.7389	25.7857	76.5246	15304927.0	15.305
30	294.30	-0.021	-0.019	-0.041	-0.042	-41.3793	-37.4384	-80.7882	-82.7586	60.5911	30.0291	90.6202	18124039.7	18.124
35	343.35	-0.024	-0.02	-0.047	-0.043	-47.2906	-39.4089	-92.6108	-84.7291	66.0099	32.0462	98.0561	19611214.2	19.611
37.5	367.88	-0.026	-0.023	-0.05	-0.052	-51.2315	-45.3202	-98.5222	-102.4631	74.3842	37.0868	111.4710	22294199.1	22.294
42.5	416.93	-0.029	-0.023	-0.056	-0.059	-57.1429	-45.3202	-110.3448	-116.2562	82.2660	44.3350	126.6010	25320197.0	25.320
47.5	465.98	-0.032	-0.027	-0.063	-0.066	-63.0542	-53.2020	-124.1379	-130.0493	92.6108	49.0834	141.6943	28338852.2	28.339
52.5	515.03	-0.035	-0.029	-0.069	-0.073	-68.9655	-57.1429	-135.9606	-143.8424	101.4778	54.7840	156.2618	31252365.5	31.252
55	539.55	-0.037	-0.031	-0.072	-0.076	-72.9064	-61.0837	-141.8719	-149.7537	106.4039	56.1663	162.5702	32514043.6	32.514
57.5	564.08	-0.039	-0.032	-0.075	-0.08	-76.8473	-63.0542	-147.7833	-157.6355	111.3300	59.1133	170.4433	34088670.0	34.089
60	588.60	-0.04	-0.032	-0.078	-0.083	-78.8177	-63.0542	-153.6946	-163.5468	114.7783	62.6604	177.4387	35487746.7	35.488

Experimental test data (continued)

RUN 9		COCKPIT STRUCTURE 1 (b) [CS1(b)]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	-0.002	-0.002	-0.005	-0.005	-3.9409	-3.9409	-9.8522	-9.8522	6.8966	4.1799	11.0765	2215298.7	2.215
6.25	61.31	-0.006	-0.005	-0.012	-0.011	-11.8227	-9.8522	-23.6453	-21.6749	16.7488	8.3599	25.1087	5021730.3	5.022
10	98.10	-0.008	-0.008	-0.017	-0.016	-15.7635	-15.7635	-33.4975	-31.5271	24.1379	11.8636	36.0016	7200314.2	7.200
15	147.15	-0.012	-0.011	-0.023	-0.022	-23.6453	-21.6749	-45.3202	-43.3498	33.4975	15.3265	48.8240	9764797.9	9.765
20	196.20	-0.016	-0.014	-0.029	-0.028	-31.5271	-27.5862	-57.1429	-55.1724	42.8571	18.8226	61.6798	12335955.3	12.336
25	245.25	-0.018	-0.015	-0.035	-0.035	-35.4680	-29.5567	-68.9655	-68.9655	50.7389	25.8609	76.5998	15319962.5	15.320
30	294.30	-0.022	-0.018	-0.04	-0.042	-43.3498	-35.4680	-78.8177	-82.7586	60.0985	29.5567	89.6552	17931034.5	17.931
35	343.35	-0.025	-0.02	-0.047	-0.049	-49.2611	-39.4089	-92.6108	-96.5517	69.4581	35.8626	105.3207	21064147.7	21.064
37.5	367.88	-0.026	-0.021	-0.05	-0.053	-51.2315	-41.3793	-98.5222	-104.4335	73.8916	39.4089	113.3005	22660098.5	22.660
42.5	416.93	-0.028	-0.023	-0.056	-0.059	-55.1724	-45.3202	-110.3448	-116.2562	81.7734	44.9330	126.7064	25341284.1	25.341
47.5	465.98	-0.032	-0.026	-0.063	-0.066	-63.0542	-51.2315	-124.1379	-130.0493	92.1182	49.8584	141.9767	28395334.7	28.395
52.5	515.03	-0.036	-0.028	-0.069	-0.073	-70.9360	-55.1724	-135.9606	-143.8424	101.4778	54.9785	156.4564	31291276.0	31.291
55	539.55	-0.037	-0.03	-0.072	-0.076	-72.9064	-59.1133	-141.8719	-149.7537	105.9113	56.9472	162.8585	32571701.3	32.572
57.5	564.08	-0.039	-0.031	-0.075	-0.08	-76.8473	-61.0837	-147.7833	-157.6355	110.8374	59.9044	170.7418	34148366.6	34.148
60	588.60	-0.041	-0.032	-0.078	-0.083	-80.7882	-63.0542	-153.6946	-163.5468	115.2709	62.0768	177.3477	35469544.0	35.470

RUN 10		COCKPIT STRUCTURE 1 (b) [CS1(b)]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	-0.002	-0.003	-0.006	-0.005	-3.9409	-5.9113	-11.8227	-9.8522	7.8818	4.4060	12.2878	2457563.7	2.458
6.25	61.31	-0.005	-0.006	-0.013	-0.011	-9.8522	-11.8227	-25.6158	-21.6749	17.2414	9.2946	26.5359	5307188.4	5.307
10	98.10	-0.008	-0.008	-0.018	-0.017	-15.7635	-15.7635	-35.4680	-33.4975	25.1232	13.2548	38.3780	7675590.9	7.676
15	147.15	-0.012	-0.012	-0.023	-0.022	-23.6453	-23.6453	-45.3202	-43.3498	33.9901	14.6464	48.6365	9727304.2	9.727
20	196.20	-0.014	-0.014	-0.029	-0.029	-27.5862	-27.5862	-57.1429	-57.1429	42.3645	20.8997	63.2642	12652848.0	12.653
25	245.25	-0.018	-0.017	-0.035	-0.035	-35.4680	-33.4975	-68.9655	-68.9655	51.7241	24.3929	76.1171	15223416.1	15.223
30	294.30	-0.021	-0.019	-0.041	-0.042	-41.3793	-37.4384	-80.7882	-82.7586	60.5911	30.0291	90.6202	18124039.7	18.124
35	343.35	-0.024	-0.02	-0.047	-0.05	-47.2906	-39.4089	-92.6108	-98.5222	69.4581	37.2435	106.7016	21340318.5	21.340
37.5	367.88	-0.026	-0.022	-0.05	-0.052	-51.2315	-43.3498	-98.5222	-102.4631	73.8916	37.8510	111.7426	22348521.3	22.349
42.5	416.93	-0.029	-0.025	-0.056	-0.059	-57.1429	-49.2611	-110.3448	-116.2562	83.2512	42.7750	126.0262	25205238.8	25.205
47.5	465.98	-0.032	-0.027	-0.063	-0.066	-63.0542	-53.2020	-124.1379	-130.0493	92.6108	49.0834	141.6943	28338852.2	28.339
52.5	515.03	-0.035	-0.029	-0.07	-0.074	-68.9655	-57.1429	-137.9310	-145.8128	102.4631	56.1663	158.6293	31725866.3	31.726
55	539.55	-0.037	-0.03	-0.072	-0.077	-72.9064	-59.1133	-141.8719	-151.7241	106.4039	57.7343	164.1383	32827653.5	32.828
57.5	564.08	-0.038	-0.031	-0.075	-0.081	-74.8768	-61.0837	-147.7833	-159.6059	110.8374	61.2821	172.1195	34423898.8	34.424
60	588.60	-0.039	-0.032	-0.078	-0.084	-76.8473	-63.0542	-153.6946	-165.5172	114.7783	64.0394	178.8177	35763546.8	35.764

Experimental test data (continued)

RUN 1		COCKPIT STRUCTURE 2 [CS2]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.001	0.003	0.002	0.001	1.9704	5.9113	3.9409	1.9704	3.4483	2.2030	5.6513	1130259.7	1.130
6.25	61.31	0.004	0.007	0.006	0.003	7.8818	13.7931	11.8227	5.9113	9.8522	4.4060	14.2583	2851652.4	2.852
10	98.10	0.006	0.011	0.009	0.005	11.8227	21.6749	17.7340	9.8522	15.2709	6.6091	21.8800	4376000.8	4.376
15	147.15	0.01	0.017	0.013	0.007	19.7044	33.4975	25.6158	13.7931	23.1527	10.2860	33.4387	6687745.1	6.688
20	196.20	0.013	0.023	0.018	0.009	25.6158	45.3202	35.4680	17.7340	31.0345	14.6464	45.6809	9136171.2	9.136
25	245.25	0.016	0.028	0.023	0.011	31.5271	55.1724	45.3202	21.6749	38.4236	18.1131	56.5367	11307345.1	11.307
30	294.30	0.02	0.035	0.027	0.013	39.4089	68.9655	53.2020	25.6158	46.7980	22.7456	69.5436	13908727.6	13.909
35	343.35	0.024	0.041	0.032	0.015	47.2906	80.7882	63.0542	29.5567	55.1724	26.8009	81.9733	16394668.2	16.395
37.5	367.88	0.026	0.044	0.035	0.016	51.2315	86.6995	68.9655	31.5271	59.6059	28.9762	88.5822	17716430.0	17.716
42.5	416.93	0.029	0.05	0.039	0.019	57.1429	98.5222	76.8473	37.4384	67.4877	32.0916	99.5793	19915861.1	19.916
47.5	465.98	0.033	0.057	0.045	0.022	65.0246	112.3153	88.6700	43.3498	77.3399	36.4532	113.7931	22758620.7	22.759
52.5	515.03	0.037	0.064	0.05	0.024	72.9064	126.1084	98.5222	47.2906	86.2069	41.4379	127.6448	25528961.9	25.529
55	539.55	0.038	0.067	0.053	0.025	74.8768	132.0197	104.4335	49.2611	90.1478	43.9391	134.0869	26817380.5	26.817
57.5	564.08	0.04	0.07	0.055	0.026	78.8177	137.9310	108.3744	51.2315	94.0887	45.7996	139.8882	27977646.7	27.978
60	588.60	0.042	0.073	0.058	0.027	82.7586	143.8424	114.2857	53.2020	98.5222	47.9834	146.5056	29301119.7	29.301

RUN 2		COCKPIT STRUCTURE 2 [CS2]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.002	0.003	0.002	0.003	3.9409	5.9113	3.9409	5.9113	4.9261	0.0000	4.9261	985221.7	0.985
6.25	61.31	0.004	0.007	0.006	0.003	7.8818	13.7931	11.8227	5.9113	9.8522	4.4060	14.2583	2851652.4	2.852
10	98.10	0.007	0.011	0.009	0.004	13.7931	21.6749	17.7340	7.8818	15.2709	7.1725	22.4435	4488691.6	4.489
15	147.15	0.01	0.017	0.014	0.007	19.7044	33.4975	27.5862	13.7931	23.6453	10.6112	34.2565	6851296.5	6.851
20	196.20	0.013	0.023	0.018	0.009	25.6158	45.3202	35.4680	17.7340	31.0345	14.6464	45.6809	9136171.2	9.136
25	245.25	0.017	0.029	0.023	0.011	33.4975	57.1429	45.3202	21.6749	39.4089	18.6933	58.1021	11620426.8	11.620
30	294.30	0.021	0.035	0.028	0.013	41.3793	68.9655	55.1724	25.6158	47.7833	22.7456	70.5289	14105772.0	14.106
35	343.35	0.024	0.041	0.033	0.016	47.2906	80.7882	65.0246	31.5271	56.1576	26.1780	82.3356	16467125.2	16.467
37.5	367.88	0.026	0.045	0.036	0.017	51.2315	88.6700	70.9360	33.4975	61.0837	29.2927	90.3765	18075298.0	18.075
42.5	416.93	0.029	0.05	0.039	0.019	57.1429	98.5222	76.8473	37.4384	67.4877	32.0916	99.5793	19915861.1	19.916
47.5	465.98	0.033	0.057	0.045	0.021	65.0246	112.3153	88.6700	41.3793	76.8473	37.3865	114.2338	22846764.9	22.847
52.5	515.03	0.037	0.064	0.05	0.024	72.9064	126.1084	98.5222	47.2906	86.2069	41.4379	127.6448	25528961.9	25.529
55	539.55	0.039	0.067	0.053	0.025	76.8473	132.0197	104.4335	49.2611	90.6404	43.6176	134.2580	26851603.4	26.852
57.5	564.08	0.041	0.07	0.056	0.026	80.7882	137.9310	110.3448	51.2315	95.0739	45.7996	140.8735	28174691.1	28.175
60	588.60	0.043	0.074	0.058	0.027	84.7291	145.8128	114.2857	53.2020	99.5074	48.6065	148.1139	29622775.5	29.623

Experimental test data (continued)

RUN 3		COCKPIT STRUCTURE 2 [CS2]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.001	0.003	0.002	0.001	1.9704	5.9113	3.9409	1.9704	3.4483	2.2030	5.6513	1130259.7	1.130
6.25	61.31	0.004	0.007	0.006	0.003	7.8818	13.7931	11.8227	5.9113	9.8522	4.4060	14.2583	2851652.4	2.852
10	98.10	0.007	0.011	0.009	0.005	13.7931	21.6749	17.7340	9.8522	15.7635	6.2311	21.9946	4398927.2	4.399
15	147.15	0.01	0.017	0.013	0.007	19.7044	33.4975	25.6158	13.7931	23.1527	10.2860	33.4387	6687745.1	6.688
20	196.20	0.014	0.023	0.018	0.009	27.5862	45.3202	35.4680	17.7340	31.5271	14.3450	45.8721	9174427.5	9.174
25	245.25	0.017	0.028	0.023	0.011	33.4975	55.1724	45.3202	21.6749	38.9163	17.7613	56.6776	11335518.5	11.336
30	294.30	0.021	0.035	0.028	0.013	41.3793	68.9655	55.1724	25.6158	47.7833	22.7456	70.5289	14105772.0	14.106
35	343.35	0.024	0.041	0.032	0.016	47.2906	80.7882	63.0542	31.5271	55.6650	25.8609	81.5259	16305184.1	16.305
37.5	367.88	0.026	0.044	0.035	0.017	51.2315	86.6995	68.9655	33.4975	60.0985	28.0399	88.1384	17627684.5	17.628
42.5	416.93	0.029	0.05	0.039	0.019	57.1429	98.5222	76.8473	37.4384	67.4877	32.0916	99.5793	19915861.1	19.916
47.5	465.98	0.034	0.057	0.044	0.021	66.9951	112.3153	86.6995	41.3793	76.8473	36.8109	113.6582	22731642.0	22.732
52.5	515.03	0.037	0.063	0.05	0.023	72.9064	124.1379	98.5222	45.3202	85.2217	41.4379	126.6596	25331917.6	25.332
55	539.55	0.039	0.067	0.052	0.024	76.8473	132.0197	102.4631	47.2906	89.6552	44.2583	133.9135	26782690.6	26.783
57.5	564.08	0.041	0.07	0.055	0.026	80.7882	137.9310	108.3744	51.2315	94.5813	45.4912	140.0725	28014499.6	28.014
60	588.60	0.042	0.073	0.057	0.027	82.7586	143.8424	112.3153	53.2020	98.0296	47.6688	145.6984	29139681.1	29.140

RUN 4		COCKPIT STRUCTURE 2												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.002	0.003	0.003	0.002	3.9409	5.9113	5.9113	3.9409	4.9261	1.3933	6.3194	1263884.4	1.264
6.25	61.31	0.005	0.008	0.006	0.004	9.8522	15.7635	11.8227	7.8818	11.3300	4.0622	15.3922	3078444.5	3.078
10	98.10	0.008	0.012	0.01	0.006	15.7635	23.6453	19.7044	11.8227	17.7340	6.2311	23.9651	4793015.8	4.793
15	147.15	0.011	0.018	0.014	0.008	21.6749	35.4680	27.5862	15.7635	25.1232	10.2860	35.4092	7081833.8	7.082
20	196.20	0.015	0.024	0.019	0.011	29.5567	47.2906	37.4384	21.6749	33.9901	13.4005	47.3906	9478122.3	9.478
25	245.25	0.018	0.031	0.024	0.013	35.4680	61.0837	47.2906	25.6158	42.3645	18.6933	61.0578	12211559.8	12.212
30	294.30	0.022	0.037	0.029	0.015	43.3498	72.9064	57.1429	29.5567	50.7389	22.7456	73.4845	14696905.0	14.697
35	343.35	0.026	0.043	0.034	0.018	51.2315	84.7291	66.9951	35.4680	59.6059	25.8609	85.4668	17093361.5	17.093
37.5	367.88	0.028	0.047	0.037	0.019	55.1724	92.6108	72.9064	37.4384	64.5320	28.9762	93.5083	18701651.7	18.702
42.5	416.93	0.031	0.052	0.041	0.021	61.0837	102.4631	80.7882	41.3793	71.4286	32.0916	103.5202	20704038.4	20.704
47.5	465.98	0.036	0.06	0.047	0.024	70.9360	118.2266	92.6108	47.2906	82.2660	37.0868	119.3528	23870553.8	23.871
52.5	515.03	0.039	0.066	0.052	0.026	76.8473	130.0493	102.4631	51.2315	90.1478	41.4379	131.5857	26317139.2	26.317
55	539.55	0.041	0.07	0.054	0.028	80.7882	137.9310	106.4039	55.1724	95.0739	43.3162	138.3900	27678009.0	27.678
57.5	564.08	0.043	0.073	0.059	0.029	84.7291	143.8424	116.2562	57.1429	100.4926	46.1269	146.6195	29323901.4	29.324
60	588.60	0.045	0.076	0.06	0.03	88.6700	149.7537	118.2266	59.1133	103.9409	47.6688	151.6097	30321947.1	30.322

Experimental test data (continued)

RUN 5		COCKPIT STRUCTURE 2 [CS2]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.002	0.003	0.002	0.001	3.9409	5.9113	3.9409	1.9704	3.9409	1.9704	5.9113	1182266.0	1.182
6.25	61.31	0.004	0.007	0.005	0.003	7.8818	13.7931	9.8522	5.9113	9.3596	4.0622	13.4218	2684355.8	2.684
10	98.10	0.007	0.011	0.009	0.004	13.7931	21.6749	17.7340	7.8818	15.2709	7.1725	22.4435	4488691.6	4.489
15	147.15	0.01	0.017	0.013	0.007	19.7044	33.4975	25.6158	13.7931	23.1527	10.2860	33.4387	6687745.1	6.688
20	196.20	0.013	0.023	0.018	0.009	25.6158	45.3202	35.4680	17.7340	31.0345	14.6464	45.6809	9136171.2	9.136
25	245.25	0.017	0.029	0.022	0.011	33.4975	57.1429	43.3498	21.6749	38.9163	18.4055	57.3217	11464343.2	11.464
30	294.30	0.021	0.035	0.027	0.013	41.3793	68.9655	53.2020	25.6158	47.2906	22.4665	69.7572	13951430.2	13.951
35	343.35	0.024	0.041	0.032	0.015	47.2906	80.7882	63.0542	29.5567	55.1724	26.8009	81.9733	16394668.2	16.395
37.5	367.88	0.026	0.045	0.035	0.017	51.2315	88.6700	68.9655	33.4975	60.5911	28.9762	89.5674	17913474.4	17.913
42.5	416.93	0.03	0.05	0.039	0.019	59.1133	98.5222	76.8473	37.4384	67.9803	31.8030	99.7833	19956655.1	19.957
47.5	465.98	0.034	0.057	0.045	0.021	66.9951	112.3153	88.6700	41.3793	77.3399	37.0868	114.4267	22885332.1	22.885
52.5	515.03	0.038	0.064	0.052	0.024	74.8768	126.1084	102.4631	47.2906	87.6847	41.7529	129.4377	25887535.0	25.888
55	539.55	0.039	0.067	0.052	0.025	76.8473	132.0197	102.4631	49.2611	90.1478	43.3162	133.4639	26692787.4	26.693
57.5	564.08	0.041	0.07	0.055	0.026	80.7882	137.9310	108.3744	51.2315	94.5813	45.4912	140.0725	28014499.6	28.014
60	588.60	0.043	0.074	0.058	0.027	84.7291	145.8128	114.2857	53.2020	99.5074	48.6065	148.1139	29622775.5	29.623

