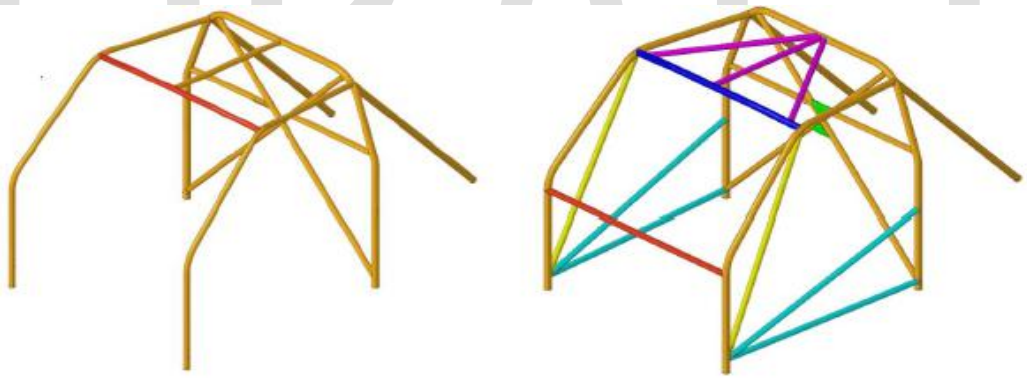
2019 Rollover Protection Review

Scope – Findings – Proposed Changes



Contents

1. Scope

The analysis is to address concerns raised by CCDA members as to the ongoing suitability of the current ROPS design into the future of the sport. Identify if the current design remains suitable and if not provide a new schedule of design and implementation plan providing engineering data to provide credibility to the design.

2. Areas of concern and reasons for review.

A number of areas of concern were raised both by seasoned winch challenge racers as well as event organizers and vehicle builders.

- The current ROPS schedule was written over 15 years ago, with little change or update in this period, the sport and vehicles progression may have left this design out dated.
- The current ROPS design had no engineering data to support it's suitability. Loosely based on other governing bodies designs (with changes) there had been no specific testing of suitability.
- The base design was intended for vehicles with a lower mass than a majority of competing vehicles.
- Many alternative designs, changes and implementation variations have been allowed to race without engineering data to support these alterations creating a varied and inconsistent range of ROPS implementations.
- While many agreed that the ROPS design needed to be investigated and updated, most also agreed that the people questioning were not suitably qualified to validate their design variation suggestions.

3. Data Available for analysis

Physical and theoretical data for the current design is available.

- Historic incident data – cage failures and vehicle rollover incidents.
- Current design specifications
- Current and historical vehicle design, mass and speed potential.

4. FEA analysis

FEA analysis provided the ability to test both the current and revised designs in various load cases to essentially push the ROPS system to failure without the cost of destructive testing. This provides a solid base for engineering support to any design changes and findings.

5. Findings

Both the first and second FEA analysis reports are appendixed to this document.
Top line findings are as follows:

- The current CCDA ROPS design has significant shortfalls against vehicle mass, particularly in the upper corner of the A pillar area.
- Maximum allowable FIA deflection was achieved marginally above some vehicle's static mass in this area.
- Proposed designs provided significant improvements in strength in rollover conditions.
- Design were modified and re-tested to find a compromise between strength and fitment ability.

6. Application of findings to new design

The findings in the FEA analysis lead to the requirement of modifications to the existing design to add sufficient strength to the vehicle ROPS system.
The following changes are proposed:

- The implementation of a new ROPS design for new vehicle builds (appendixed into this document)
- The addition of key members to existing vehicles to improve existing vehicle ROPS in identified areas.
- The removal of allowance of modified and altered designs without engineering support. (e.g. twin 4 point cages, pivoting A to B pillar joins, etc) from any future vehicle builds.

7. Implementation

- Existing log booked vehicles

Existing vehicles under current logbook will not require the full new design ROPS.
These vehicles will require the following additional members prior to their next required annual scrutineering that falls after 6 months from the implementation date.

- A-B pillar floor bar (to the specification in the new design schedule)
- A pillar support brace (to the specification in the new design schedule)

- Vehicles currently part way into build process

The CCDA recognizes that vehicles may currently be under construction with the current CCDA ROPS system fitted. These vehicles will have a period of 6 months to be completed and log booked under the current design with the addition of the above mentioned members.

