This form must be completed and uploaded to the “My Team” area on the FSG website **no later than the date specified** in the Action Deadlines. The FSG Technical Committee will review all submissions which deviate from the FSAE® and FSG rules for the Impact Attenuator. This form must also accompany the vehicle to Technical Inspection.

The Impact Attenuator Data (IAD) and supporting calculations must be submitted electronically in Adobe Acrobat format (*.pdf). Late submissions will be penalized with -10 (minus ten) points per each commenced day, up to a maximum of -70 points, which will be deducted from the team’s Total Score. Teams, which miss the IAD deadline by more than 7 days will be removed from the FSG competition.

In the event that the FSG Technical Committee requests additional information or calculations, teams have **7 days** from the date of the request to submit the requested information. Late submissions will be penalized with -5 (minus five) points per each commenced day, up to a maximum of -35 points, which will be deducted from the team’s Total Score.

Contact Details

Car Number	018
University Name	Mumbai Somaiya
Team Contact Person	
Last Name, First Name	Patel, Pramath
Telephone Number	+919920700065
E-mail Address	pramath.patel@orion-racing.com

Please NOTE: Rule T3.22.10!
Please NOTE: In case a dynamic test is performed, a certificate including contact details of and signed by either the institute where the test was performed, or a responsible of the university must be included in the report.

Attach Proof of Impact Attenuator

Impact Attenuator Data Report (IAD) - 2013

Car No. 018

ORION RACING INDIA

K. J. Somaiya College of Engineering, Mumbai.

Table of Contents

AIM FOR IMPACT ATTENUATOR

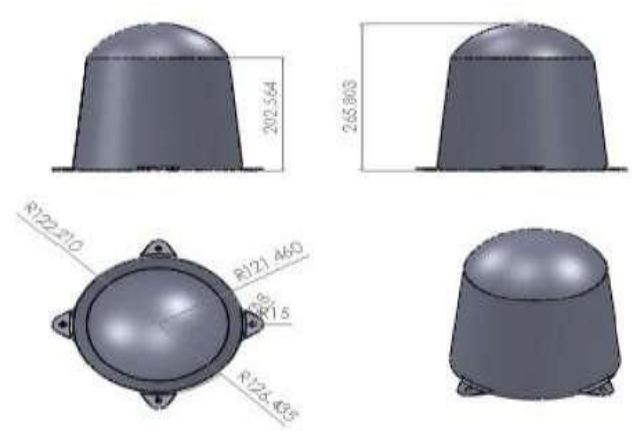
- To design an impact attenuator which is light weight (<700gms)
- Energy absorbing capacity >8000Joules
- Design an impact attenuator cylindrical – dome shaped to fit in between bodyworks and chassis.
- Maximum 'g' value < 35 g's
- Average 'g' value < 15g's
- Have the base of the impact attenuator large enough relative to bulkhead size to prevent deflection of Anti-Intrusion by more than 1inch.

Important Rules interpreted for Impact Attenuator

- *T3.18.2* Forward of the Front Bulkhead must be an energy-absorbing impact Attenuator.
- *T3.21.1* 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.
- *T3.21.5* Impact Attenuator should be attached to an Anti Intrusion plate of 1.5mm thick solid steel.
- *T3.22.1* Energy absorbing capacity **> 7500 joules** with maximum and average acceleration values less than **40g** and **20g** respectively. The impact test should be done by dropping a mass of **300kg** with a velocity greater than **7m/s**
- *T3.22.9* 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 **25.4 mm (1 inch)** beyond the position of the anti-intrusion plate before the test.

Impact Attenuator Geometry and Dimensions

Carbon Fiber Impact with Beta Foam



Dimension of Beta foam: 150mm diameter X 70mm height

Description of Anti Intrusion Plate: 1.5mm solid steel plate, Welded to the front bulkhead.