RUN 6		COCKPIT STRUCTURE 2 [CS2]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.002	0.003	0.002	0.001	3.9409	5.9113	3.9409	1.9704	3.9409	1.9704	5.9113	1182266.0	1.182
6.25	61.31	0.004	0.007	0.006	0.003	7.8818	13.7931	11.8227	5.9113	9.8522	4.4060	14.2583	2851652.4	2.852
10	98.10	0.007	0.011	0.009	0.005	13.7931	21.6749	17.7340	9.8522	15.7635	6.2311	21.9946	4398927.2	4.399
15	147.15	0.01	0.017	0.013	0.007	19.7044	33.4975	25.6158	13.7931	23.1527	10.2860	33.4387	6687745.1	6.688
20	196.20	0.014	0.023	0.018	0.009	27.5862	45.3202	35.4680	17.7340	31.5271	14.3450	45.8721	9174427.5	9.174
25	245.25	0.017	0.029	0.023	0.011	33.4975	57.1429	45.3202	21.6749	39.4089	18.6933	58.1021	11620426.8	11.620
30	294.30	0.02	0.035	0.027	0.013	39.4089	68.9655	53.2020	25.6158	46.7980	22.7456	69.5436	13908727.6	13.909
35	343.35	0.024	0.041	0.032	0.015	47.2906	80.7882	63.0542	29.5567	55.1724	26.8009	81.9733	16394668.2	16.395
37.5	367.88	0.026	0.044	0.035	0.017	51.2315	86.6995	68.9655	33.4975	60.0985	28.0399	88.1384	17627684.5	17.628
42.5	416.93	0.029	0.05	0.039	0.019	57.1429	98.5222	76.8473	37.4384	67.4877	32.0916	99.5793	19915861.1	19.916
47.5	465.98	0.033	0.057	0.045	0.021	65.0246	112.3153	88.6700	41.3793	76.8473	37.3865	114.2338	22846764.9	22.847
52.5	515.03	0.037	0.063	0.05	0.023	72.9064	124.1379	98.5222	45.3202	85.2217	41.4379	126.6596	25331917.6	25.332
55	539.55	0.039	0.067	0.052	0.025	76.8473	132.0197	102.4631	49.2611	90.1478	43.3162	133.4639	26692787.4	26.693
57.5	564.08	0.041	0.069	0.055	0.026	80.7882	135.9606	108.3744	51.2315	94.0887	44.5534	138.6420	27728409.1	27.728
60	588.60	0.043	0.073	0.057	0.027	84.7291	143.8424	112.3153	53.2020	98.5222	47.3727	145.8948	29178967.7	29.179

Experimental test data (continued)

RUN 7		COCKPIT STRUCTURE 2 [CS2]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.002	0.003	0.002	0.001	3.9409	5.9113	3.9409	1.9704	3.9409	1.9704	5.9113	1182266.0	1.182
6.25	61.31	0.004	0.007	0.005	0.003	7.8818	13.7931	9.8522	5.9113	9.3596	4.0622	13.4218	2684355.8	2.684
10	98.10	0.007	0.011	0.009	0.004	13.7931	21.6749	17.7340	7.8818	15.2709	7.1725	22.4435	4488691.6	4.489
15	147.15	0.01	0.017	0.013	0.007	19.7044	33.4975	25.6158	13.7931	23.1527	10.2860	33.4387	6687745.1	6.688
20	196.20	0.014	0.023	0.018	0.009	27.5862	45.3202	35.4680	17.7340	31.5271	14.3450	45.8721	9174427.5	9.174
25	245.25	0.017	0.029	0.023	0.011	33.4975	57.1429	45.3202	21.6749	39.4089	18.6933	58.1021	11620426.8	11.620
30	294.30	0.021	0.035	0.028	0.013	41.3793	68.9655	55.1724	25.6158	47.7833	22.7456	70.5289	14105772.0	14.106
35	343.35	0.024	0.041	0.033	0.015	47.2906	80.7882	65.0246	29.5567	55.6650	27.1070	82.7721	16554410.4	16.554
37.5	367.88	0.027	0.045	0.035	0.017	53.2020	88.6700	68.9655	33.4975	61.0837	28.6901	89.7738	17954766.4	17.955
42.5	416.93	0.03	0.05	0.037	0.018	59.1133	98.5222	72.9064	35.4680	66.5025	32.2726	98.7751	19755010.6	19.755
47.5	465.98	0.034	0.057	0.045	0.021	66.9951	112.3153	88.6700	41.3793	77.3399	37.0868	114.4267	22885332.1	22.885
52.5	515.03	0.038	0.064	0.05	0.023	74.8768	126.1084	98.5222	45.3202	86.2069	42.0887	128.2956	25659117.0	25.659
55	539.55	0.04	0.067	0.053	0.025	78.8177	132.0197	104.4335	49.2611	91.1330	43.3162	134.4492	26889831.7	26.890
57.5	564.08	0.041	0.07	0.055	0.026	80.7882	137.9310	108.3744	51.2315	94.5813	45.4912	140.0725	28014499.6	28.014
60	588.60	0.043	0.074	0.058	0.027	84.7291	145.8128	114.2857	53.2020	99.5074	48.6065	148.1139	29622775.5	29.623

RUN 8		COCKPIT STRUCTURE 2 [CS2]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.001	0.003	0.002	0.001	1.9704	5.9113	3.9409	1.9704	3.4483	2.2030	5.6513	1130259.7	1.130
6.25	61.31	0.004	0.007	0.005	0.003	7.8818	13.7931	9.8522	5.9113	9.3596	4.0622	13.4218	2684355.8	2.684
10	98.10	0.006	0.011	0.008	0.004	11.8227	21.6749	15.7635	7.8818	14.2857	7.1725	21.4582	4291647.3	4.292
15	147.15	0.01	0.017	0.013	0.007	19.7044	33.4975	25.6158	13.7931	23.1527	10.2860	33.4387	6687745.1	6.688
20	196.20	0.013	0.023	0.018	0.009	25.6158	45.3202	35.4680	17.7340	31.0345	14.6464	45.6809	9136171.2	9.136
25	245.25	0.017	0.029	0.023	0.011	33.4975	57.1429	45.3202	21.6749	39.4089	18.6933	58.1021	11620426.8	11.620
30	294.30	0.02	0.035	0.027	0.013	39.4089	68.9655	53.2020	25.6158	46.7980	22.7456	69.5436	13908727.6	13.909
35	343.35	0.024	0.041	0.032	0.015	47.2906	80.7882	63.0542	29.5567	55.1724	26.8009	81.9733	16394668.2	16.395
37.5	367.88	0.026	0.045	0.035	0.017	51.2315	88.6700	68.9655	33.4975	60.5911	28.9762	89.5674	17913474.4	17.913
42.5	416.93	0.03	0.05	0.039	0.018	59.1133	98.5222	76.8473	35.4680	67.4877	32.7503	100.2380	20047594.1	20.048
47.5	465.98	0.034	0.057	0.045	0.021	66.9951	112.3153	88.6700	41.3793	77.3399	37.0868	114.4267	22885332.1	22.885
52.5	515.03	0.038	0.064	0.05	0.023	74.8768	126.1084	98.5222	45.3202	86.2069	42.0887	128.2956	25659117.0	25.659
55	539.55	0.039	0.067	0.052	0.024	76.8473	132.0197	102.4631	47.2906	89.6552	44.2583	133.9135	26782690.6	26.783
57.5	564.08	0.041	0.07	0.055	0.025	80.7882	137.9310	108.3744	49.2611	94.0887	46.4310	140.5197	28103938.3	28.104
60	588.60	0.043	0.073	0.058	0.027	84.7291	143.8424	114.2857	53.2020	99.0148	47.6688	146.6836	29336725.4	29.337

Experimental test data (continued)

RUN 9		COCKPIT STRUCTURE 2 [CS2]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.002	0.003	0.002	0.001	3.9409	5.9113	3.9409	1.9704	3.9409	1.9704	5.9113	1182266.0	1.182
6.25	61.31	0.004	0.007	0.006	0.003	7.8818	13.7931	11.8227	5.9113	9.8522	4.4060	14.2583	2851652.4	2.852
10	98.10	0.007	0.011	0.009	0.004	13.7931	21.6749	17.7340	7.8818	15.2709	7.1725	22.4435	4488691.6	4.489
15	147.15	0.01	0.017	0.013	0.007	19.7044	33.4975	25.6158	13.7931	23.1527	10.2860	33.4387	6687745.1	6.688
20	196.20	0.013	0.023	0.018	0.009	25.6158	45.3202	35.4680	17.7340	31.0345	14.6464	45.6809	9136171.2	9.136
25	245.25	0.017	0.029	0.023	0.011	33.4975	57.1429	45.3202	21.6749	39.4089	18.6933	58.1021	11620426.8	11.620
30	294.30	0.02	0.035	0.028	0.013	39.4089	68.9655	55.1724	25.6158	47.2906	23.0634	70.3541	14070817.7	14.071
35	343.35	0.024	0.041	0.033	0.015	47.2906	80.7882	65.0246	29.5567	55.6650	27.1070	82.7721	16554410.4	16.554
37.5	367.88	0.026	0.045	0.035	0.017	51.2315	88.6700	68.9655	33.4975	60.5911	28.9762	89.5674	17913474.4	17.913
42.5	416.93	0.029	0.05	0.039	0.019	57.1429	98.5222	76.8473	37.4384	67.4877	32.0916	99.5793	19915861.1	19.916
47.5	465.98	0.033	0.057	0.045	0.021	65.0246	112.3153	88.6700	41.3793	76.8473	37.3865	114.2338	22846764.9	22.847
52.5	515.03	0.037	0.063	0.05	0.024	72.9064	124.1379	98.5222	47.2906	85.7143	40.5021	126.2164	25243272.8	25.243
55	539.55	0.039	0.067	0.053	0.025	76.8473	132.0197	104.4335	49.2611	90.6404	43.6176	134.2580	26851603.4	26.852
57.5	564.08	0.041	0.07	0.055	0.026	80.7882	137.9310	108.3744	51.2315	94.5813	45.4912	140.0725	28014499.6	28.014
60	588.60	0.043	0.073	0.058	0.027	84.7291	143.8424	114.2857	53.2020	99.0148	47.6688	146.6836	29336725.4	29.337

RUN 10		COCKPIT STRUCTURE 2 [CS2]												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.002	0.003	0.002	0.001	3.9409	5.9113	3.9409	1.9704	3.9409	1.9704	5.9113	1182266.0	1.182
6.25	61.31	0.004	0.007	0.005	0.002	7.8818	13.7931	9.8522	3.9409	8.8670	5.0237	13.8907	2778131.9	2.778
10	98.10	0.007	0.011	0.009	0.004	13.7931	21.6749	17.7340	7.8818	15.2709	7.1725	22.4435	4488691.6	4.489
15	147.15	0.01	0.017	0.013	0.006	19.7044	33.4975	25.6158	11.8227	22.6601	11.2333	33.8934	6778670.8	6.779
20	196.20	0.014	0.023	0.018	0.008	27.5862	45.3202	35.4680	15.7635	31.0345	15.2948	46.3292	9265847.2	9.266
25	245.25	0.017	0.029	0.022	0.011	33.4975	57.1429	43.3498	21.6749	38.9163	18.4055	57.3217	11464343.2	11.464
30	294.30	0.021	0.035	0.027	0.013	41.3793	68.9655	53.2020	25.6158	47.2906	22.4665	69.7572	13951430.2	13.951
35	343.35	0.024	0.041	0.033	0.015	47.2906	80.7882	65.0246	29.5567	55.6650	27.1070	82.7721	16554410.4	16.554
37.5	367.88	0.027	0.045	0.035	0.016	53.2020	88.6700	68.9655	31.5271	60.5911	29.6386	90.2298	18045954.3	18.046
42.5	416.93	0.03	0.05	0.039	0.018	59.1133	98.5222	76.8473	35.4680	67.4877	32.7503	100.2380	20047594.1	20.048
47.5	465.98	0.034	0.057	0.045	0.021	66.9951	112.3153	88.6700	41.3793	77.3399	37.0868	114.4267	22885332.1	22.885
52.5	515.03	0.038	0.063	0.05	0.023	74.8768	124.1379	98.5222	45.3202	85.7143	41.1441	126.8584	25371670.2	25.372
55	539.55	0.039	0.067	0.052	0.024	76.8473	132.0197	102.4631	47.2906	89.6552	44.2583	133.9135	26782690.6	26.783
57.5	564.08	0.041	0.07	0.055	0.026	80.7882	137.9310	108.3744	51.2315	94.5813	45.4912	140.0725	28014499.6	28.014
60	588.60	0.043	0.073	0.057	0.027	84.7291	143.8424	112.3153	53.2020	98.5222	47.3727	145.8948	29178967.7	29.179

Experimental test data (continued)

RUN 1		REAR STRUCTURE												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	-0.005	0	0.004	0	-9.8522	0.0000	7.8818	0.0000	0.4926	8.8670	9.3596	1871921.2	1.872
6.25	61.31	-0.012	-0.001	0.009	-0.001	-23.6453	-1.9704	17.7340	-1.9704	2.4631	20.6897	23.1527	4630541.9	4.631
10	98.10	-0.018	-0.002	0.015	-0.001	-35.4680	-3.9409	29.5567	-1.9704	2.9557	32.5272	35.4829	7096580.9	7.097
15	147.15	-0.027	-0.003	0.022	-0.001	-53.2020	-5.9113	43.3498	-1.9704	4.4335	48.3161	52.7496	10549911.2	10.550
20	196.20	-0.037	-0.003	0.031	-0.002	-72.9064	-5.9113	61.0837	-3.9409	5.4187	67.0023	72.4210	14484207.4	14.484
25	245.25	-0.046	-0.004	0.038	-0.003	-90.6404	-7.8818	74.8768	-5.9113	7.3892	82.7645	90.1536	18030729.5	18.031
30	294.30	-0.056	-0.005	0.047	-0.003	-110.3448	-9.8522	92.6108	-5.9113	8.3744	101.4970	109.8713	21974269.1	21.974
35	343.35	-0.067	-0.006	0.055	-0.005	-132.0197	-11.8227	108.3744	-9.8522	11.3300	120.2011	131.5311	26306226.3	26.306
37.5	367.88	-0.073	-0.007	0.06	-0.005	-143.8424	-13.7931	118.2266	-9.8522	12.3153	131.0493	143.3646	28672913.6	28.673
42.5	416.93	-0.083	-0.008	0.067	-0.006	-163.5468	-15.7635	132.0197	-11.8227	14.7783	147.7964	162.5747	32514942.4	32.515
47.5	465.98	-0.094	-0.009	0.077	-0.006	-185.2217	-17.7340	151.7241	-11.8227	15.7635	168.4988	184.2624	36852475.6	36.852
52.5	515.03	-0.104	-0.01	0.086	-0.007	-204.9261	-19.7044	169.4581	-13.7931	17.2414	187.2155	204.4568	40891366.1	40.891
55	539.55	-0.11	-0.01	0.091	-0.009	-216.7488	-19.7044	179.3103	-17.7340	18.7192	198.0320	216.7512	43350243.9	43.350
57.5	564.08	-0.115	-0.011	0.095	-0.01	-226.6010	-21.6749	187.1921	-19.7044	20.1970	206.8989	227.0959	45419188.4	45.419
60	588.60	-0.121	-0.012	0.1	-0.011	-238.4236	-23.6453	197.0443	-21.6749	21.6749	217.7362	239.4111	47882219.2	47.882

RUN 2		REAR STRUCTURE												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	-0.004	-0.001	0.004	0	-7.8818	-1.9704	7.8818	0.0000	0.4926	7.9431	8.4357	1687144.4	1.687
6.25	61.31	-0.01	-0.001	0.009	-0.001	-19.7044	-1.9704	17.7340	-1.9704	1.4778	18.7192	20.1970	4039408.9	4.039
10	98.10	-0.018	-0.002	0.015	-0.001	-35.4680	-3.9409	29.5567	-1.9704	2.9557	32.5272	35.4829	7096580.9	7.097
15	147.15	-0.026	-0.003	0.002	-0.002	-51.2315	-5.9113	3.9409	-3.9409	14.2857	27.6038	41.8895	8377901.8	8.378
20	196.20	-0.036	-0.004	0.03	-0.003	-70.9360	-7.8818	59.1133	-5.9113	6.4039	65.0321	71.4360	14287207.0	14.287
25	245.25	-0.044	-0.005	0.038	-0.004	-86.6995	-9.8522	74.8768	-7.8818	7.3892	80.7942	88.1833	17636669.4	17.637
30	294.30	-0.054	-0.006	0.046	-0.005	-106.4039	-11.8227	90.6404	-9.8522	9.3596	98.5271	107.8867	21577339.9	21.577
35	343.35	-0.065	-0.007	0.055	-0.006	-128.0788	-13.7931	108.3744	-11.8227	11.3300	118.2307	129.5608	25912151.1	25.912
37.5	367.88	-0.068	-0.007	0.06	-0.006	-133.9901	-13.7931	118.2266	-11.8227	10.3448	126.1122	136.4571	27291410.1	27.291
42.5	416.93	-0.076	-0.008	0.067	-0.006	-149.7537	-15.7635	132.0197	-11.8227	11.3300	140.9005	152.2305	30446105.5	30.446
47.5	465.98	-0.085	-0.008	0.077	-0.006	-167.4877	-15.7635	151.7241	-11.8227	10.8374	159.6181	170.4555	34091102.5	34.091
52.5	515.03	-0.095	-0.01	0.085	-0.006	-187.1921	-19.7044	167.4877	-11.8227	12.8079	177.3837	190.1916	38038313.1	38.038
55	539.55	-0.101	-0.011	0.09	-0.007	-199.0148	-21.6749	177.3399	-13.7931	14.2857	188.2186	202.5043	40500863.1	40.501
57.5	564.08	-0.105	-0.011	0.094	-0.007	-206.8966	-21.6749	185.2217	-13.7931	14.2857	196.0987	210.3844	42076886.1	42.077
60	588.60	-0.109	-0.012	0.1	-0.007	-214.7783	-23.6453	197.0443	-13.7931	13.7931	205.9702	219.7633	43952670.0	43.953

Experimental test data (continued)