- New vehicles not currently underway

Any new vehicles log booked after the 6 month period above will require the new ROPS system to be fitted in full. Any exceptions, or alterations must be approved by the CCDA committee and engineering data may be required to support the approval of changes. This approval may require external analysis at a cost to be borne by the requestor.

- Vehicles currently log booked and within scrutineering that are sold or change owners.

Vehicles sold or that change ownership require a new logbook application and full scrutineering. The CCDA identifies that the change to ROPS regulations may affect these vehicles. Any vehicle that is under current annual scrutineering and currently log booked that is sold or changes ownership may be passed with the same alterations as current vehicles with proof of scrutineering currency and logbook provided. Some previously allowed ROPS alternations may not be accepted at the discretion of the CCDA it is recommended that you seek clarification on this point prior to purchasing any vehicle that has a CCDA ROPS if you intend to race it without ROPS modification.

Appendix 1:
ROPS design specifications

5 ROLLOVER PROTECTION

5.1 APPLICATION

Rollover protection is required as specified in the CCDA Class Specifications and Event Supplementary Rules

5.2 DEFINITIONS

ROPS (Roll Over Protection System) – A structural framework designed to prevent serious body shell deformation
in the event of a collision or the vehicle turning over.
Main roll bar – Structure consisting of a near vertical frame or hoop located across the vehicle just behind the front seats.
Front roll bars – Longitudinal bar - its shape following the roofline and A pillars connecting the main roll bar to the floor at the base of the A pillar.
Lower floor side bar – A single longitudinal bar linking the bottom section of the Main roll bar to the bottom section of the Front roll bar following the floor line.
Diagonal member - Transverse tube between a top corner of the main roll bar and a lower mounting point on the other side of the roll bar.
A pillar strut – a single bar joining the upper corner of the front roll bar to the lower point of the front roll bar, straight when viewed from the side of the vehicle.
Framework reinforcement – Reinforcing member fixed to the roll cage to improve its structural efficiency.
Reinforcement plate – Metal plate fixed to the body shell or chassis structure under a roll bar mounting foot to spread load into the structure.
Mounting foot – Plate welded to a roll bar tube to provide for bolting or welding to the body shell or chassis structure, usually onto a reinforcement plate.
Removable members – Structural members of a safety cage which shall be able to be removed.

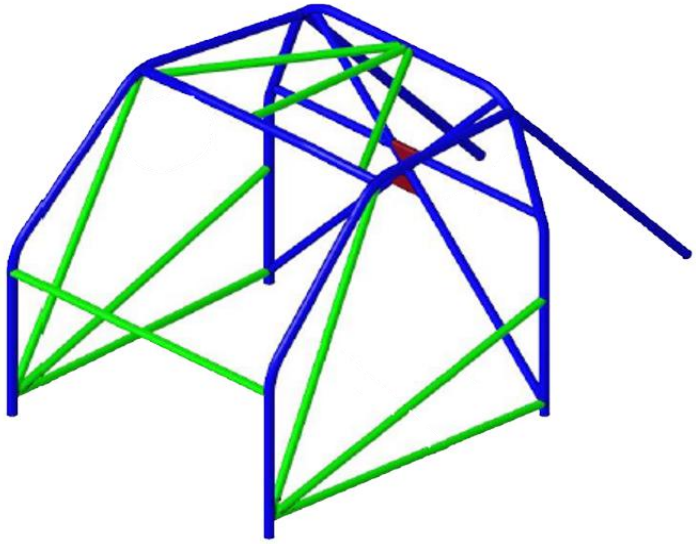
5.3 SPECIFICATIONS

5.3.1 GENERAL COMMENTS

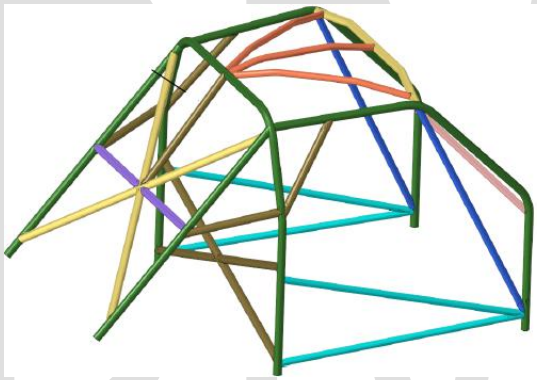
Safety cages shall be designed and made so that, when correctly installed, they substantially reduce body shell deformation and so reduce the risk of injury to occupants. The essential features of safety cages are sound construction designed to suit the particular vehicle, adequate fixings and a close fit to the body shell. Tubes shall not carry fluids or compressed air or be used as a pressure vessel. The safety cage shall be designed and fitted to minimize impact on ingress and egress of the crew.