RUN 3		REAR STRUCTURE												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	-0.005	0	0.004	0	-9.8522	0.0000	7.8818	0.0000	0.4926	8.8670	9.3596	1871921.2	1.872
6.25	61.31	-0.013	-0.001	0.01	0	-25.6158	-1.9704	19.7044	0.0000	1.9704	22.6815	24.6519	4930389.9	4.930
10	98.10	-0.019	-0.001	0.016	-0.001	-37.4384	-1.9704	31.5271	-1.9704	2.4631	34.4828	36.9458	7389162.6	7.389
15	147.15	-0.028	-0.001	0.023	-0.001	-55.1724	-1.9704	45.3202	-1.9704	3.4483	50.2463	53.6946	10738916.3	10.739
20	196.20	-0.038	-0.002	0.031	-0.002	-74.8768	-3.9409	61.0837	-3.9409	5.4187	67.9803	73.3990	14679803.0	14.680
25	245.25	-0.049	-0.003	0.039	-0.002	-96.5517	-5.9113	76.8473	-3.9409	7.3892	86.7051	94.0943	18818853.5	18.819
30	294.30	-0.061	-0.004	0.048	-0.002	-120.1970	-7.8818	94.5813	-3.9409	9.3596	107.4072	116.7668	23353368.9	23.353
35	343.35	-0.072	-0.005	0.056	-0.001	-141.8719	-9.8522	110.3448	-1.9704	10.8374	126.1699	137.0074	27401474.8	27.401
37.5	367.88	-0.076	-0.005	0.061	0	-149.7537	-9.8522	120.1970	0.0000	9.8522	135.0652	144.9174	28983489.8	28.983
42.5	416.93	-0.083	-0.005	0.069	0	-163.5468	-9.8522	135.9606	0.0000	9.3596	149.8347	159.1943	31838860.0	31.839
47.5	465.98	-0.092	-0.006	0.079	-0.001	-181.2808	-11.8227	155.6650	-1.9704	9.8522	168.5449	178.3971	35679425.4	35.679
52.5	515.03	-0.102	-0.007	0.088	-0.006	-200.9852	-13.7931	173.3990	-11.8227	13.3005	187.1947	200.4952	40099040.7	40.099
55	539.55	-0.106	-0.008	0.092	-0.008	-208.8670	-15.7635	181.2808	-15.7635	14.7783	195.0739	209.8522	41970443.3	41.970
57.5	564.08	-0.11	-0.008	0.097	-0.011	-216.7488	-15.7635	191.1330	-21.6749	15.7635	203.9623	219.7259	43945170.0	43.945
60	588.60	-0.114	-0.008	0.101	-0.013	-224.6305	-15.7635	199.0148	-25.6158	16.7488	211.8799	228.6287	45725740.2	45.726

RUN 4		REAR STRUCTURE												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	-0.005	-0.001	0.003	0	-9.8522	-1.9704	5.9113	0.0000	1.4778	7.9431	9.4209	1884188.7	1.884
6.25	61.31	-0.011	-0.001	0.009	-0.001	-21.6749	-1.9704	17.7340	-1.9704	1.9704	19.7044	21.6749	4334975.4	4.335
10	98.10	-0.018	-0.002	0.014	-0.001	-35.4680	-3.9409	27.5862	-1.9704	3.4483	31.5425	34.9908	6998152.0	6.998
15	147.15	-0.026	-0.003	0.022	-0.002	-51.2315	-5.9113	43.3498	-3.9409	4.4335	47.3009	51.7344	10346879.9	10.347
20	196.20	-0.036	-0.004	0.03	-0.003	-70.9360	-7.8818	59.1133	-5.9113	6.4039	65.0321	71.4360	14287207.0	14.287
25	245.25	-0.045	-0.004	0.038	-0.004	-88.6700	-7.8818	74.8768	-7.8818	7.3892	81.7734	89.1626	17832512.3	17.833
30	294.30	-0.054	-0.005	0.047	-0.004	-106.4039	-9.8522	92.6108	-7.8818	7.8818	99.5123	107.3940	21478808.0	21.479
35	343.35	-0.064	-0.006	0.055	-0.005	-126.1084	-11.8227	108.3744	-9.8522	9.8522	117.2455	127.0977	25419547.1	25.420
37.5	367.88	-0.069	-0.007	0.06	-0.006	-135.9606	-13.7931	118.2266	-11.8227	10.8374	127.0974	137.9349	27586970.6	27.587
42.5	416.93	-0.077	-0.007	0.067	-0.006	-151.7241	-13.7931	132.0197	-11.8227	11.3300	141.8753	153.2054	30641078.3	30.641
47.5	465.98	-0.088	-0.008	0.077	-0.007	-173.3990	-15.7635	151.7241	-13.7931	12.8079	162.5646	175.3724	35074488.7	35.074
52.5	515.03	-0.098	-0.009	0.086	-0.007	-193.1034	-17.7340	169.4581	-13.7931	13.7931	181.2915	195.0846	39016920.0	39.017
55	539.55	-0.103	-0.01	0.09	-0.007	-202.9557	-19.7044	177.3399	-13.7931	14.7783	190.1708	204.9491	40989815.7	40.990
57.5	564.08	-0.107	-0.01	0.094	-0.008	-210.8374	-19.7044	185.2217	-15.7635	15.2709	198.0394	213.3103	42662059.1	42.662
60	588.60	-0.112	-0.011	0.099	-0.008	-220.6897	-21.6749	195.0739	-15.7635	15.7635	207.9028	223.6663	44733266.2	44.733

Experimental test data (continued)

RUN 5		REAR STRUCTURE												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	-0.004	0	0.004	0	-7.8818	0.0000	7.8818	0.0000	0.0000	7.8818	7.8818	1576354.7	1.576
6.25	61.31	-0.011	-0.001	0.009	-0.001	-21.6749	-1.9704	17.7340	-1.9704	1.9704	19.7044	21.6749	4334975.4	4.335
10	98.10	-0.018	-0.002	0.015	-0.001	-35.4680	-3.9409	29.5567	-1.9704	2.9557	32.5272	35.4829	7096580.9	7.097
15	147.15	-0.026	-0.002	0.022	-0.002	-51.2315	-3.9409	43.3498	-3.9409	3.9409	47.2906	51.2315	10246305.4	10.246
20	196.20	-0.036	-0.003	0.03	-0.003	-70.9360	-5.9113	59.1133	-5.9113	5.9113	65.0246	70.9360	14187192.1	14.187
25	245.25	-0.045	-0.004	0.038	-0.003	-88.6700	-7.8818	74.8768	-5.9113	6.8966	81.7793	88.6759	17735177.1	17.735
30	294.30	-0.055	-0.005	0.047	-0.004	-108.3744	-9.8522	92.6108	-7.8818	8.3744	100.4974	108.8718	21774364.9	21.774
35	343.35	-0.065	-0.006	0.055	-0.005	-128.0788	-11.8227	108.3744	-9.8522	10.3448	118.2307	128.5755	25715106.7	25.715
37.5	367.88	-0.071	-0.007	0.06	-0.005	-139.9015	-13.7931	118.2266	-9.8522	11.3300	129.0791	140.4091	28081825.9	28.082
42.5	416.93	-0.079	-0.007	0.068	-0.006	-155.6650	-13.7931	133.9901	-11.8227	11.8227	144.8309	156.6536	31330719.5	31.331
47.5	465.98	-0.09	-0.008	0.077	-0.007	-177.3399	-15.7635	151.7241	-13.7931	13.7931	164.5350	178.3281	35665614.6	35.666
52.5	515.03	-0.1	-0.009	0.086	-0.008	-197.0443	-17.7340	169.4581	-15.7635	15.2709	183.2539	198.5248	39704963.2	39.705
55	539.55	-0.105	-0.009	0.09	-0.008	-206.8966	-17.7340	177.3399	-15.7635	15.7635	192.1208	207.8843	41576859.9	41.577
57.5	564.08	-0.11	-0.01	0.095	-0.008	-216.7488	-19.7044	187.1921	-15.7635	16.2562	201.9801	218.2362	43647242.5	43.647
60	588.60	-0.115	-0.011	0.099	-0.009	-226.6010	-21.6749	195.0739	-17.7340	17.7340	210.8466	228.5806	45716127.2	45.716

RUN 6		REAR STRUCTURE												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	-0.004	0	0.004	0	-7.8818	0.0000	7.8818	0.0000	0.0000	7.8818	7.8818	1576354.7	1.576
6.25	61.31	-0.011	-0.001	0.01	-0.001	-2.1675	-1.9704	19.7044	-1.9704	3.3990	10.9360	14.3350	2866995.1	2.867
10	98.10	-0.018	-0.001	0.015	-0.001	-35.4680	-1.9704	29.5567	-1.9704	2.4631	32.5123	34.9754	6995073.9	6.995
15	147.15	-0.027	-0.002	0.002	-0.002	-53.2020	-3.9409	3.9409	-3.9409	14.2857	28.5714	42.8571	8571428.6	8.571
20	196.20	-0.036	-0.003	0.031	-0.003	-70.9360	-5.9113	61.0837	-5.9113	5.4187	66.0099	71.4286	14285714.3	14.286
25	245.25	-0.045	-0.004	0.038	-0.004	-88.6700	-7.8818	74.8768	-7.8818	7.3892	81.7734	89.1626	17832512.3	17.833
30	294.30	-0.055	-0.005	0.047	-0.004	-108.3744	-9.8522	92.6108	-7.8818	8.3744	100.4974	108.8718	21774364.9	21.774
35	343.35	-0.065	-0.006	0.055	-0.005	-128.0788	-11.8227	108.3744	-9.8522	10.3448	118.2307	128.5755	25715106.7	25.715
37.5	367.88	-0.071	-0.006	0.061	-0.006	-139.9015	-11.8227	120.1970	-11.8227	10.8374	130.0493	140.8867	28177339.9	28.177
42.5	416.93	-0.079	-0.007	0.068	-0.006	-155.6650	-13.7931	133.9901	-11.8227	11.8227	144.8309	156.6536	31330719.5	31.331
47.5	465.98	-0.09	-0.008	0.077	-0.007	-177.3399	-15.7635	151.7241	-13.7931	13.7931	164.5350	178.3281	35665614.6	35.666
52.5	515.03	-0.101	-0.009	0.086	-0.008	-199.0148	-17.7340	169.4581	-15.7635	15.7635	184.2391	200.0026	40000526.9	40.001
55	539.55	-0.106	-0.01	0.091	-0.008	-208.8670	-19.7044	179.3103	-15.7635	16.2562	194.0987	210.3548	42070965.9	42.071
57.5	564.08	-0.111	-0.01	0.095	-0.008	-218.7192	-19.7044	187.1921	-15.7635	16.7488	202.9652	219.7140	43942799.7	43.943
60	588.60	-0.116	-0.011	0.099	-0.008	-228.5714	-21.6749	195.0739	-15.7635	17.7340	211.8433	229.5773	45915454.0	45.915

Experimental test data (continued)

RUN 7		REAR STRUCTURE												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	-0.005	0	0.004	0	-9.8522	0.0000	7.8818	0.0000	0.4926	8.8670	9.3596	1871921.2	1.872
6.25	61.31	-0.012	-0.001	0.009	-0.001	-23.6453	-1.9704	17.7340	-1.9704	2.4631	20.6897	23.1527	4630541.9	4.631
10	98.10	-0.018	-0.001	0.015	-0.001	-35.4680	-1.9704	29.5567	-1.9704	2.4631	32.5123	34.9754	6995073.9	6.995
15	147.15	-0.027	-0.002	0.023	-0.002	-53.2020	-3.9409	45.3202	-3.9409	3.9409	49.2611	53.2020	10640394.1	10.640
20	196.20	-0.037	-0.003	0.031	-0.003	-72.9064	-5.9113	61.0837	-5.9113	5.9113	66.9951	72.9064	14581280.8	14.581
25	245.25	-0.046	-0.004	0.038	-0.004	-90.6404	-7.8818	74.8768	-7.8818	7.8818	82.7586	90.6404	18128078.8	18.128
30	294.30	-0.056	-0.005	0.047	-0.005	-110.3448	-9.8522	92.6108	-9.8522	9.3596	101.4778	110.8374	22167487.7	22.167
35	343.35	-0.066	-0.006	0.055	-0.005	-130.0493	-11.8227	108.3744	-9.8522	10.8374	119.2159	130.0533	26010666.4	26.011
37.5	367.88	-0.072	-0.007	0.06	-0.006	-141.8719	-13.7931	118.2266	-11.8227	12.3153	130.0530	142.3683	28473652.8	28.474
42.5	416.93	-0.08	-0.007	0.068	-0.006	-157.6355	-13.7931	133.9901	-11.8227	12.3153	145.8161	158.1314	31626281.4	31.626
47.5	465.98	-0.092	-0.008	0.077	-0.007	-181.2808	-15.7635	151.7241	-13.7931	14.7783	166.5054	181.2837	36256740.6	36.257
52.5	515.03	-0.102	-0.009	0.086	-0.007	-200.9852	-17.7340	169.4581	-13.7931	15.7635	185.2322	200.9957	40199140.5	40.199
55	539.55	-0.108	-0.01	0.09	-0.007	-212.8079	-19.7044	177.3399	-13.7931	17.2414	195.0963	212.3377	42467532.2	42.468
57.5	564.08	-0.112	-0.01	0.095	-0.007	-220.6897	-19.7044	187.1921	-13.7931	16.7488	203.9623	220.7111	44142214.4	44.142
60	588.60	-0.117	-0.01	0.1	-0.007	-230.5419	-19.7044	197.0443	-13.7931	16.7488	213.8135	230.5623	46112460.4	46.112

RUN 8		REAR STRUCTURE												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	-0.005	-0.001	-0.004	0	-9.8522	-1.9704	-7.8818	0.0000	4.9261	1.3933	6.3194	1263884.4	1.264
6.25	61.31	-0.011	-0.001	0.009	-0.001	-21.6749	-1.9704	17.7340	-1.9704	1.9704	19.7044	21.6749	4334975.4	4.335
10	98.10	-0.018	-0.002	0.015	-0.001	-35.4680	-3.9409	29.5567	-1.9704	2.9557	32.5272	35.4829	7096580.9	7.097
15	147.15	-0.027	-0.002	0.023	-0.002	-53.2020	-3.9409	45.3202	-3.9409	3.9409	49.2611	53.2020	10640394.1	10.640
20	196.20	-0.036	-0.003	0.03	-0.003	-70.9360	-5.9113	59.1133	-5.9113	5.9113	65.0246	70.9360	14187192.1	14.187
25	245.25	-0.045	-0.004	0.038	-0.003	-88.6700	-7.8818	74.8768	-5.9113	6.8966	81.7793	88.6759	17735177.1	17.735
30	294.30	-0.055	-0.005	0.047	-0.004	-108.3744	-9.8522	92.6108	-7.8818	8.3744	100.4974	108.8718	21774364.9	21.774
35	343.35	-0.066	-0.006	0.055	-0.005	-130.0493	-11.8227	108.3744	-9.8522	10.8374	119.2159	130.0533	26010666.4	26.011
37.5	367.88	-0.071	-0.007	0.06	-0.005	-139.9015	-13.7931	118.2266	-9.8522	11.3300	129.0791	140.4091	28081825.9	28.082
42.5	416.93	-0.08	-0.007	0.067	-0.006	-157.6355	-13.7931	132.0197	-11.8227	12.8079	144.8309	157.6388	31527763.8	31.528
47.5	465.98	-0.091	-0.008	0.077	-0.006	-179.3103	-15.7635	151.7241	-11.8227	13.7931	165.5290	179.3221	35864414.6	35.864
52.5	515.03	-0.101	-0.009	0.086	-0.007	-199.0148	-17.7340	169.4581	-13.7931	15.2709	184.2470	199.5179	39903585.2	39.904
55	539.55	-0.106	-0.01	0.09	-0.008	-208.8670	-19.7044	177.3399	-15.7635	16.7488	193.1135	209.8623	41972454.0	41.972
57.5	564.08	-0.112	-0.01	0.095	-0.008	-220.6897	-19.7044	187.1921	-15.7635	17.2414	203.9504	221.1918	44238357.0	44.238
60	588.60	-0.116	-0.011	0.099	-0.008	-228.5714	-21.6749	195.0739	-15.7635	17.7340	211.8433	229.5773	45915454.0	45.915

Experimental test data (continued)

RUN 9		REAR STRUCTURE												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	-0.005	0	0.004	0	-9.8522	0.0000	7.8818	0.0000	0.4926	8.8670	9.3596	1871921.2	1.872
6.25	61.31	-0.011	-0.001	0.009	-0.001	-21.6749	-1.9704	17.7340	-1.9704	1.9704	19.7044	21.6749	4334975.4	4.335
10	98.10	-0.018	-0.001	0.015	-0.001	-35.4680	-1.9704	29.5567	-1.9704	2.4631	32.5123	34.9754	6995073.9	6.995
15	147.15	-0.027	-0.002	0.023	-0.002	-53.2020	-3.9409	45.3202	-3.9409	3.9409	49.2611	53.2020	10640394.1	10.640
20	196.20	-0.036	-0.003	0.031	-0.003	-70.9360	-5.9113	61.0837	-5.9113	5.4187	66.0099	71.4286	14285714.3	14.286
25	245.25	-0.045	-0.004	0.039	-0.003	-88.6700	-7.8818	76.8473	-5.9113	6.4039	82.7645	89.1684	17833685.2	17.834
30	294.30	-0.056	-0.005	0.047	-0.004	-110.3448	-9.8522	92.6108	-7.8818	8.8670	101.4826	110.3496	22069922.0	22.070
35	343.35	-0.065	-0.005	0.055	-0.005	-128.0788	-9.8522	108.3744	-9.8522	9.8522	118.2266	128.0788	25615763.5	25.616
37.5	367.88	-0.071	-0.006	0.06	-0.006	-139.9015	-11.8227	118.2266	-11.8227	11.3300	129.0640	140.3941	28078817.7	28.079
42.5	416.93	-0.079	-0.006	0.067	-0.006	-155.6650	-11.8227	132.0197	-11.8227	11.8227	143.8424	155.6650	31133004.9	31.133
47.5	465.98	-0.09	-0.007	0.077	-0.007	-177.3399	-13.7931	151.7241	-13.7931	13.3005	164.5320	177.8325	35566502.5	35.567
52.5	515.03	-0.101	-0.009	0.086	-0.008	-199.0148	-17.7340	169.4581	-15.7635	15.7635	184.2391	200.0026	40000526.9	40.001
55	539.55	-0.106	-0.01	0.09	-0.008	-208.8670	-19.7044	177.3399	-15.7635	16.7488	193.1135	209.8623	41972454.0	41.972
57.5	564.08	-0.111	-0.01	0.094	-0.008	-218.7192	-19.7044	185.2217	-15.7635	17.2414	201.9801	219.2214	43844286.9	43.844
60	588.60	-0.115	-0.01	0.099	-0.008	-226.6010	-19.7044	195.0739	-15.7635	16.7488	210.8466	227.5954	45519082.9	45.519

RUN 10		REAR STRUCTURE												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	-0.005	-0.001	0.004	0	-9.8522	-1.9704	7.8818	0.0000	0.9852	8.9216	9.9068	1981356.7	1.981
6.25	61.31	-0.011	-0.001	0.009	-0.001	-21.6749	-1.9704	17.7340	-1.9704	1.9704	19.7044	21.6749	4334975.4	4.335
10	98.10	-0.018	-0.002	0.015	-0.001	-35.4680	-3.9409	29.5567	-1.9704	2.9557	32.5272	35.4829	7096580.9	7.097
15	147.15	-0.026	-0.002	0.023	-0.002	-51.2315	-3.9409	45.3202	-3.9409	3.4483	48.2759	51.7241	10344827.6	10.345
20	196.20	-0.035	-0.003	0.031	-0.003	-68.9655	-5.9113	61.0837	-5.9113	4.9261	65.0246	69.9507	13990147.8	13.990
25	245.25	-0.045	-0.004	0.039	-0.004	-88.6700	-7.8818	76.8473	-7.8818	6.8966	82.7586	89.6552	17931034.5	17.931
30	294.30	-0.055	-0.005	0.047	-0.005	-108.3744	-9.8522	92.6108	-9.8522	8.8670	100.4926	109.3596	21871921.2	21.872
35	343.35	-0.066	-0.006	0.055	-0.005	-130.0493	-11.8227	108.3744	-9.8522	10.8374	119.2159	130.0533	26010666.4	26.011
37.5	367.88	-0.072	-0.007	0.06	-0.006	-141.8719	-13.7931	118.2266	-11.8227	12.3153	130.0530	142.3683	28473652.8	28.474
42.5	416.93	-0.08	-0.007	0.068	-0.006	-157.6355	-13.7931	133.9901	-11.8227	12.3153	145.8161	158.1314	31626281.4	31.626
47.5	465.98	-0.091	-0.008	0.077	-0.007	-179.3103	-15.7635	151.7241	-13.7931	14.2857	165.5202	179.8059	35961177.6	35.961
52.5	515.03	-0.101	-0.009	0.086	-0.008	-199.0148	-17.7340	169.4581	-15.7635	15.7635	184.2391	200.0026	40000526.9	40.001
55	539.55	-0.107	-0.01	0.09	-0.009	-210.8374	-19.7044	177.3399	-17.7340	17.7340	194.0912	211.8252	42365032.1	42.365
57.5	564.08	-0.112	-0.011	0.094	-0.01	-220.6897	-21.6749	185.2217	-19.7044	19.2118	202.9581	222.1699	44433975.8	44.434
60	588.60	-0.117	-0.011	0.099	-0.011	-230.5419	-21.6749	195.0739	-21.6749	19.7044	212.8079	232.5123	46502463.1	46.502

Experimental test data (continued)

RUN 1		FRONT STRUCTURE												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.002	0	0.001	-0.001	3.9409	0.0000	1.9704	-1.9704	0.9852	1.3933	2.3785	475707.1	0.476
6.25	61.31	0.005	0.001	0.002	-0.003	9.8522	1.9704	3.9409	-5.9113	2.4631	4.9261	7.3892	1477832.5	1.478
10	98.10	0.009	0.001	0.003	-0.004	17.7340	1.9704	5.9113	-7.8818	4.4335	7.6948	12.1283	2425665.0	2.426
15	147.15	0.013	0.001	0.005	-0.006	25.6158	1.9704	9.8522	-11.8227	6.4039	10.4731	16.8770	3375398.2	3.375
20	196.20	0.018	0.002	0.006	-0.008	35.4680	3.9409	11.8227	-15.7635	8.8670	15.3897	24.2566	4851329.9	4.851
25	245.25	0.022	0.002	0.008	-0.011	43.3498	3.9409	15.7635	-21.6749	10.3448	18.8226	29.1675	5833492.3	5.833
30	294.30	0.027	0.003	0.009	-0.013	53.2020	5.9113	17.7340	-25.6158	12.8079	23.7273	36.5352	7307032.3	7.307
35	343.35	0.032	0.003	0.011	-0.015	63.0542	5.9113	21.6749	-29.5567	15.2709	27.2499	42.5208	8504164.2	8.504
37.5	367.88	0.034	0.003	0.012	-0.017	66.9951	5.9113	23.6453	-33.4975	15.7635	29.2927	45.0563	9011258.6	9.011
42.5	416.93	0.038	0.004	0.014	-0.019	74.8768	7.8818	27.5862	-37.4384	18.2266	32.7503	50.9769	10195377.4	10.195
47.5	465.98	0.043	0.004	0.015	-0.021	84.7291	7.8818	29.5567	-41.3793	20.1970	36.9819	57.1790	11435792.9	11.436
52.5	515.03	0.048	0.005	0.017	-0.023	94.5813	9.8522	33.4975	-45.3202	23.1527	41.1559	64.3086	12861713.7	12.862
55	539.55	0.051	0.005	0.018	-0.025	100.4926	9.8522	35.4680	-49.2611	24.1379	43.9391	68.0771	13615410.1	13.615
57.5	564.08	0.053	0.005	0.019	-0.026	104.4335	9.8522	37.4384	-51.2315	25.1232	45.3309	70.4541	14090811.5	14.091
60	588.60	0.056	0.005	0.02	-0.027	110.3448	9.8522	39.4089	-53.2020	26.6010	47.4546	74.0555	14811109.0	14.811

RUN 2		FRONT STRUCTURE												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.003	0.001	0.001	0	5.9113	1.9704	1.9704	0.0000	2.4631	2.2030	4.6661	933215.4	0.933
6.25	61.31	0.006	0.002	0.002	-0.002	11.8227	3.9409	3.9409	-3.9409	3.9409	5.5733	9.5141	1902828.4	1.903
10	98.10	0.01	0.002	0.004	-0.003	19.7044	3.9409	7.8818	-5.9113	6.4039	7.6948	14.0988	2819753.6	2.820
15	147.15	0.014	0.003	0.006	-0.005	27.5862	5.9113	11.8227	-9.8522	8.8670	11.1465	20.0135	4002701.2	4.003
20	196.20	0.019	0.004	0.007	-0.007	37.4384	7.8818	13.7931	-13.7931	11.3300	16.0382	27.3683	5473659.2	5.474
25	245.25	0.024	0.004	0.009	-0.009	47.2906	7.8818	17.7340	-17.7340	13.7931	19.5561	33.3492	6669839.1	6.670
30	294.30	0.028	0.005	0.011	-0.011	55.1724	9.8522	21.6749	-21.6749	16.2562	23.0002	39.2564	7851277.8	7.851
35	343.35	0.033	0.006	0.013	-0.013	65.0246	11.8227	25.6158	-25.6158	19.2118	27.1786	46.3904	9278074.6	9.278
37.5	367.88	0.036	0.006	0.014	-0.014	70.9360	11.8227	27.5862	-27.5862	20.6897	29.2927	49.9824	9996480.3	9.996
42.5	416.93	0.04	0.006	0.015	-0.016	78.8177	11.8227	29.5567	-31.5271	22.1675	32.8095	54.9770	10995399.3	10.995
47.5	465.98	0.045	0.007	0.017	-0.019	88.6700	13.7931	33.4975	-37.4384	24.6305	37.6453	62.2758	12455161.8	12.455
52.5	515.03	0.05	0.008	0.019	-0.021	98.5222	15.7635	37.4384	-41.3793	27.5862	41.8226	69.4088	13881767.6	13.882
55	539.55	0.052	0.008	0.02	-0.022	102.4631	15.7635	39.4089	-43.3498	28.5714	43.2152	71.7866	14357325.0	14.357
57.5	564.08	0.055	0.008	0.02	-0.023	108.3744	15.7635	39.4089	-45.3202	29.5567	46.0637	75.6204	15124074.7	15.124
60	588.60	0.058	0.009	0.021	-0.025	114.2857	17.7340	41.3793	-49.2611	31.0345	49.5068	80.5413	16108251.8	16.108

Experimental test data (continued)

RUN 3		FRONT STRUCTURE 1												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.002	0	0.001	-0.001	3.9409	0.0000	1.9704	-1.9704	0.9852	1.3933	2.3785	475707.1	0.476
6.25	61.31	0.005	0.001	0.002	-0.002	9.8522	1.9704	3.9409	-3.9409	2.9557	4.1799	7.1356	1427121.3	1.427
10	98.10	0.009	0.001	0.003	-0.003	17.7340	1.9704	5.9113	-5.9113	4.9261	7.1045	12.0306	2406128.6	2.406
15	147.15	0.013	0.002	0.005	-0.005	25.6158	3.9409	9.8522	-9.8522	7.3892	10.4731	17.8622	3572442.5	3.572
20	196.20	0.018	0.003	0.007	-0.007	35.4680	5.9113	13.7931	-13.7931	10.3448	14.6464	24.9912	4998240.1	4.998
25	245.25	0.023	0.003	0.009	-0.009	45.3202	5.9113	17.7340	-17.7340	12.8079	18.1666	30.9745	6194894.4	6.195
30	294.30	0.028	0.004	0.011	-0.012	55.1724	7.8818	21.6749	-23.6453	15.2709	23.0002	38.2712	7654233.5	7.654
35	343.35	0.033	0.005	0.012	-0.014	65.0246	9.8522	23.6453	-27.5862	17.7340	27.9011	45.6351	9127015.7	9.127
37.5	367.88	0.036	0.005	0.013	-0.015	70.9360	9.8522	25.6158	-29.5567	19.2118	30.0291	49.2409	9848177.6	9.848
42.5	416.93	0.04	0.006	0.015	-0.017	78.8177	11.8227	29.5567	-33.4975	21.6749	33.4685	55.1434	11028684.8	11.029
47.5	465.98	0.045	0.006	0.017	-0.019	88.6700	11.8227	33.4975	-37.4384	24.1379	36.9819	61.1199	12223970.2	12.224
52.5	515.03	0.05	0.007	0.019	-0.021	98.5222	13.7931	37.4384	-41.3793	27.0936	41.1559	68.2495	13649891.1	13.650
55	539.55	0.053	0.007	0.02	-0.023	104.4335	13.7931	39.4089	-45.3202	28.0788	43.9391	72.0179	14403587.4	14.404
57.5	564.08	0.055	0.008	0.021	-0.024	108.3744	15.7635	41.3793	-47.2906	29.5567	46.0005	75.5571	15111422.7	15.111
60	588.60	0.058	0.008	0.022	-0.025	114.2857	15.7635	43.3498	-49.2611	31.0345	48.1147	79.1492	15829844.7	15.830

RUN 4		FRONT STRUCTURE												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.002	0	0.001	-0.001	3.9409	0.0000	1.9704	-1.9704	0.9852	1.3933	2.3785	475707.1	0.476
6.25	61.31	0.005	0	0.002	-0.002	9.8522	0.0000	3.9409	-3.9409	2.4631	3.5523	6.0153	1203064.3	1.203
10	98.10	0.009	0.001	0.003	-0.004	17.7340	1.9704	5.9113	-7.8818	4.4335	7.6948	12.1283	2425665.0	2.426
15	147.15	0.013	0.001	0.005	-0.006	25.6158	1.9704	9.8522	-11.8227	6.4039	10.4731	16.8770	3375398.2	3.375
20	196.20	0.018	0.002	0.006	-0.008	35.4680	3.9409	11.8227	-15.7635	8.8670	15.3897	24.2566	4851329.9	4.851
25	245.25	0.022	0.002	0.008	-0.01	43.3498	3.9409	15.7635	-19.7044	10.8374	18.1666	29.0040	5800805.7	5.801
30	294.30	0.027	0.003	0.009	-0.012	53.2020	5.9113	17.7340	-23.6453	13.3005	23.0845	36.3850	7276994.9	7.277
35	343.35	0.032	0.003	0.012	-0.015	63.0542	5.9113	23.6453	-29.5567	15.7635	26.5096	42.2732	8454630.2	8.455
37.5	367.88	0.035	0.004	0.012	-0.016	68.9655	7.8818	23.6453	-31.5271	17.2414	30.0291	47.2704	9454088.9	9.454
42.5	416.93	0.038	0.004	0.014	-0.018	74.8768	7.8818	27.5862	-35.4680	18.7192	32.0765	50.7957	10159141.1	10.159
47.5	465.98	0.044	0.005	0.016	-0.021	86.6995	9.8522	31.5271	-41.3793	21.6749	37.6453	59.3201	11864028.8	11.864
52.5	515.03	0.049	0.005	0.017	-0.023	96.5517	9.8522	33.4975	-45.3202	23.6453	41.8922	65.5375	13107504.1	13.108
55	539.55	0.051	0.005	0.018	-0.024	100.4926	9.8522	35.4680	-47.2906	24.6305	43.2825	67.9131	13582613.8	13.583
57.5	564.08	0.054	0.006	0.019	-0.025	106.4039	11.8227	37.4384	-49.2611	26.6010	46.0637	72.6647	14532941.7	14.533
60	588.60	0.056	0.006	0.02	-0.026	110.3448	11.8227	39.4089	-51.2315	27.5862	47.4546	75.0408	15008153.4	15.008

Experimental test data (continued)

RUN 5		FRONT STRUCTURE												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.002	0	0.001	-0.001	3.9409	0.0000	1.9704	-1.9704	0.9852	1.3933	2.3785	475707.1	0.476
6.25	61.31	0.005	0.001	0.002	-0.003	9.8522	1.9704	3.9409	-5.9113	2.4631	4.9261	7.3892	1477832.5	1.478
10	98.10	0.009	0.001	0.003	-0.004	17.7340	1.9704	5.9113	-7.8818	4.4335	7.6948	12.1283	2425665.0	2.426
15	147.15	0.013	0.001	0.005	-0.006	25.6158	1.9704	9.8522	-11.8227	6.4039	10.4731	16.8770	3375398.2	3.375
20	196.20	0.018	0.002	0.006	-0.008	35.4680	3.9409	11.8227	-15.7635	8.8670	15.3897	24.2566	4851329.9	4.851
25	245.25	0.022	0.002	0.008	-0.011	43.3498	3.9409	15.7635	-21.6749	10.3448	18.8226	29.1675	5833492.3	5.833
30	294.30	0.027	0.003	0.009	-0.013	53.2020	5.9113	17.7340	-25.6158	12.8079	23.7273	36.5352	7307032.3	7.307
35	343.35	0.032	0.003	0.011	-0.015	63.0542	5.9113	21.6749	-29.5567	15.2709	27.2499	42.5208	8504164.2	8.504
37.5	367.88	0.034	0.003	0.012	-0.017	66.9951	5.9113	23.6453	-33.4975	15.7635	29.2927	45.0563	9011258.6	9.011
42.5	416.93	0.038	0.004	0.014	-0.019	74.8768	7.8818	27.5862	-37.4384	18.2266	32.7503	50.9769	10195377.4	10.195
47.5	465.98	0.043	0.004	0.015	-0.021	84.7291	7.8818	29.5567	-41.3793	20.1970	36.9819	57.1790	11435792.9	11.436
52.5	515.03	0.048	0.005	0.017	-0.023	94.5813	9.8522	33.4975	-45.3202	23.1527	41.1559	64.3086	12861713.7	12.862
55	539.55	0.051	0.005	0.018	-0.025	100.4926	9.8522	35.4680	-49.2611	24.1379	43.9391	68.0771	13615410.1	13.615
57.5	564.08	0.053	0.005	0.019	-0.026	104.4335	9.8522	37.4384	-51.2315	25.1232	45.3309	70.4541	14090811.5	14.091
60	588.60	0.056	0.005	0.02	-0.027	110.3448	9.8522	39.4089	-53.2020	26.6010	47.4546	74.0555	14811109.0	14.811

RUN 6		FRONT STRUCTURE												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.002	0	0.001	-0.001	3.9409	0.0000	1.9704	-1.9704	0.9852	1.3933	2.3785	475707.1	0.476
6.25	61.31	0.006	0.001	0.002	-0.002	11.8227	1.9704	3.9409	-3.9409	3.4483	4.9261	8.3744	1674876.8	1.675
10	98.10	0.009	0.001	0.003	-0.004	17.7340	1.9704	5.9113	-7.8818	4.4335	7.6948	12.1283	2425665.0	2.426
15	147.15	0.013	0.002	0.005	-0.006	25.6158	3.9409	9.8522	-11.8227	6.8966	11.1465	18.0431	3608612.5	3.609
20	196.20	0.018	0.002	0.006	-0.008	35.4680	3.9409	11.8227	-15.7635	8.8670	15.3897	24.2566	4851329.9	4.851
25	245.25	0.022	0.003	0.008	-0.01	43.3498	5.9113	15.7635	-19.7044	11.3300	18.8226	30.1527	6030536.6	6.031
30	294.30	0.027	0.003	0.009	-0.012	53.2020	5.9113	17.7340	-23.6453	13.3005	23.0845	36.3850	7276994.9	7.277
35	343.35	0.032	0.004	0.011	-0.015	63.0542	7.8818	21.6749	-29.5567	15.7635	27.9011	43.6646	8732927.0	8.733
37.5	367.88	0.035	0.004	0.012	-0.016	68.9655	7.8818	23.6453	-31.5271	17.2414	30.0291	47.2704	9454088.9	9.454
42.5	416.93	0.039	0.004	0.014	-0.018	76.8473	7.8818	27.5862	-35.4680	19.2118	32.8095	52.0213	10404266.3	10.404
47.5	465.98	0.044	0.005	0.016	-0.021	86.6995	9.8522	31.5271	-41.3793	21.6749	37.6453	59.3201	11864028.8	11.864
52.5	515.03	0.049	0.006	0.017	-0.023	96.5517	11.8227	33.4975	-45.3202	24.1379	42.5474	66.6854	13337073.1	13.337
55	539.55	0.052	0.006	0.018	-0.024	102.4631	11.8227	35.4680	-47.2906	25.6158	44.6730	70.2888	14057760.8	14.058
57.5	564.08	0.054	0.006	0.019	-0.025	106.4039	11.8227	37.4384	-49.2611	26.6010	46.0637	72.6647	14532941.7	14.533
60	588.60	0.056	0.006	0.02	-0.027	110.3448	11.8227	39.4089	-53.2020	27.0936	48.1147	75.2083	15041667.3	15.042

Experimental test data (continued)

RUN 7		FRONT STRUCTURE												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.003	0.001	0.001	-0.001	5.9113	1.9704	1.9704	-1.9704	1.9704	2.7866	4.7571	951414.2	0.951
6.25	61.31	0.006	0.001	0.002	-0.002	11.8227	1.9704	3.9409	-3.9409	3.4483	4.9261	8.3744	1674876.8	1.675
10	98.10	0.009	0.002	0.003	-0.004	17.7340	3.9409	5.9113	-7.8818	4.9261	8.3599	13.2860	2657198.3	2.657
15	147.15	0.014	0.002	0.005	-0.006	27.5862	3.9409	9.8522	-11.8227	7.3892	11.8636	19.2528	3850560.5	3.851
20	196.20	0.018	0.003	0.007	-0.008	35.4680	5.9113	13.7931	-15.7635	9.8522	15.3265	25.1787	5035733.8	5.036
25	245.25	0.023	0.003	0.008	-0.01	45.3202	5.9113	15.7635	-19.7044	11.8227	19.5561	31.3788	6275750.4	6.276
30	294.30	0.028	0.004	0.011	-0.012	55.1724	7.8818	21.6749	-23.6453	15.2709	23.0002	38.2712	7654233.5	7.654
35	343.35	0.033	0.006	0.012	-0.014	65.0246	11.8227	23.6453	-27.5862	18.2266	28.5714	46.7980	9359605.9	9.360
37.5	367.88	0.035	0.005	0.013	-0.016	68.9655	9.8522	25.6158	-31.5271	18.2266	29.9643	48.1909	9638189.7	9.638
42.5	416.93	0.039	0.005	0.015	-0.018	76.8473	9.8522	29.5567	-35.4680	20.1970	32.7503	52.9473	10589466.1	10.589
47.5	465.98	0.045	0.006	0.016	-0.02	88.6700	11.8227	31.5271	-39.4089	23.1527	38.3731	61.5258	12305159.4	12.305
52.5	515.03	0.05	0.006	0.018	-0.023	98.5222	11.8227	35.4680	-45.3202	25.1232	42.5474	67.6706	13534117.4	13.534
55	539.55	0.052	0.006	0.019	-0.024	102.4631	11.8227	37.4384	-47.2906	26.1084	43.9391	70.0475	14009498.8	14.009
57.5	564.08	0.055	0.007	0.02	-0.025	108.3744	13.7931	39.4089	-49.2611	28.0788	46.7228	74.8016	14960319.8	14.960
60	588.60	0.057	0.007	0.021	-0.026	112.3153	13.7931	41.3793	-51.2315	29.0640	48.1147	77.1788	15435756.0	15.436