5.3.2 TECHNICAL SPECIFICATIONS

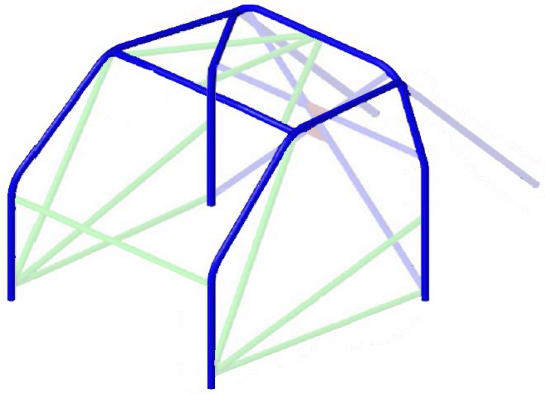
Complete ROPS Structure overview:



V2.1 ROPS



V2.2 ROPS

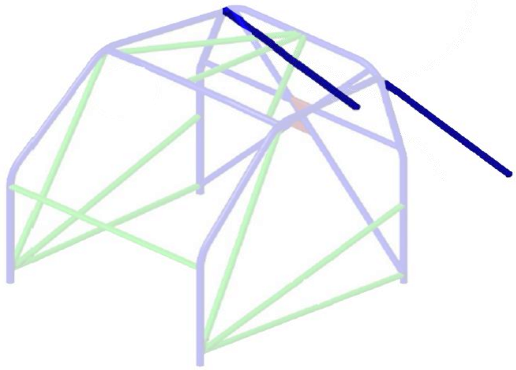


Main Cage structure:

Definition: The basic cage structure, consisting of main hoop, front hoops and upper transverse bar.
Minimum Material Specifications:
Diameter: 44.45mm
Wall thickness 2.5mm

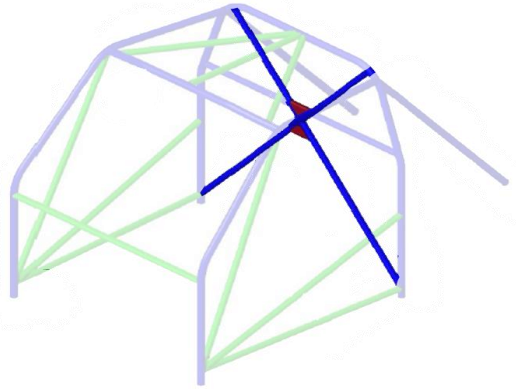
Notes: Main & front hoops shall be made in one piece without joints with smooth and even construction without ripples or cracks. The vertical part of the main roll bar shall be parallel to the interior contour or the body shell where possible.
The front leg of a front roll bar or of a lateral roll bar shall be straight, or shall follow the windscreen pillars and have only one bend with its lower vertical part.
To achieve an efficient fixing to the body shell, the original interior trim may be modified around the safety cages and their fixings by cutting it away or by removing it.
No part of the interior trim/ roof lining etc. should compromise the positioning of the ROP.
In open cars the roll bar shall be a minimum of 50 mm above any occupant's head. In conjunction with the vehicle's structure the roll cage should not leave unprotected any part of an occupant's shoulders when viewed from front or rear.
The main roll bar shall not overhang but shall be within 150mm of any occupant's head.
An occupant's helmet shall be prevented from passing between the bars to the extent that the helmet is visible at the rear of the hoop when viewed from the side.
No holes may be drilled in the basic cage structure.

Back Stays:



Definition: Straight reinforcing bars to support the main cage structure.
Minimum Material Specifications:
Diameter: 44.45mm
Wall thickness 2.5mm

Notes: Backstays shall be attached to the main hoop near the roofline and near the top outer bends of the main roll bar on both sides of the vehicle. Backstays shall be attached to the main hoop within 100mm of the intersection of the diagonal cross brace. They shall be at angle of at least 30 degrees with the vertical, shall run rearwards and be straight and as close as possible to the interior side panels of the body shell.
Their fixings shall be reinforced by plates. Each backstay should be secured by bolts having a cumulative section area at least two thirds of that recommended for each roll bar leg mounting, and with identical reinforcement plates of at least 6,000mm2 area.
A single bolt in double shear is permitted, provided it is of adequate section and strength and provided that a bush is welded into the backstay. No holes may be drilled in the backstays.