RUN 8		FRONT STRUCTURE												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.003	0.001	0.002	0	5.9113	1.9704	3.9409	0.0000	2.9557	1.3933	4.3490	869795.8	0.870
6.25	61.31	0.007	0.002	0.003	-0.001	13.7931	3.9409	5.9113	-1.9704	5.4187	4.9261	10.3448	2068965.5	2.069
10	98.10	-0.01	0.003	0.004	-0.002	-19.7044	5.9113	7.8818	-3.9409	2.4631	14.6464	17.1094	3421885.5	3.422
15	147.15	0.015	0.004	0.006	-0.004	29.5567	7.8818	11.8227	-7.8818	10.3448	11.8636	22.2085	4441693.5	4.442
20	196.20	0.019	0.004	0.008	-0.007	37.4384	7.8818	15.7635	-13.7931	11.8227	15.3265	27.1491	5429822.5	5.430
25	245.25	0.024	0.005	0.01	-0.009	47.2906	9.8522	19.7044	-17.7340	14.7783	19.5064	34.2847	6856943.8	6.857
30	294.30	0.029	0.006	0.011	-0.011	57.1429	11.8227	21.6749	-21.6749	17.2414	24.3929	41.6343	8326864.4	8.327
35	343.35	0.034	0.006	0.013	-0.013	66.9951	11.8227	25.6158	-25.6158	19.7044	27.9011	47.6055	9521104.3	9.521
37.5	367.88	0.037	0.006	0.014	-0.014	72.9064	11.8227	27.5862	-27.5862	21.1823	30.0291	51.2113	10242266.3	10.242
42.5	416.93	0.041	0.007	0.016	-0.016	80.7882	13.7931	31.5271	-31.5271	23.6453	33.4685	57.1139	11422773.5	11.423
47.5	465.98	0.046	0.007	0.018	-0.019	90.6404	13.7931	35.4680	-37.4384	25.6158	37.6453	63.2610	12652206.2	12.652
52.5	515.03	0.051	0.008	0.019	-0.021	100.4926	15.7635	37.4384	-41.3793	28.0788	42.5474	70.6263	14125250.4	14.125
55	539.55	0.054	0.008	0.02	-0.022	106.4039	15.7635	39.4089	-43.3498	29.5567	44.6730	74.2297	14845938.2	14.846
57.5	564.08	0.056	0.009	0.021	-0.024	110.3448	17.7340	41.3793	-47.2906	30.5419	47.3932	77.9350	15587005.7	15.587
60	588.60	0.058	0.009	0.022	-0.025	114.2857	17.7340	43.3498	-49.2611	31.5271	48.7859	80.3130	16062595.8	16.063

Experimental test data (continued)

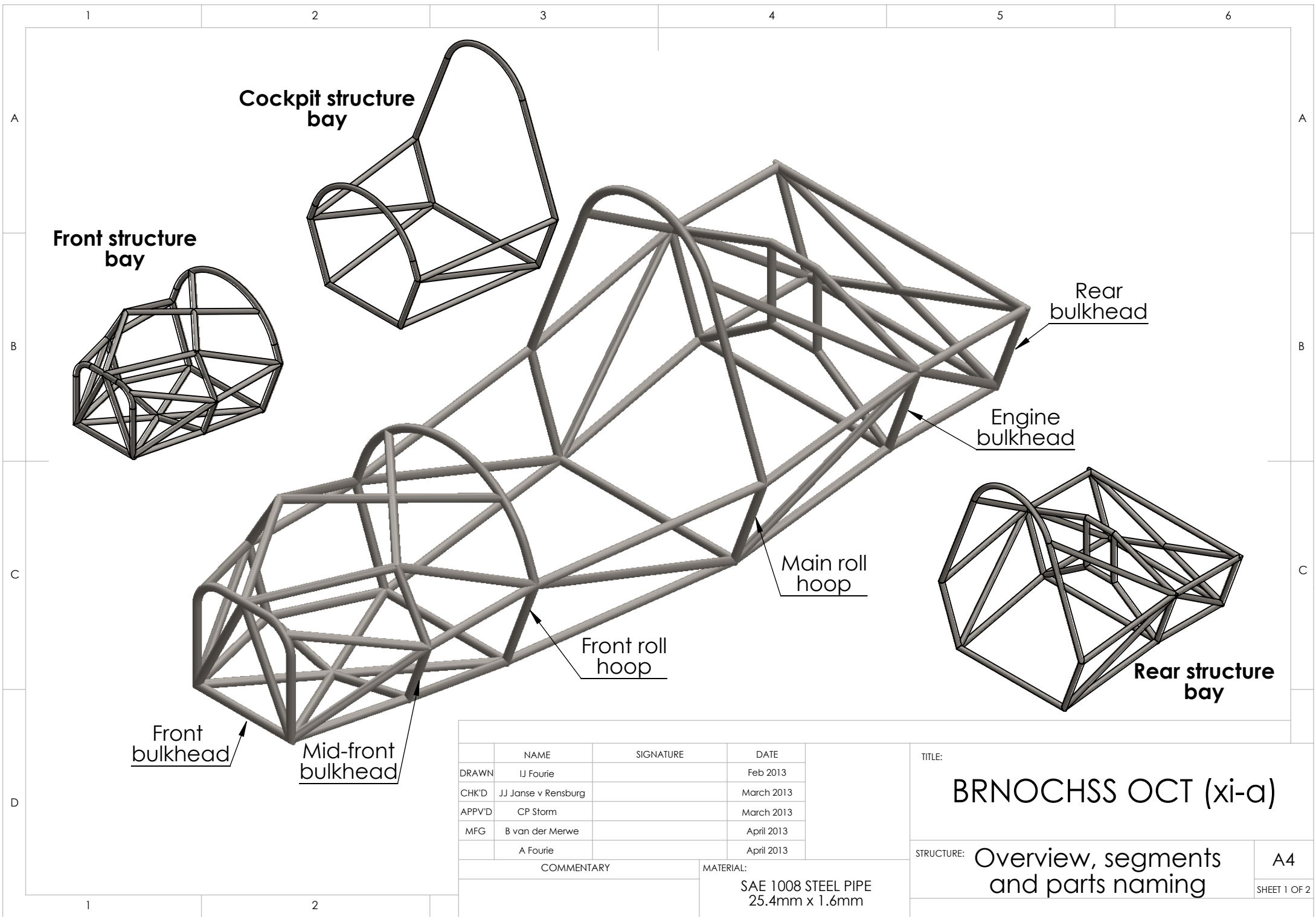
RUN 9		FRONT STRUCTURE												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.003	0.001	0.001	0	5.9113	1.9704	1.9704	0.0000	2.4631	2.2030	4.6661	933215.4	0.933
6.25	61.31	0.006	0.002	0.002	-0.002	11.8227	3.9409	3.9409	-3.9409	3.9409	5.5733	9.5141	1902828.4	1.903
10	98.10	0.01	0.002	0.004	-0.003	19.7044	3.9409	7.8818	-5.9113	6.4039	7.6948	14.0988	2819753.6	2.820
15	147.15	0.014	0.003	0.006	-0.005	27.5862	5.9113	11.8227	-9.8522	8.8670	11.1465	20.0135	4002701.2	4.003
20	196.20	0.019	0.004	0.007	-0.007	37.4384	7.8818	13.7931	-13.7931	11.3300	16.0382	27.3683	5473659.2	5.474
25	245.25	0.024	0.004	0.009	-0.009	47.2906	7.8818	17.7340	-17.7340	13.7931	19.5561	33.3492	6669839.1	6.670
30	294.30	0.028	0.005	0.011	-0.011	55.1724	9.8522	21.6749	-21.6749	16.2562	23.0002	39.2564	7851277.8	7.851
35	343.35	0.033	0.006	0.013	-0.013	65.0246	11.8227	25.6158	-25.6158	19.2118	27.1786	46.3904	9278074.6	9.278
37.5	367.88	0.036	0.006	0.014	-0.014	70.9360	11.8227	27.5862	-27.5862	20.6897	29.2927	49.9824	9996480.3	9.996
42.5	416.93	0.04	0.006	0.015	-0.016	78.8177	11.8227	29.5567	-31.5271	22.1675	32.8095	54.9770	10995399.3	10.995
47.5	465.98	0.045	0.007	0.017	-0.019	88.6700	13.7931	33.4975	-37.4384	24.6305	37.6453	62.2758	12455161.8	12.455
52.5	515.03	0.05	0.008	0.019	-0.021	98.5222	15.7635	37.4384	-41.3793	27.5862	41.8226	69.4088	13881767.6	13.882
55	539.55	0.052	0.008	0.02	-0.022	102.4631	15.7635	39.4089	-43.3498	28.5714	43.2152	71.7866	14357325.0	14.357
57.5	564.08	0.055	0.008	0.02	-0.023	108.3744	15.7635	39.4089	-45.3202	29.5567	46.0637	75.6204	15124074.7	15.124
60	588.60	0.058	0.009	0.021	-0.025	114.2857	17.7340	41.3793	-49.2611	31.0345	49.5068	80.5413	16108251.8	16.108

RUN 10		FRONT STRUCTURE												
Weight [kg]	Torsion, T [N.m]	Channel 1 [mV / V]	Channel 2 [mV / V]	Channel 3 [mV / V]	Channel 4 [mV / V]	Strain Ch 1 [micro]	Strain Ch 2 [micro]	Strain Ch 3 [micro]	Strain Ch 4 [micro]	AXIAL STRAIN [micro]	RES BEND STRAIN [micro]	TOTAL STRAIN [micro]	STR _{MAX} [Pa]	STR _{MAX} [MPa]
2.5	24.53	0.002	0	0	-0.001	3.9409	0.0000	0.0000	-1.9704	0.4926	2.2030	2.6956	539126.7	0.539
6.25	61.31	0.005	0.001	0.002	-0.002	9.8522	1.9704	3.9409	-3.9409	2.9557	4.1799	7.1356	1427121.3	1.427
10	98.10	0.008	0.001	0.003	-0.004	15.7635	1.9704	5.9113	-7.8818	3.9409	6.9666	10.9075	2181491.2	2.181
15	147.15	0.013	0.001	0.005	-0.006	25.6158	1.9704	9.8522	-11.8227	6.4039	10.4731	16.8770	3375398.2	3.375
20	196.20	0.017	0.002	0.006	-0.008	33.4975	3.9409	11.8227	-15.7635	8.3744	14.6464	23.0208	4604151.5	4.604
25	245.25	0.022	0.002	0.008	-0.01	43.3498	3.9409	15.7635	-19.7044	10.8374	18.1666	29.0040	5800805.7	5.801
30	294.30	0.027	0.003	0.009	-0.013	53.2020	5.9113	17.7340	-25.6158	12.8079	23.7273	36.5352	7307032.3	7.307
35	343.35	0.031	0.003	0.011	-0.015	61.0837	5.9113	21.6749	-29.5567	14.7783	26.5096	41.2879	8257585.8	8.258
37.5	367.88	0.034	0.004	0.012	-0.016	66.9951	7.8818	23.6453	-31.5271	16.7488	29.2927	46.0415	9208303.0	9.208
42.5	416.93	0.038	0.004	0.013	-0.018	74.8768	7.8818	25.6158	-35.4680	18.2266	32.8095	51.0361	10207222.0	10.207
47.5	465.98	0.043	0.004	0.015	-0.021	84.7291	7.8818	29.5567	-41.3793	20.1970	36.9819	57.1790	11435792.9	11.436
52.5	515.03	0.048	0.005	0.017	-0.023	94.5813	9.8522	33.4975	-45.3202	23.1527	41.1559	64.3086	12861713.7	12.862
55	539.55	0.051	0.005	0.018	-0.024	100.4926	9.8522	35.4680	-47.2906	24.6305	43.2825	67.9131	13582613.8	13.583
57.5	564.08	0.053	0.005	0.019	-0.026	104.4335	9.8522	37.4384	-51.2315	25.1232	45.3309	70.4541	14090811.5	14.091
60	588.60	0.055	0.006	0.02	-0.027	108.3744	11.8227	39.4089	-53.2020	26.6010	47.3932	73.9941	14798828.4	14.799

Appendix E

Chassis manufacturing drawings

Appendix E contains the drawings required for the manufacturing process of the chassis. It provides an overview of the chassis and its dimensions as well as detail descriptions of each section and the associated pipe and structural members.



	NAME	SIGNATURE	DATE
DRAWN	IJ Fourie		Feb 2013
CHK'D	JJ Janse v Rensburg		March 2013
APPV'D	CP Storm		March 2013
MFG	B van der Merwe		April 2013
	A Fourie		April 2013
COMMENTARY		MATERIAL:	
		SAE 1008 STEEL PIPE 25.4mm x 1.6mm	

TITLE:

BRNOCHSS OCT (xi-a)

STRUCTURE: Overview, segments and parts naming

A4
SHEET 1 OF 2



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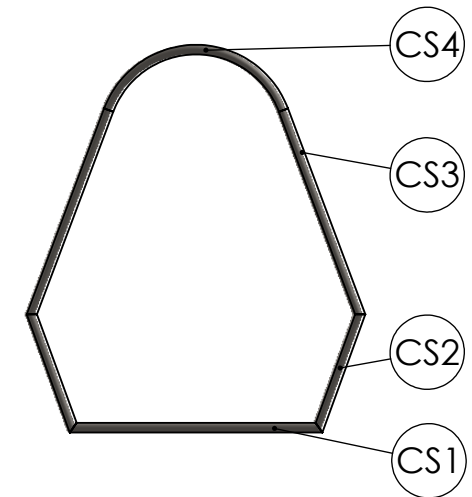
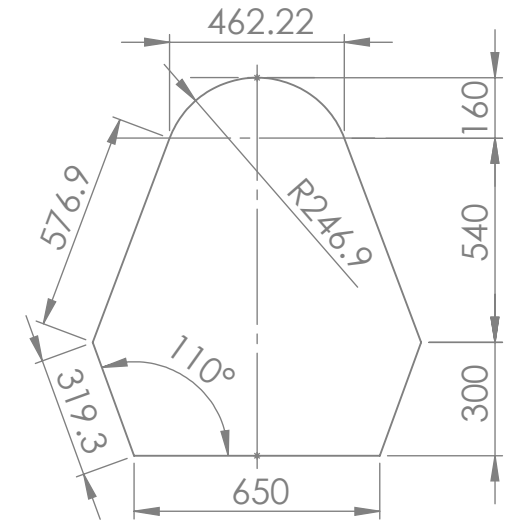
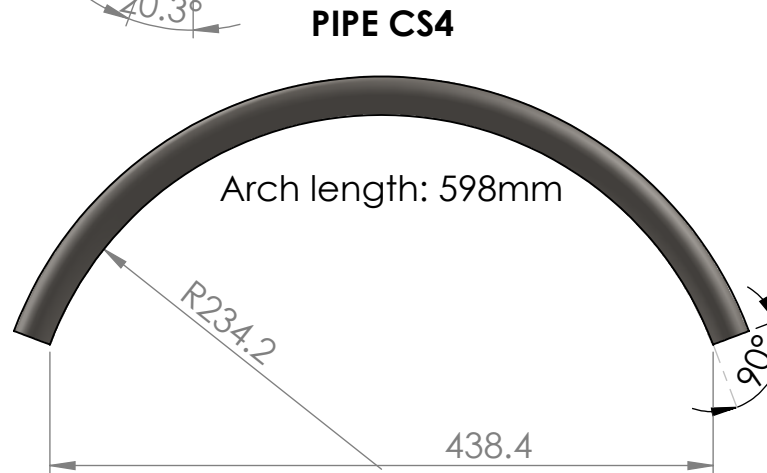
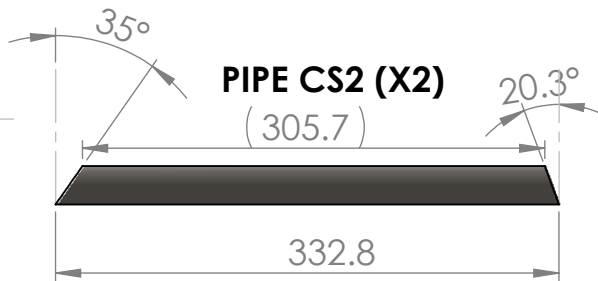
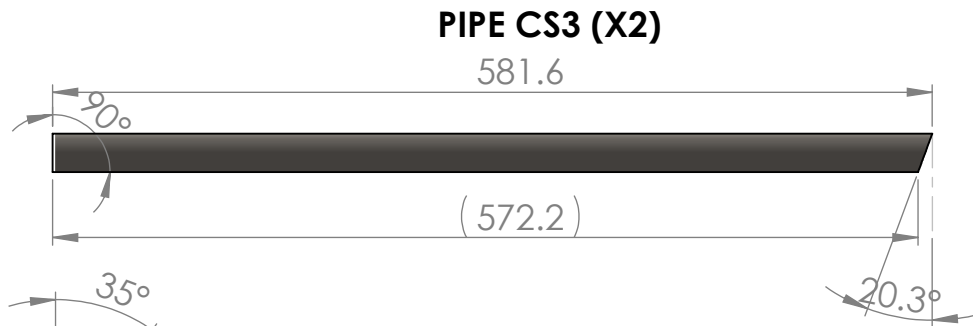
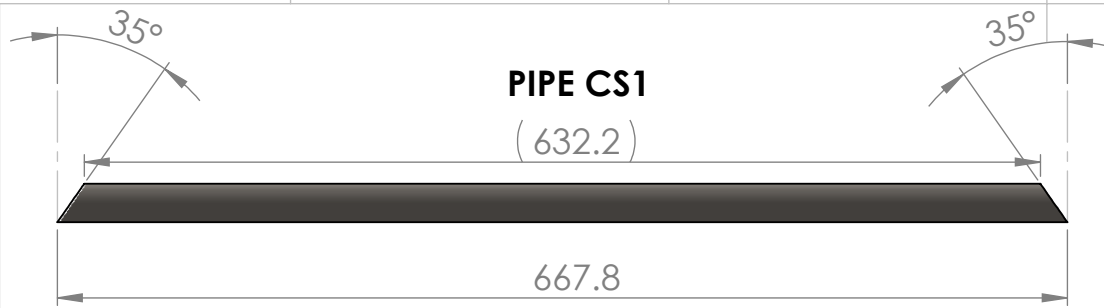
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A4

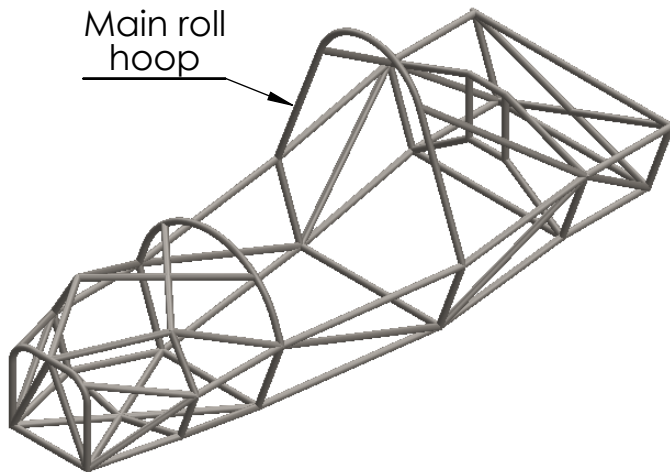
COMMENTARY

MATERIAL:

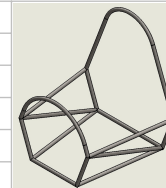
SAE 1008 STEEL PIPE
25.4mm x 1.6mm



Main roll
hoop



	NAME	SIGNATURE	DATE
DRAWN	IJ Fourie		Feb 2013
CHK'D	JJ Janse v Rensburg		March 2013
APPV'D	CP Storm		March 2013
MFG	B van der Merwe		April 2013
	A Fourie		April 2013
COMMENTARY		MATERIAL:	
		SAE 1008 STEEL PIPE 25.4mm x 1.6mm	

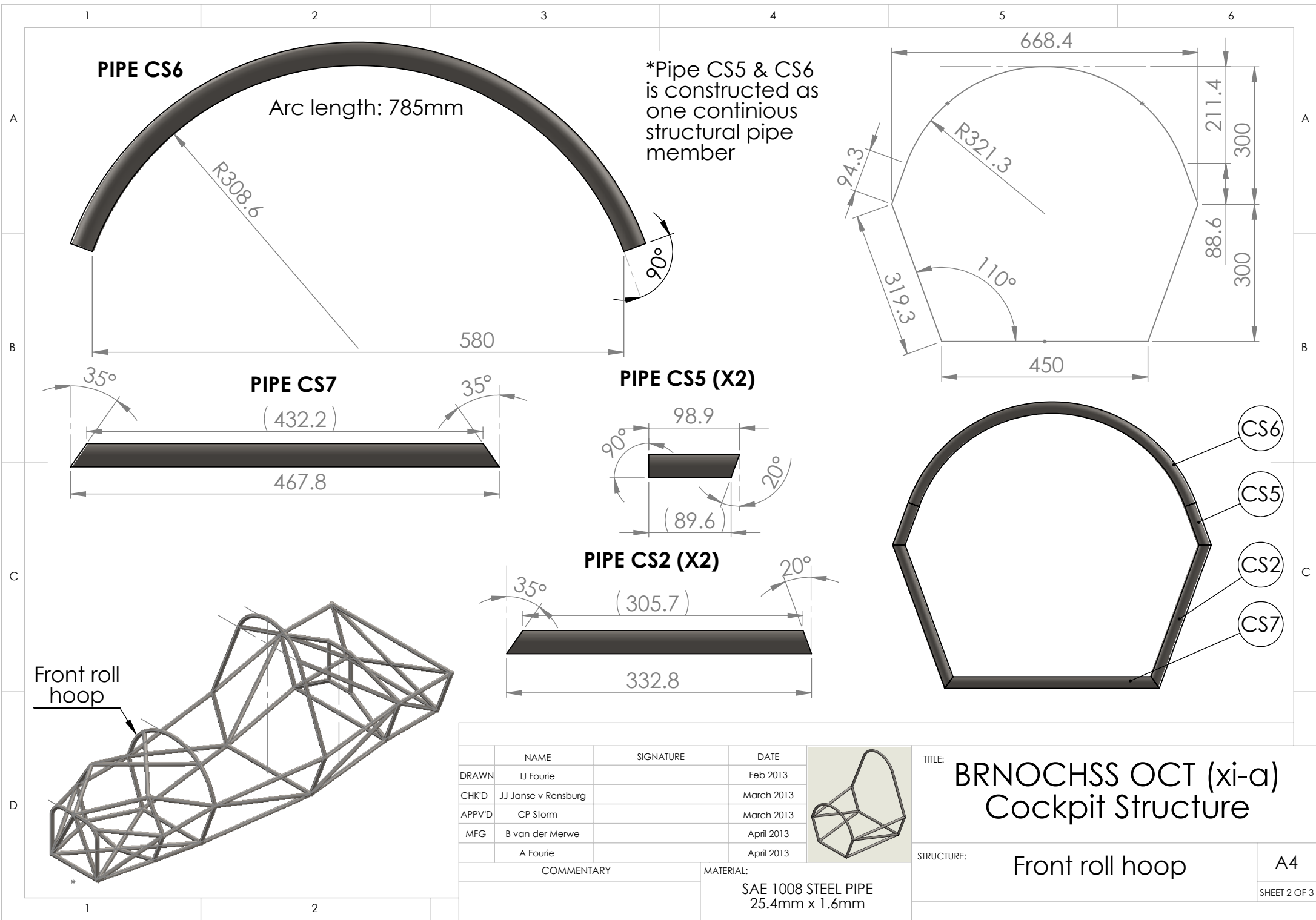


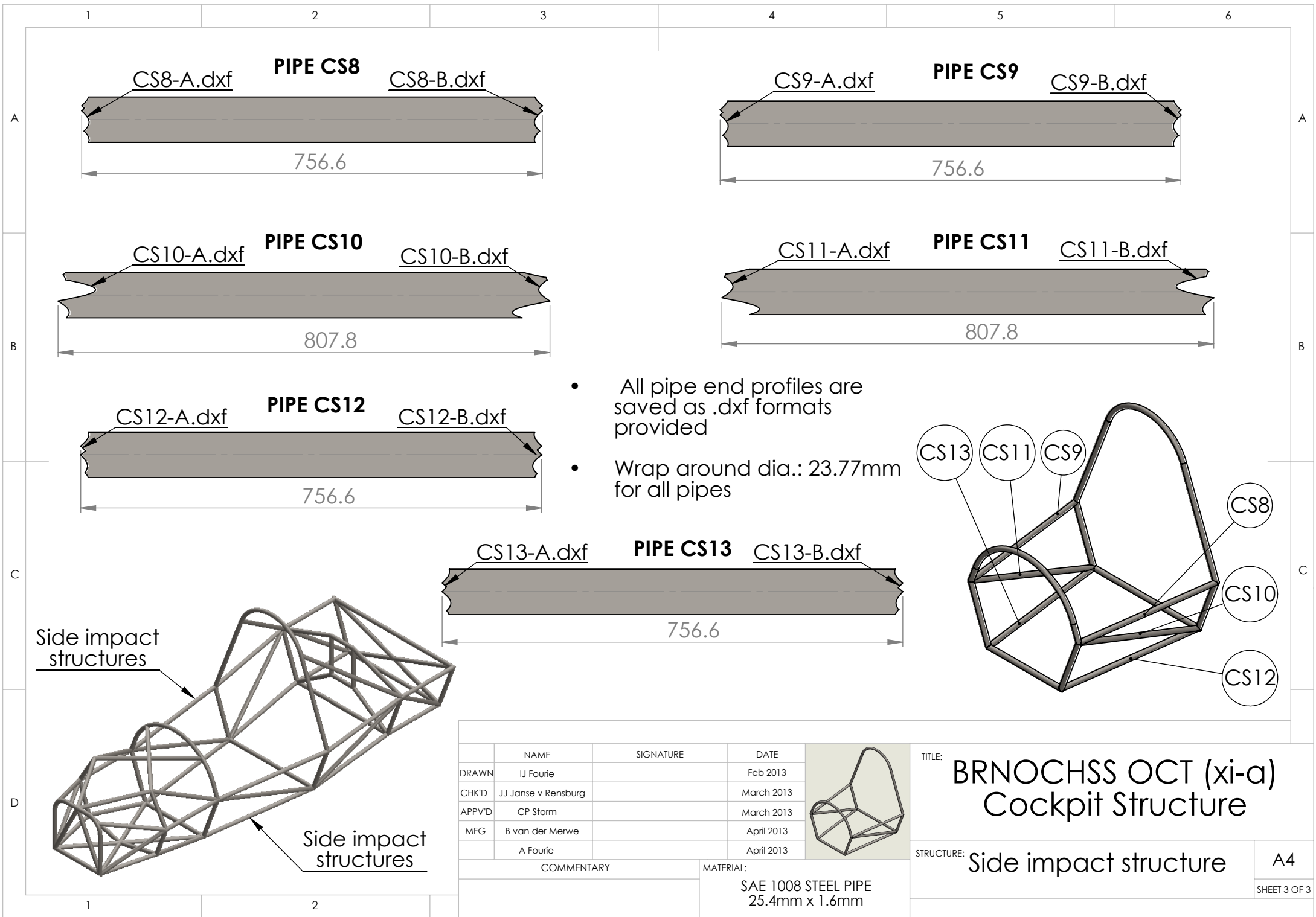
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Cockpit Structure**

STRUCTURE: **Main roll hoop**

A4

SHEET 1 OF 3



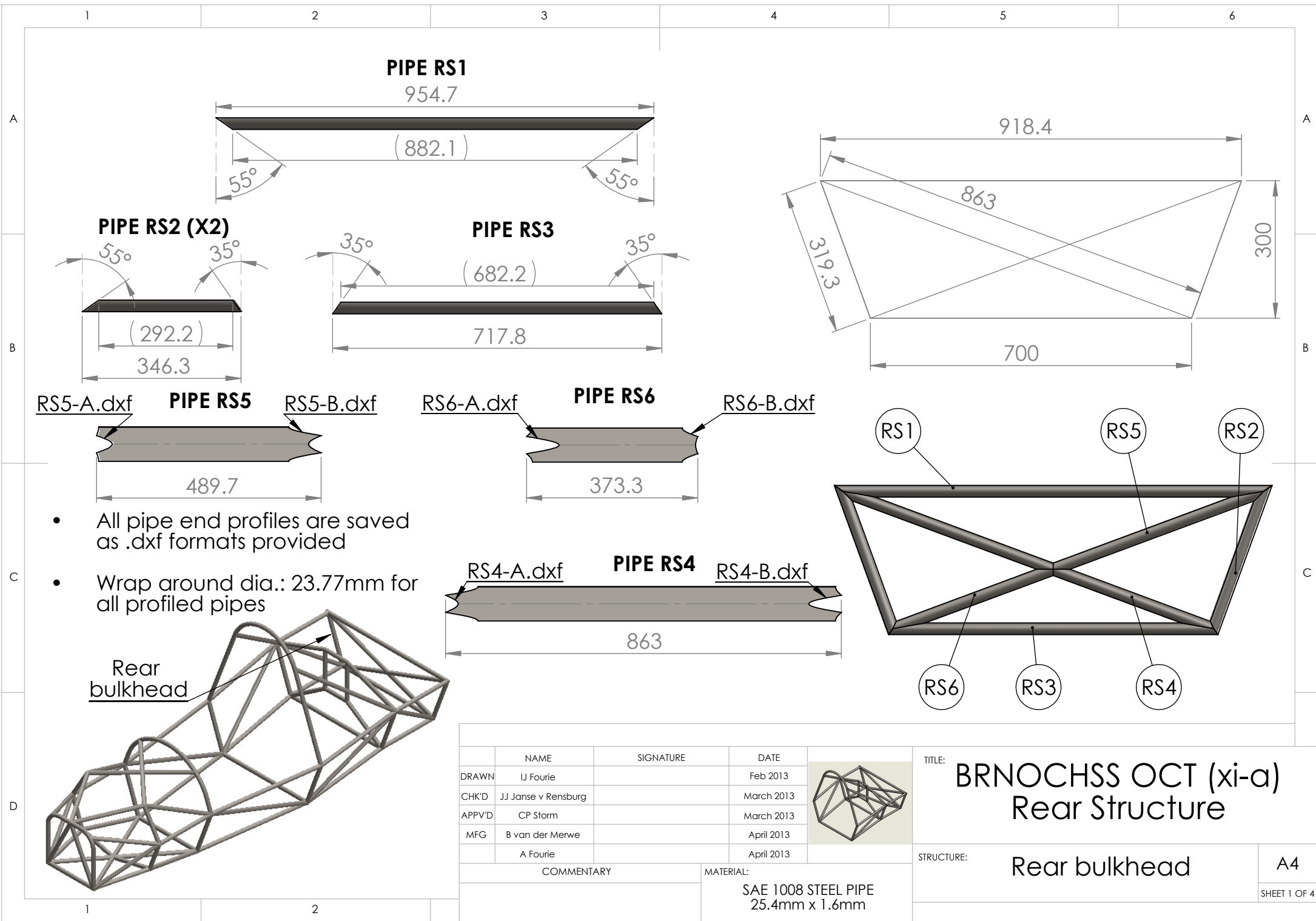


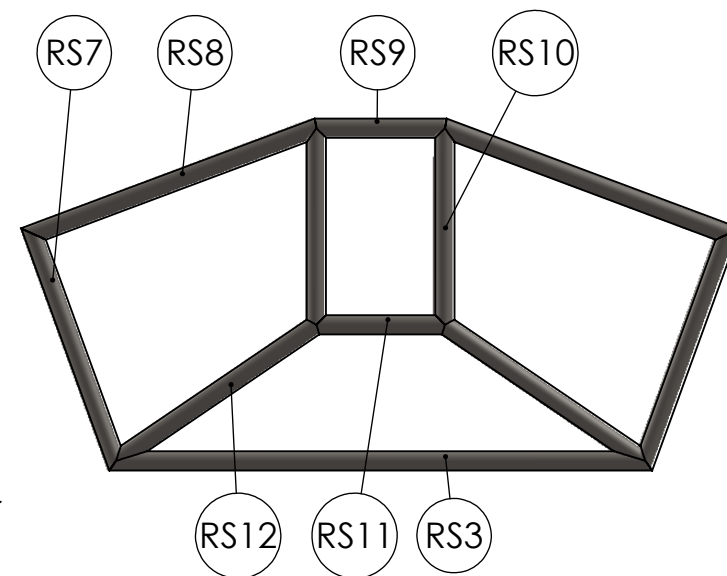
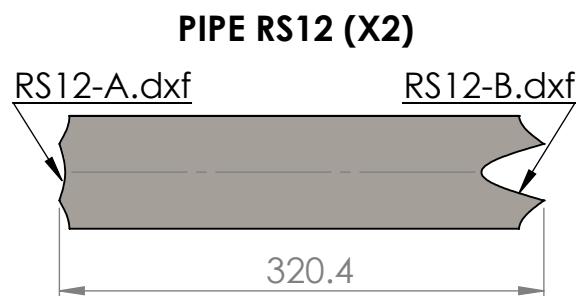
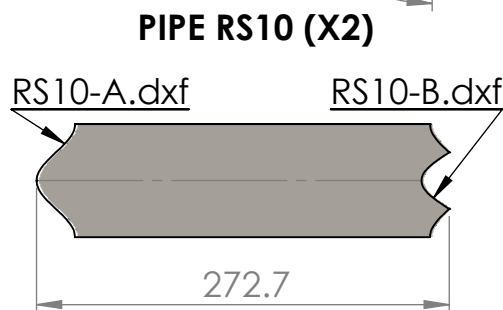
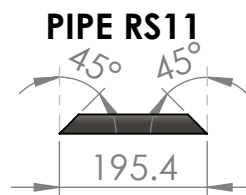
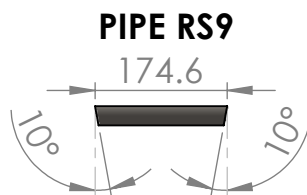
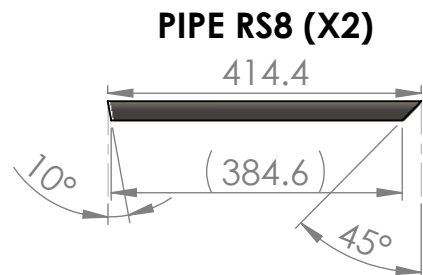
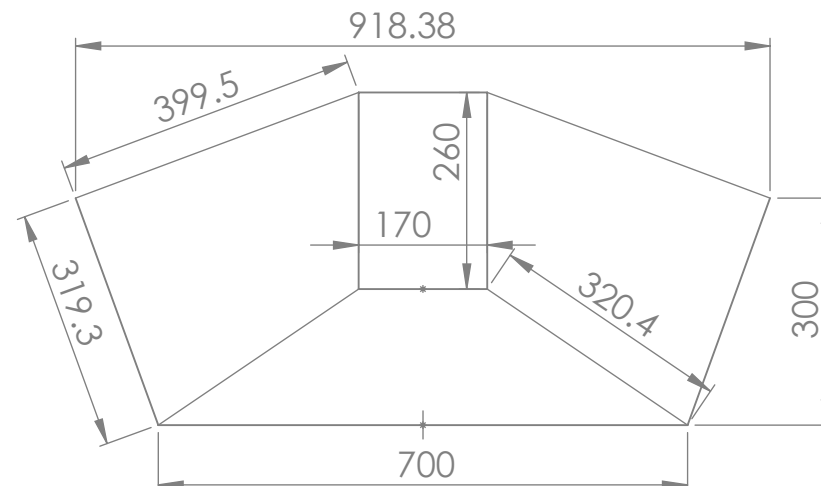
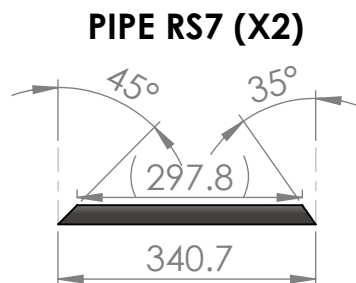
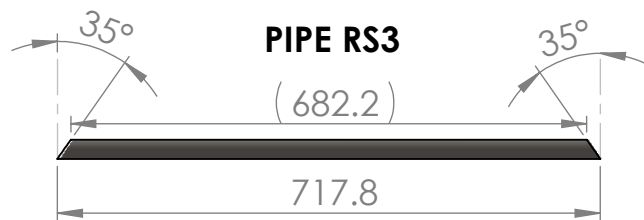
	NAME	SIGNATURE	DATE
DRAWN	IJ Fourie		Feb 2013
CHK'D	JJ Janse v Rensburg		March 2013
APPV'D	CP Storm		March 2013
MFG	B van der Merwe		April 2013
	A Fourie		April 2013
COMMENTARY		MATERIAL:	
		SAE 1008 STEEL PIPE 25.4mm x 1.6mm	

TITLE:
**BRNOCHSS OCT (xi-a)
Cockpit Structure**

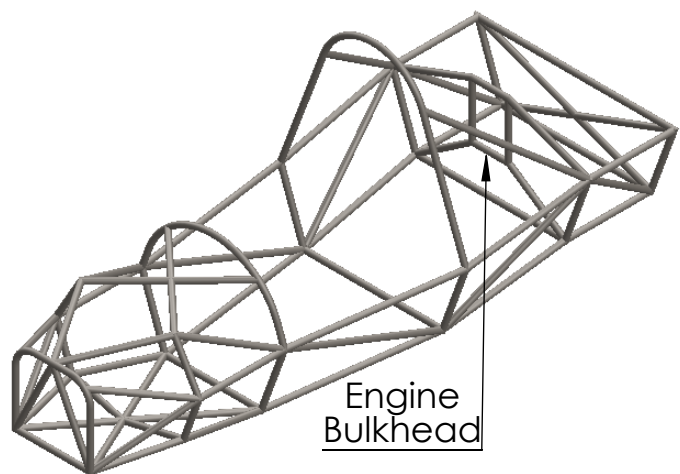
STRUCTURE:
Side impact structure

A4
SHEET 3 OF 3





- All pipe end profiles are saved as .dxf formats provided
- Wrap around dia.: 23.77mm for all profiled pipes



	NAME	SIGNATURE	DATE
DRAWN	IJ Fourie		Feb 2013
CHK'D	JJ Janse v Rensburg		March 2013
APPV'D	CP Storm		March 2013
MFG	B van der Merwe		April 2013
	A Fourie		April 2013
COMMENTARY		MATERIAL:	
		SAE 1008 STEEL PIPE 25.4mm x 1.6mm	