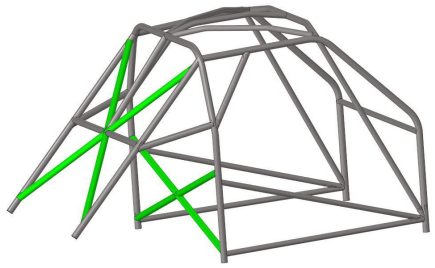
Diagonal Cross Brace V2.1 ROPS:

Definition: Straight diagonal intersecting members reinforcing the main hoop.
Minimum Material Specifications:
Diameter: 44.45mm
Wall thickness 2.5mm

Notes: At least two diagonal members shall be fitted and shall be straight. The lower end of the diagonal shall join the main roll bar or the backstay not further than 100mm from the fixing

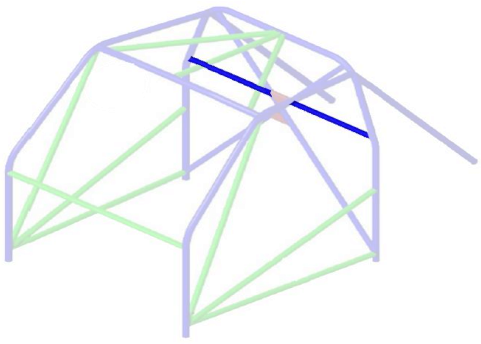
foot. The upper end must join the main roll bar not further than 100mm from the junction of the backstay joint. Gussets shall be fitted on the upper and lower sections of the intersection from minimum 2mm Mild steel, roller along the horizontal profile and welded into the mid point of the tube.

Diagonal Cross Brace V2.2 ROPS:



Definition: Straight diagonal intersecting members reinforcing the main hoop intersecting with the junction of the upper side bar on the main hoop. Plus a second cross brace in the backstays. The cross brace in the backstays also includes the straight bar from the top center of the main hoop to the center of the cross braces in the backstays.
Minimum Material Specifications:
Diameter: 44.45mm
Wall thickness 2.5mm

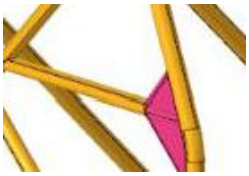
Notes: At least two diagonal members shall be fitted and shall be straight in the lower section of the main hoop and the second in the backstays.
The lower end of the main hoop diagonal shall join the main roll bar or the backstay not further than 100mm from the fixing foot. The upper end must join the main roll bar not further than 100mm from the junction of the side intrusion bar. Gussets shall be fitted on the upper and lower sections of the intersection from minimum 2mm Mild steel, roller along the horizontal profile and welded into the mid point of the tube.



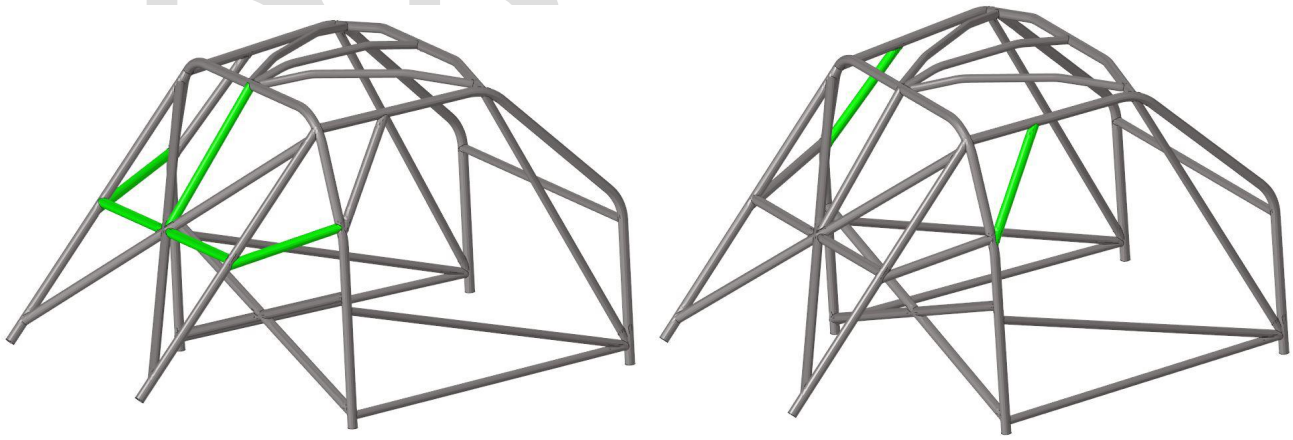
Harness Bars V2.1 ROPS:

Definition: Horizontal bar joining the main hoop to the diagonal cross braces to support the main hoop and retain the harness vertically.
Minimum Material Specifications:
Diameter: 44.45mm
Wall thickness 2.5mm

Notes: The harness bar must be placed level with or within 50mm above the shoulder height of the occupant allowing the harness to pass over the bar and forward in a near horizontal plane before contacting the shoulders. Optional Gusseting (as shown)of the harness bar to the main hoop is recommended to further improve side impact load strength.



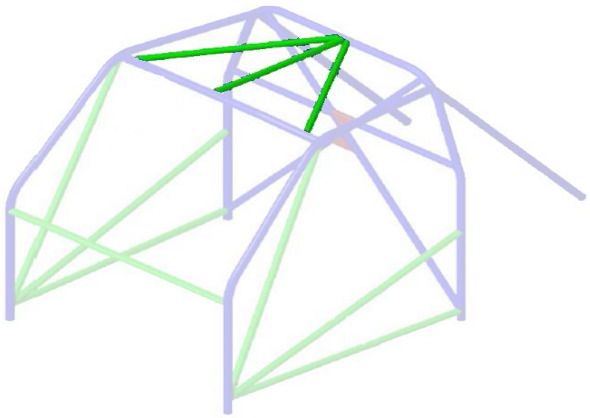
Harness Bars V2.2 ROPS



Definition: Horizontal bar joining the main hoop to support the main hoop and retain the harness vertically.
Minimum Material Specifications:
Diameter: 44.45mm
Wall thickness 2.5mm

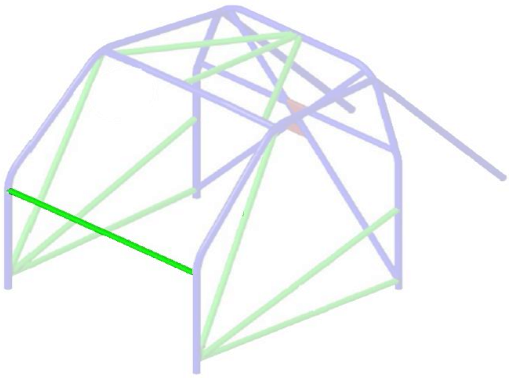
Notes: The harness bar must be placed level with or within 50mm above the shoulder height of the occupant allowing the harness to pass over the bar and forward in a near horizontal plane before contacting the shoulders. The harness bar in V2.2 ROPS is mounted to the backstays of the main cage structure to allow clearance inside the cabin. Optional Gusseting (as shown)of the harness bar to the main hoop is recommended to further improve side impact load strength.

Roof Reinforcement:



Definition: Reinforcing bars to support the roof section and upper front hoop corners.
Minimum Material Specifications:
Diameter: 38mm
Wall thickness 2.5mm

Notes: Roof reinforcement shall consist of at least one longitudinal bar down the center joining the upper windscreen bar to the main hoop, along with two diagonal members joining the outer front corners of the main structure to the center of the main hoop roof bar. These members may have bends up to 20 degrees to allow bars to fit closer to the roof line maximizing occupant headroom. Each member must be fitted so they appear straight when viewed from above.

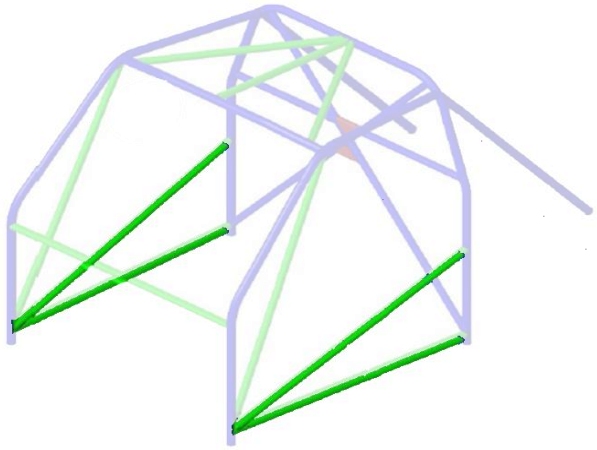


Windscreen Spreader Bar:

Definition: Straight horizontal member to support front hoops.
Minimum Material Specifications:
Diameter: 38mm
Wall thickness 2.5mm

Notes: The windscreen spreader bar shall join the two front hoops. The member shall be straight and attached to the front hoops within 150mm above or below the lower most bend.