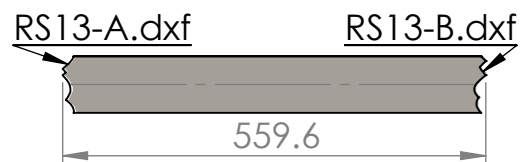
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Rear Structure**

STRUCTURE: **Engine Bulkhead**

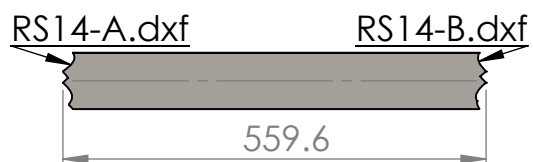
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SHEET 2 OF 4

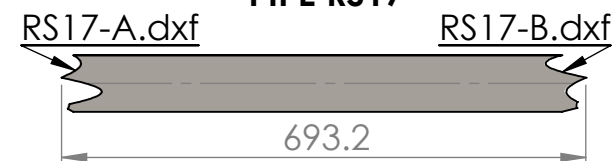
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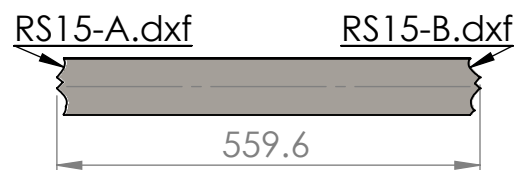
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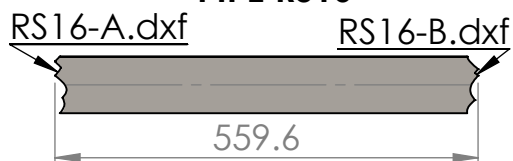
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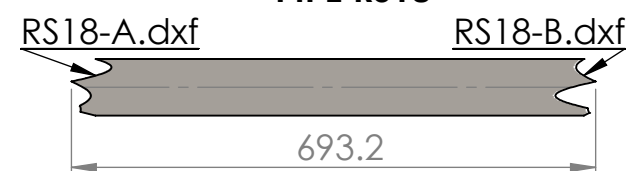
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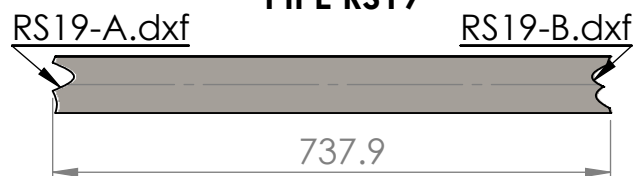
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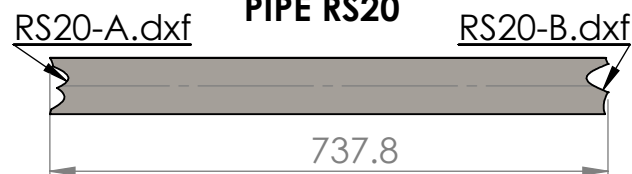
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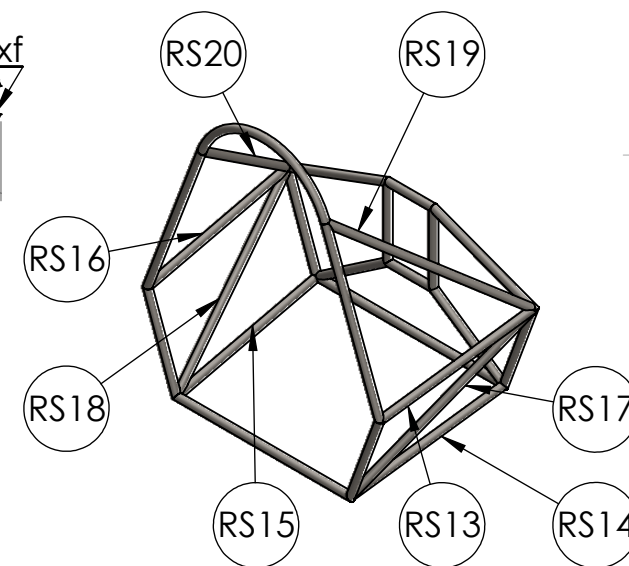
PIPE RS19



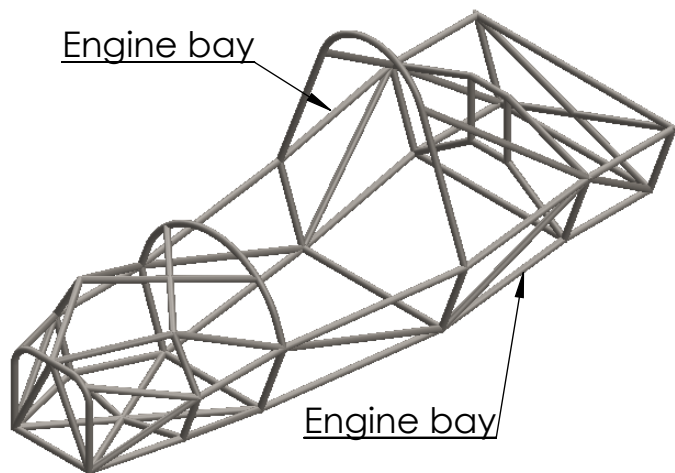
PIPE RS20



- All pipe end profiles are saved as .dxf formats provided
- Wrap around dia.: 23.77mm for all profiled pipes



Engine bay



Engine bay

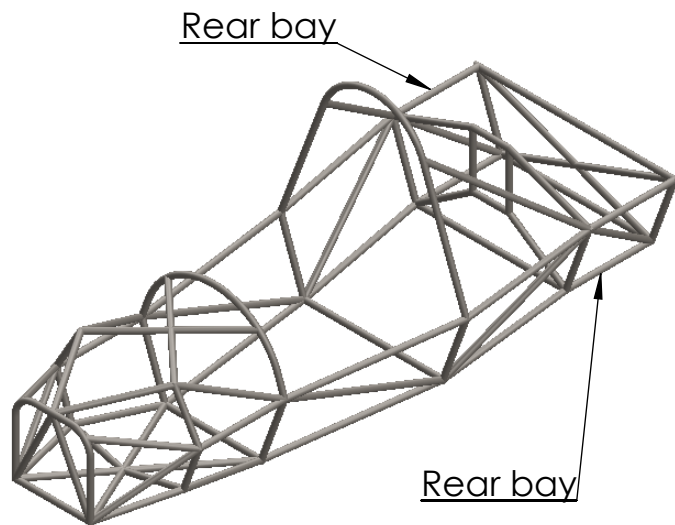
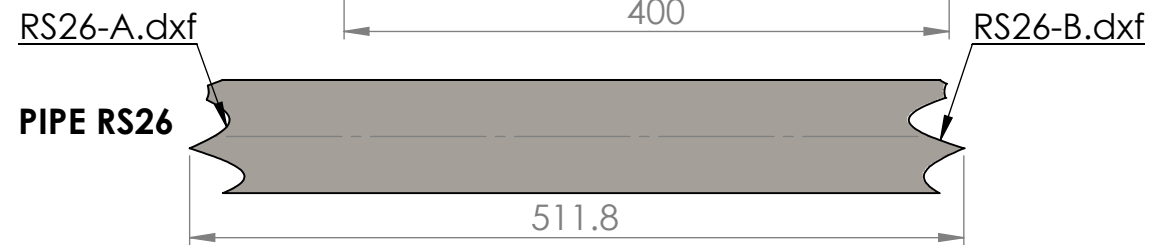
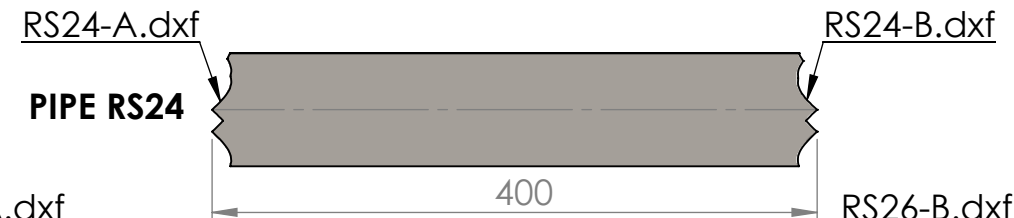
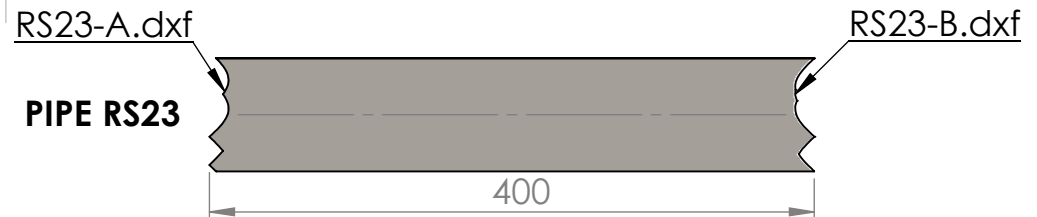
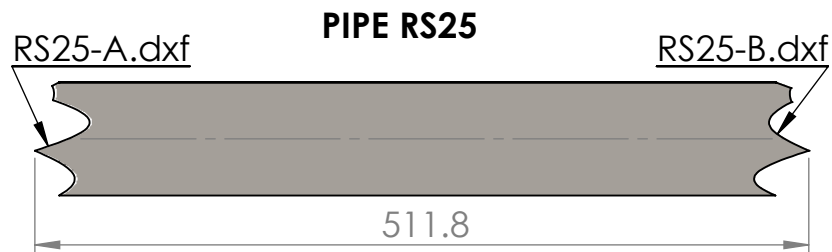
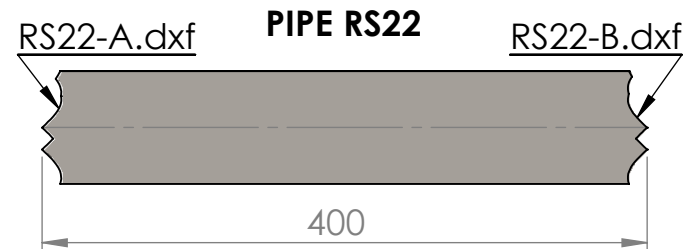
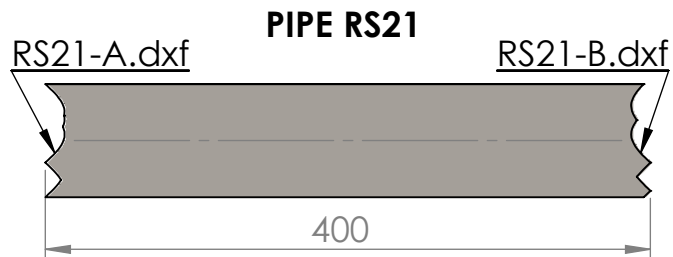
	NAME	SIGNATURE	DATE
DRAWN	IJ Fourie		Feb 2013
CHK'D	JJ Janse v Rensburg		March 2013
APPV'D	CP Storm		March 2013
MFG	B van der Merwe		April 2013
	A Fourie		April 2013
COMMENTARY		MATERIAL:	
		SAE 1008 STEEL PIPE 25.4mm x 1.6mm	

TITLE: **BRNOCHSS OCT (xi-a)**
Rear Structure

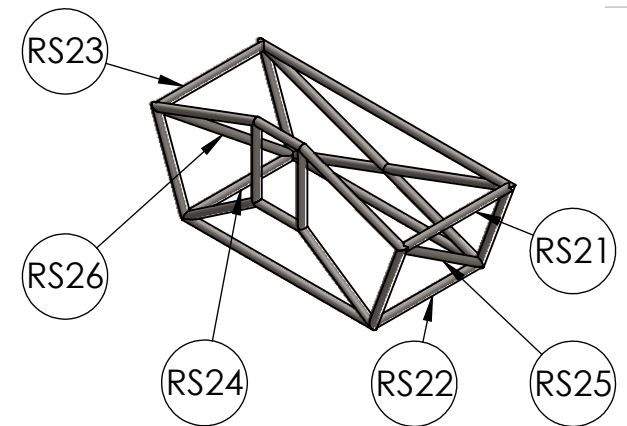
STRUCTURE: **Engine bay**

A4

SHEET 3 OF 4



- All pipe end profiles are saved as .dxf formats provided
- Wrap around dia.: 23.77mm for all profiled pipes



	NAME	SIGNATURE	DATE
DRAWN	IJ Fourie		Feb 2013
CHK'D	JJ Janse v Rensburg		March 2013
APPV'D	CP Storm		March 2013
MFG	B van der Merwe		April 2013
	A Fourie		April 2013
COMMENTARY		MATERIAL:	
		SAE 1008 STEEL PIPE 25.4mm x 1.6mm	

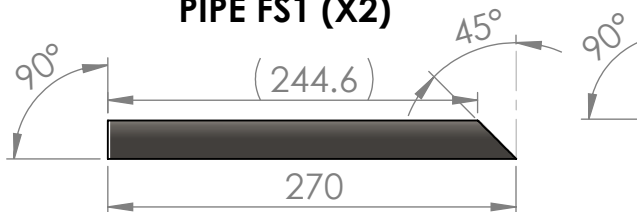
TITLE: BRNOCHSS OCT (xi-a)
Rear Structure

STRUCTURE: Rear bay

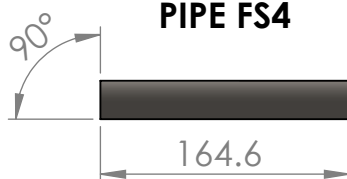
A4

SHEET 4 OF 4

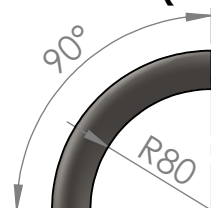
PIPE FS1 (X2)



PIPE FS4



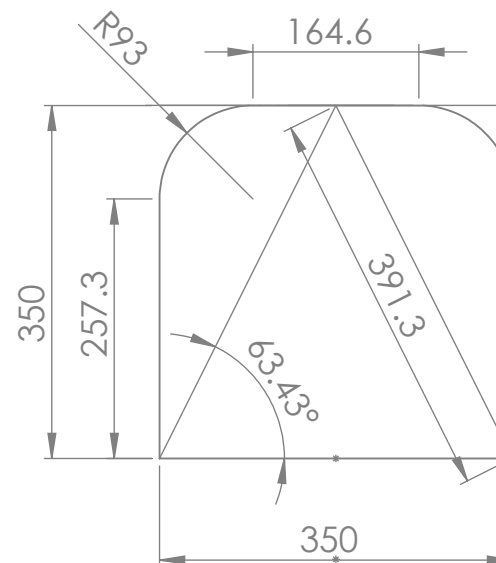
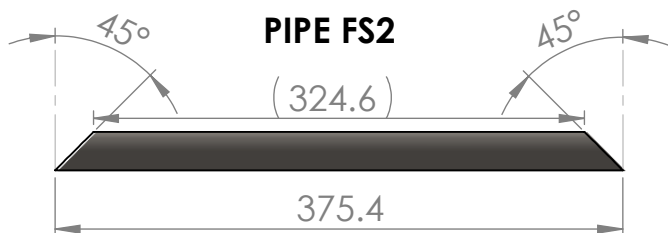
PIPE FS3 (X2)



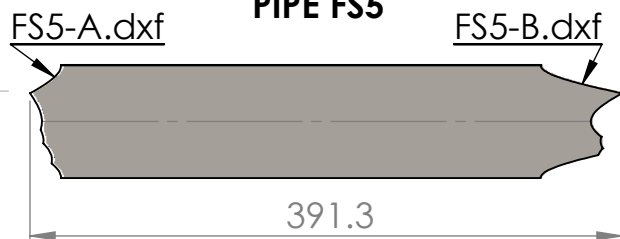
Arc length: 146mm

*Pipes FS1, FS3 & FS4 is constructed as one continuous structural pipe member

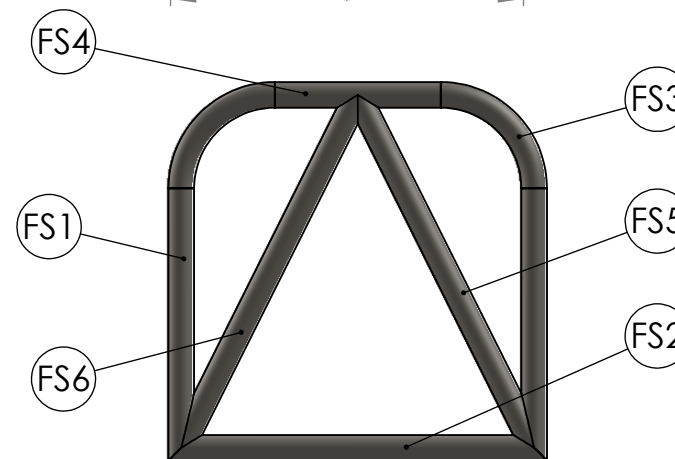
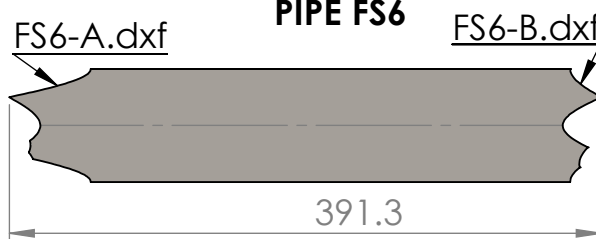
PIPE FS2



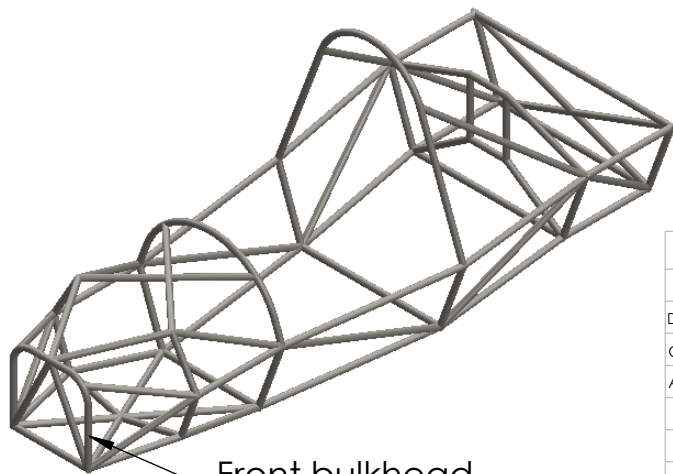
PIPE FS5



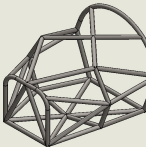
PIPE FS6



- All pipe end profiles are saved as .dxf formats provided
- Wrap around dia.: 23.77mm for all profiled pipes