Side Intrusion and lower floor bar:

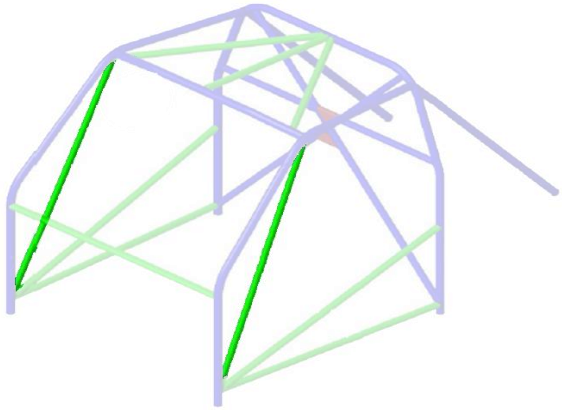


Definition: Straight reinforcing bars to support the main hoop and provide side intrusion protection. These members also provide significant “Punch Through” strength adding to the main and front hoop foot plates. The lower floor bar also provides strength into the lower front hoop in the event of contact with a tree or other immovable object in the lower firewall section of the vehicle.
Minimum Material Specifications:
Diameter: 38mm
Wall thickness 2.5mm

Notes:
Lower Floor Bar – the lower floor bar shall be fundamentally straight, attached to the main hoop and front hoop within 150mm of the foot plate. This bar may be bent up to 20 degrees at one or both ends to allow fitment however the majority of the member shall follow the floor.

Side intrusion bar – the side intrusion bar shall be joined to the main hoop and front hoop above the lower floor bar. It may be either straight or bent to follow the seat line. If bent the side intrusion bar must have a reinforcing member to the lower floor bar in the center third of the bar. The rear attachment must be at the center or above of the lower vertical section of the main hoop. The side intrusion bar shall be mounted as low as possible to the front hoop to minimize impact on occupant access.

Front Hoop Support:



Definition: Primary reinforcement to add rollover capacity to the upper corners of the A pillar and front hoop.
Minimum Material Specifications:
Diameter: 38mm
Wall thickness 2.5mm

Notes: The front hoop reinforcement member shall be fitted to both sides, attached to the horizontal section of the front hoop within 100mm of the upper windscreen transverse bar. The lower section attached to the lower most section of the front hoop generally at the junction of the lower floor bar or foot plate or both. If the front hoop support intersects the side intrusion bar it must be sectioned and straight when viewed from the side. The member may be bent by up to 20 degrees however must be fitted so the bar appears straight when viewed from the side.

Optional Reinforcement of the Roll Cage

Recommended optional members consist of reinforcing gussets on the harness bar to main hoop junctions and a single vertical strut front he center of the diagonal cross brace to the center of the main hoop horizontal section. These members/gussets provide additional support and are especially recommended in vehicles over 3200kg

Other optional reinforcing members are allowed however must be manufactured out of 44.45 or 38mm tube as per the specifications contained in this schedule and shall be fitted in a way to minimize occupant access and/or injury risk.

5.9 Reinforcement of Bends and Junctions

The junction of the main roll bar or the front roll bar, the top rear bends of the lateral roll bars and the junction between the main roll bar and the backstays may be reinforced with longitudinal struts.
The ends of these reinforcing struts shall not be more than half way down or along the members to which they are attached, except for those at the junction of the front roll bar, which may join the junction of the door strut/front roll bar.

5.4 Fixing of Roll Cages to the Body Shell

Roll cages shall be fixed to the vehicle by one of the following three options:

5.4.1 Option 1

As a minimum, fixings shall comprise:
One for each leg of the main or lateral roll bar;
One for each of the front roll bar;
One for each backstay.
Fixing may be by bolting or welding to the body shell.
Each fixing plate of the front, main and lateral roll bars shall include a reinforcement plate 3mm
thick, or the gauge of the tube onto which it is welded, whichever is the greatest.
If bolted to the body shell each fixing plate shall be attached by a minimum of three bolts on a steel reinforcement plate at least 3mm thick and of at least 15,000mm2 area which is welded to
the body shell. This area can be made up of a single plate or by adding a third dimension (i.e. angle) to its profile. Minimum Base Plate to be at least 10,000mm2 with a 100mm single dimension.
Bolts shall be either M8 size to ISO standard 8.8, hexagon head high tensile fasteners to AS2465 or caps crews to AS14201 with nuts to AS1112 or better. Pins for removable connections shall be the same strength specifications as the bolts.
Fasteners shall be self-locking or fitted with lock washers. Additional fasteners may be used however all fasteners shall meet these requirements.

If welded to the body shell roll bar legs shall be welded to reinforcement plates. Roll bar feet shall not be welded directly to the body shell without a reinforcement plate.

5.4.2 Option 2

Alternatively all the attachment points of the roll cage may be fitted with a base plate and lower
plate complying with the table below. The base plate, complying with the area requirements shown in the table below, may be welded to the body shell, in which case the use of bolts and the lower plate is not required.

Application	Minimum Area	Minimum single dimension
Upper (base) plate		
Over 1151kg	15,000mm^2	Min Baseplate of 10,000mm^2 100mm
Lower plate		
	4,500mm^2	Proportional to upper plate

5.4.3 Option 3

Where Event Group regulations permit, the roll bar protection may be an integral part of a space
frame tubular chassis. The roll cage shall comply with these regulations from a point above where the predominately vertical portion of the roll cage meets a predominately horizontal portion of the chassis. Parts of the roll cage may extend below this horizontal plane and become integral with the chassis. Vertical components shall be braced from the chassis.

5.10 Protective Padding

All sections of the roll cage that could come into contact with occupant's bodies or helmets shall
be provide with non-flammable padding for protection.

5.11 Removable Members

Demountable joints are not recommended in any members, any demountable joints must carry certification of a level higher than this schedule and we recommend you discuss your plans with the chief scrutineer prior to purchasing/fitting any demountable joints.
Demountable joints shall not be used as part of the main, front or lateral roll bar, or the junction of the backstays to the main hoop.

5.12 Guidance on Welding

All welding shall be of the highest possible quality with full penetration and preferably using a gas shielded arc, and shall demonstrate good workmanship.
When using heat–treated steel the special instructions of the manufacturers shall be followed

5.13 Material Specifications

All tubing used in roll bar protection structures shall be circular section cold drawn steel tube (CDS with properties as shown in the following tables.

Composition

Property Specification	
Carbon content	0.3% max.
Magnese content	1.0% max.
Other alloy content	0.5% max.
Tensile strength	350 Mpa min.

These figures represent the minimum permitted specification. In selecting the steel, attention shall be paid to obtaining good elongation properties and adequate weldability.
The tubing shall be bent by a cold working process and the centerline bend radius shall be at least three times the tube diameter. Where the tubing is distorted during bending, the ratio of major to minor diameter shall be 0.9 or greater.

5.14 Flexible Joints

The use of flexible mounts only on the backstay lower mounting point shall be permitted provided the following minimum specifications are met:

5.14.1 A. Outer sleeve

The material shall be that used for the rear brace or of a higher specification and shall be welded to end of rear brace.
The wall thickness shall be 2.5mm minimum
The minimum outside diameter shall be that used for the rear brace and the maximum outside diameter shall be 25% larger than that used for the rear brace.
The minimum length shall be equal to the outside diameter of the rear brace.

5.14.2 B. Bushing Material

Bushings may be rubber, urethane, nylon or similar flexible material
Bushing outside diameter shall be no greater than three and a half times the outside diameter of
the inner sleeve.
The minimum length of bushings shall be equal to the length of the outer sleeve.

5.14.3 C. Inner sleeve/Spacer tube

Inner sleeves shall be steel of minimum thickness of 1.0mm.
The inside diameter of inner sleeves shall equal the outside diameter of the cross bolt.
Inner sleeve length shall be no greater than the length of the bushing material, and at least 200mm longer than outer sleeve.

5.14.4 D. Cross Bolt

Cross bolts shall be 11mm or 7/16 inch, minimum diameter and at least 8.0 Grade steel.

5.14.5 E. Fixing Lugs

Fixing lugs shall be steel with a minimum thickness of 5mm and a minimum length no less than
the outside diameter of the bushing material.

Appendix 2:
FEA report 1

Appendix 3:
FEA report 2