Front bulkhead

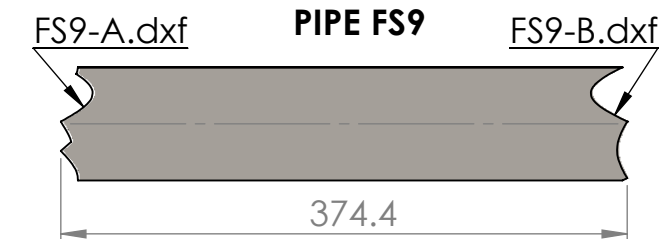
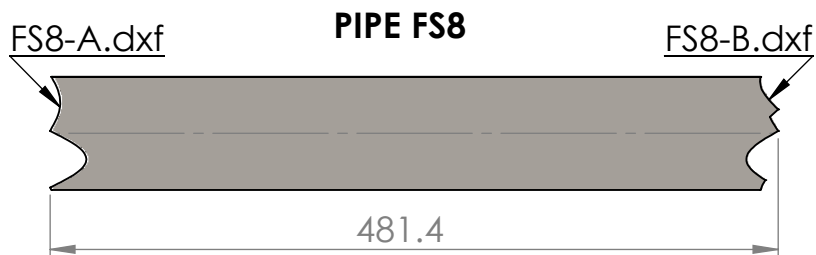
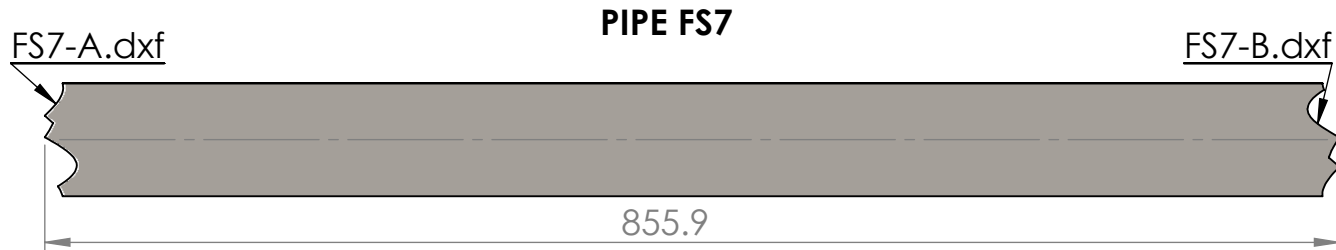
	NAME	SIGNATURE	DATE	
DRAWN	IJ Fourie		Feb 2013	
CHK'D	JJ Janse v Rensburg		March 2013	
APPV'D	CP Storm		March 2013	
MFG	B van der Merwe		April 2013	
	A Fourie		April 2013	
COMMENTARY			MATERIAL:	
			SAE 1008 STEEL PIPE 25.4mm x 1.6mm	

TITLE: **BRNOCHSS OCT (xi-a)
Front Structure**

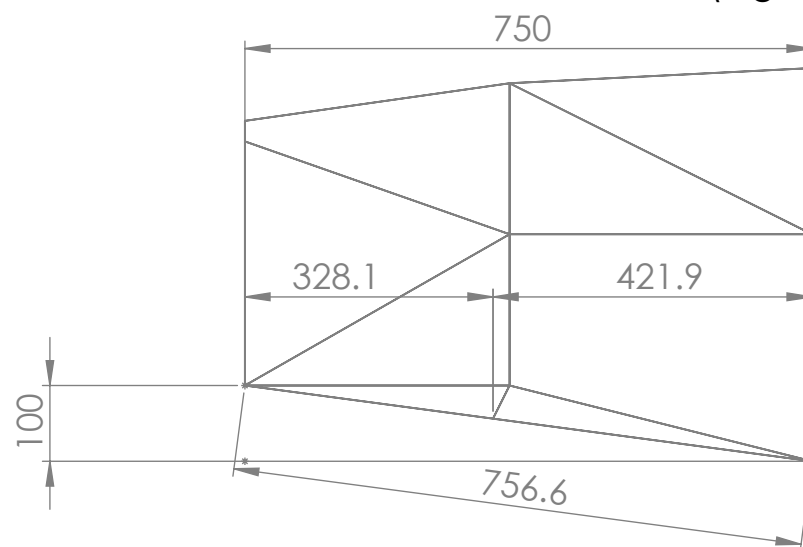
STRUCTURE: **Front bulkhead**

A4

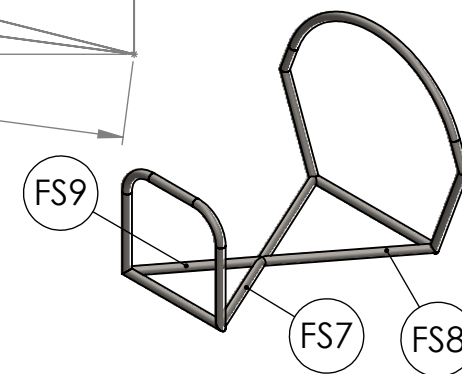
SHEET 1 OF 5



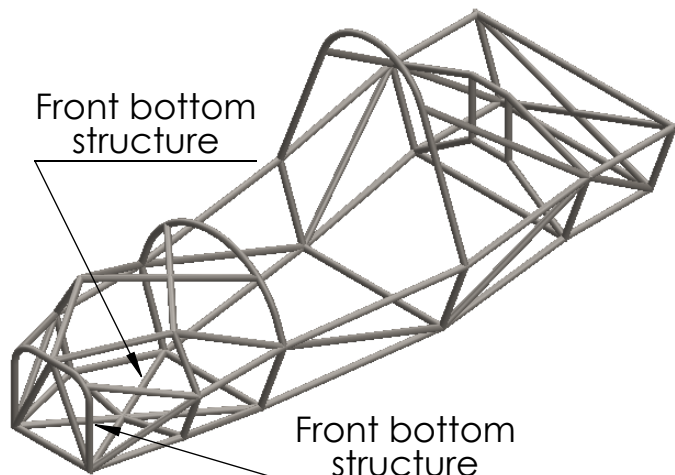
Centreline Distances
(Right view)



- All pipe end profiles are saved as .dxf formats provided
- Wrap around dia.: 23.77mm for all profiled pipes



Front bottom
structure



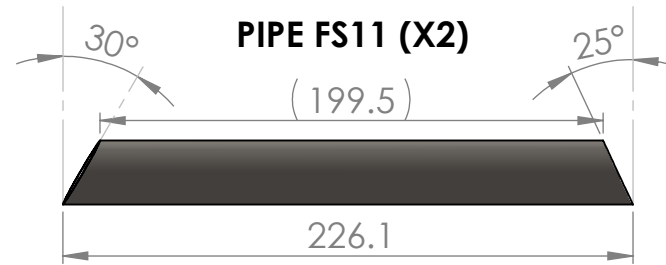
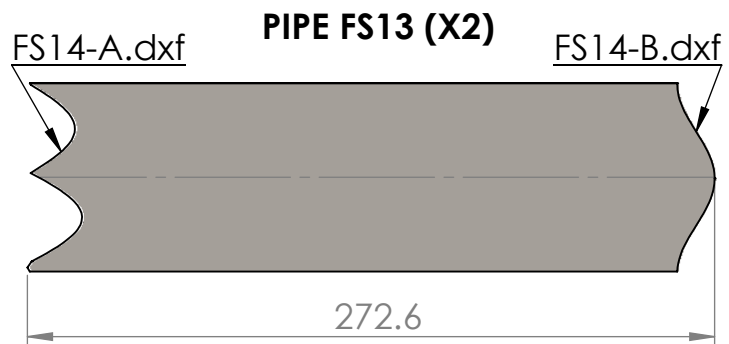
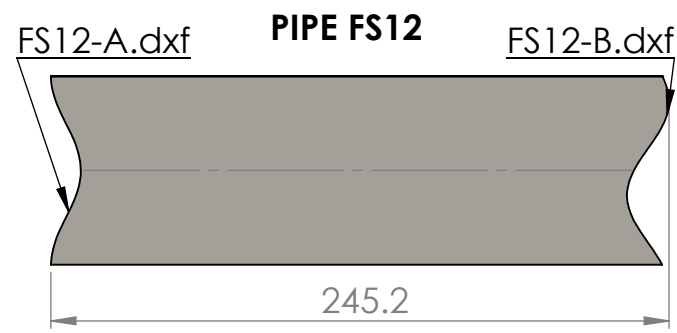
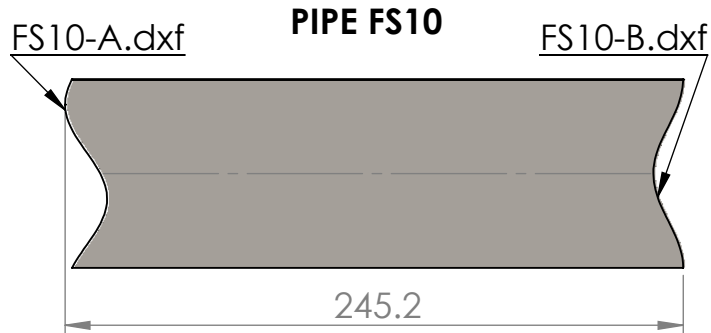
	NAME	SIGNATURE	DATE	
DRAWN	IJ Fourie		Feb 2013	
CHK'D	JJ Janse v Rensburg		March 2013	
APPV'D	CP Storm		March 2013	
MFG	B van der Merwe		April 2013	
	A Fourie		April 2013	
COMMENTARY			MATERIAL:	
			SAE 1008 STEEL PIPE	
			25.4mm x 1.6mm	

TITLE: **BRNOCHSS OCT (xi-a)**
Front Structure

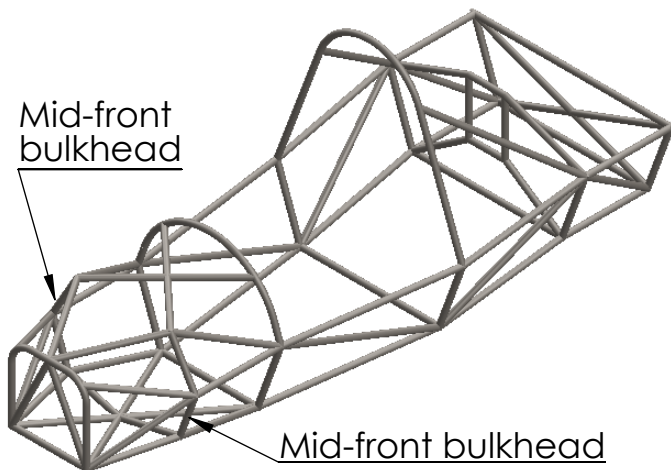
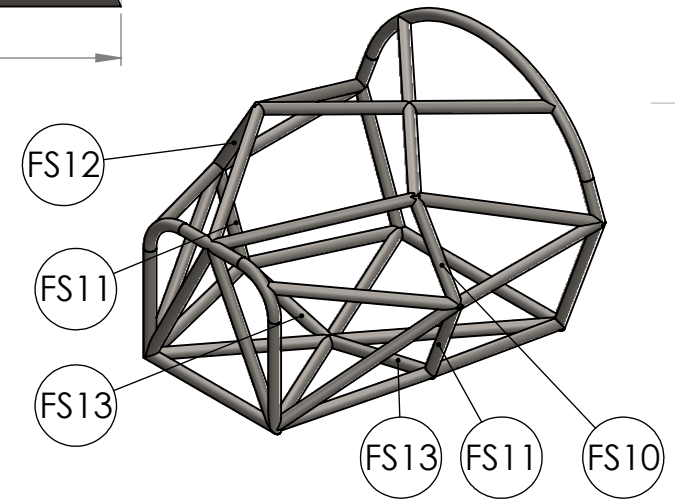
STRUCTURE: **Front bottom structure**

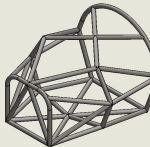
A4

SHEET 2 OF 5



- All pipe end profiles are saved as .dxf formats provided
- Wrap around dia.: 23.77mm for all profiled pipes



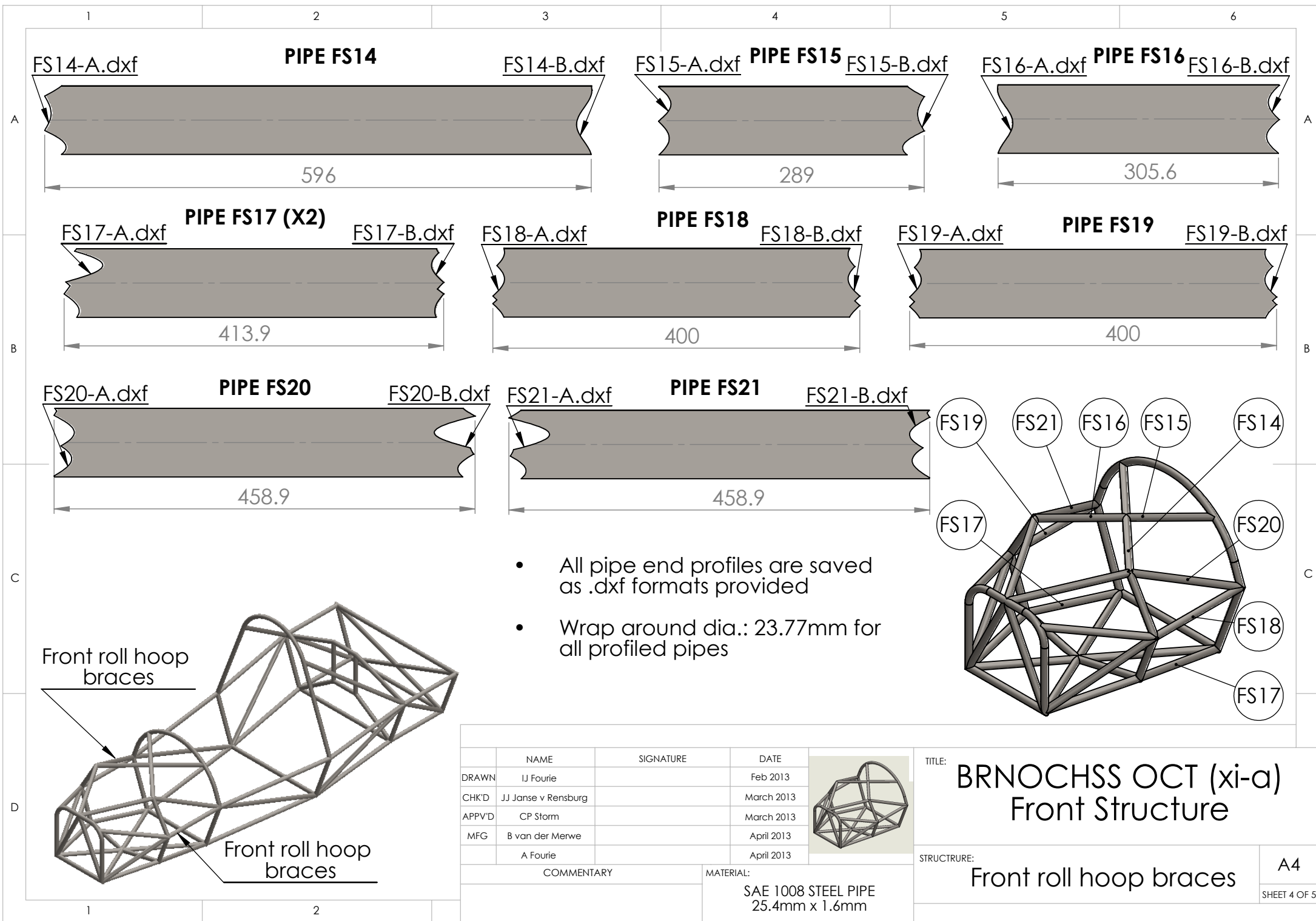
	NAME	SIGNATURE	DATE	
DRAWN	IJ Fourie		Feb 2013	
CHK'D	JJ Janse v Rensburg		March 2013	
APPV'D	CP Storm		March 2013	
MFG	B van der Merwe		April 2013	
	A Fourie		April 2013	
COMMENTARY			MATERIAL:	
			SAE 1008 STEEL PIPE 25.4mm x 1.6mm	

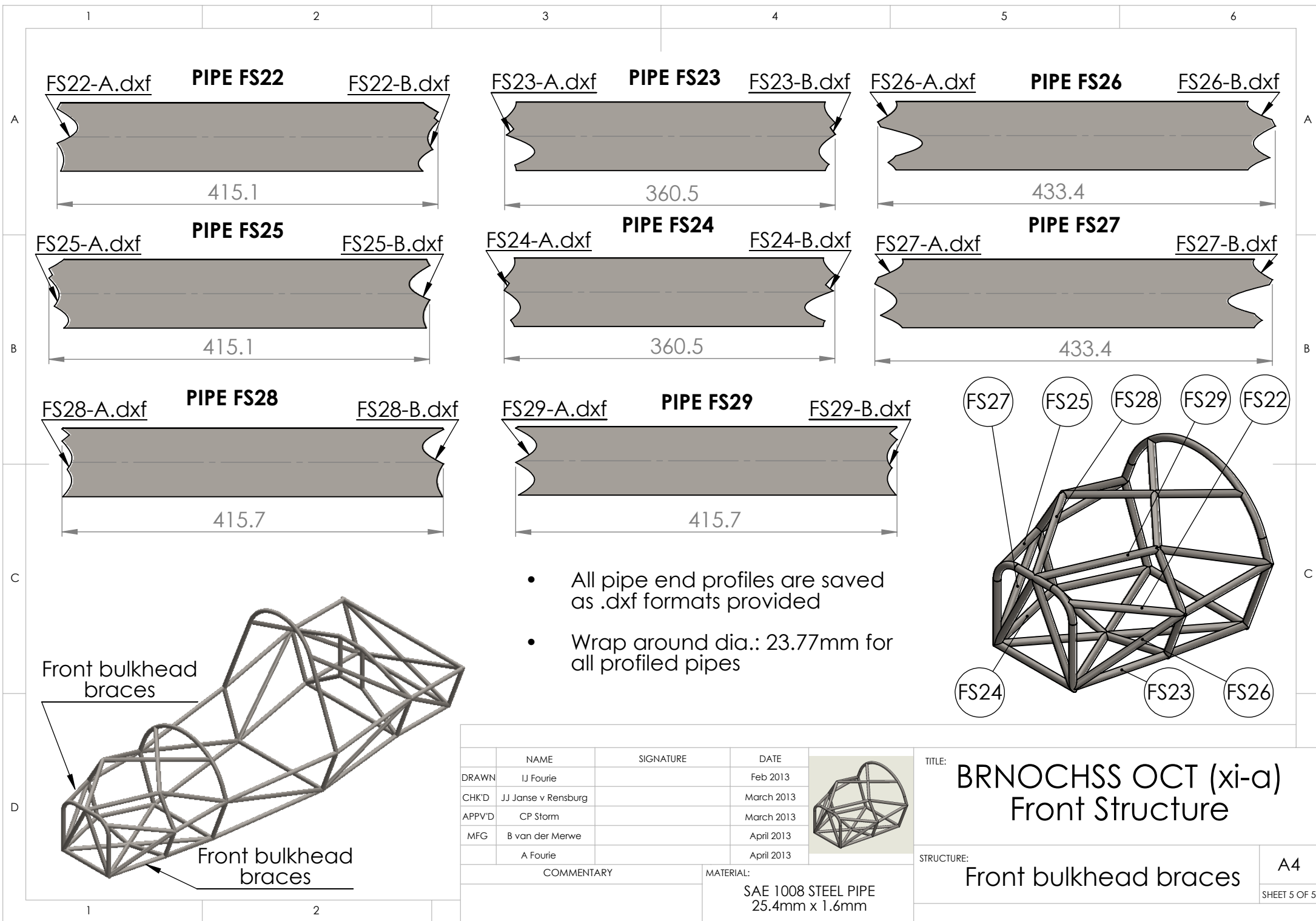
TITLE: **BRNOCHSS OCT (xi-a)
Front Structure**

STRUCTURE: **Mid-front bulkhead**

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SHEET 3 OF 5





Appendix F

Data DVD

Appendix F is an included data DVD that contains the complete set of Formula SAE rules, all developed chassis concepts, the final chassis model and its drawings, together with the required manufacturing information.