Material Properties

Carbon Fiber Properties:

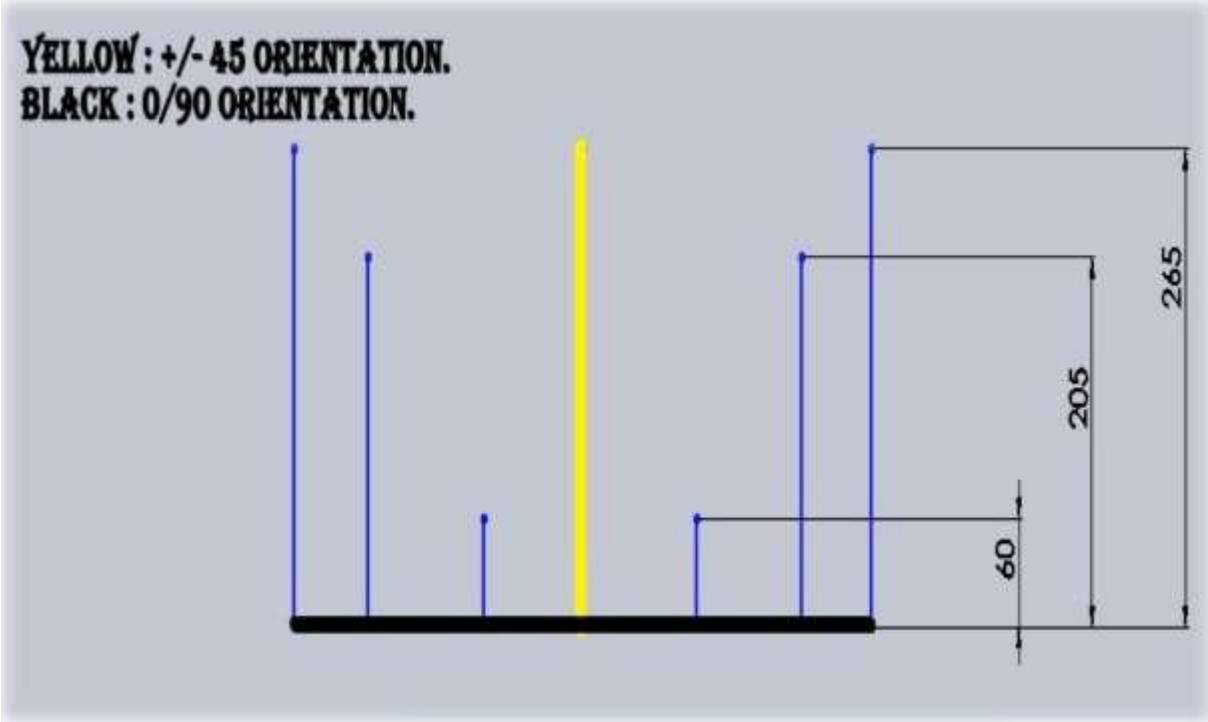
Tensile Strength	1,760 MPa
Tensile Modulus	130 GPa
Tensile Strain	1.3 %
Compressive Strength	1,570 MPa
Compressive Modulus	125 GPa
In-Plane Shear Strength	98 MPa
ILSS	11 kgf/mm2
90° Tensile Strength	80 MPa
Density	1.76 g/cm3
Filament Diameter	7 µm
3K	198 g/1000m

Beta Foam Properties:

Compressive strength	300kpa
Density	63kg/m3

Layer Orientation

- 3 layers : 265mm from base, (0/90, +/-45 , 0/90).
- 5layers : 205mm from base, (0/90,0/90, +/-45 , 0/90,0/90).
- 7layers : 60mm from base, (0/90,0/90,0/90, +/-45, 0/90,0/90,0/90).



Dymanic testing and testing procedure

Testing Method:
The Testing method employed by us is a **Dead weight - Free Drop test**, where our Attenuator will be observed by a high Speed Motion Camera capable of logging acceleration values of tracing objects.

Specifications of the Motion Camera:
Red lake MotionXtra camera system. A preferred choice among many automotive manufacturers for imaging crash tests and other applications, the MotionXtra series of cameras offers the best durability and quality of performance required for ultra-high speed motion analysis. The MotionXtra HG-100K delivers frame rates between 1,000 (full res) and 100,000 frames-per-second(reduced res), with a maximum resolution of 1504x1128 (color or mono)

Other features include:

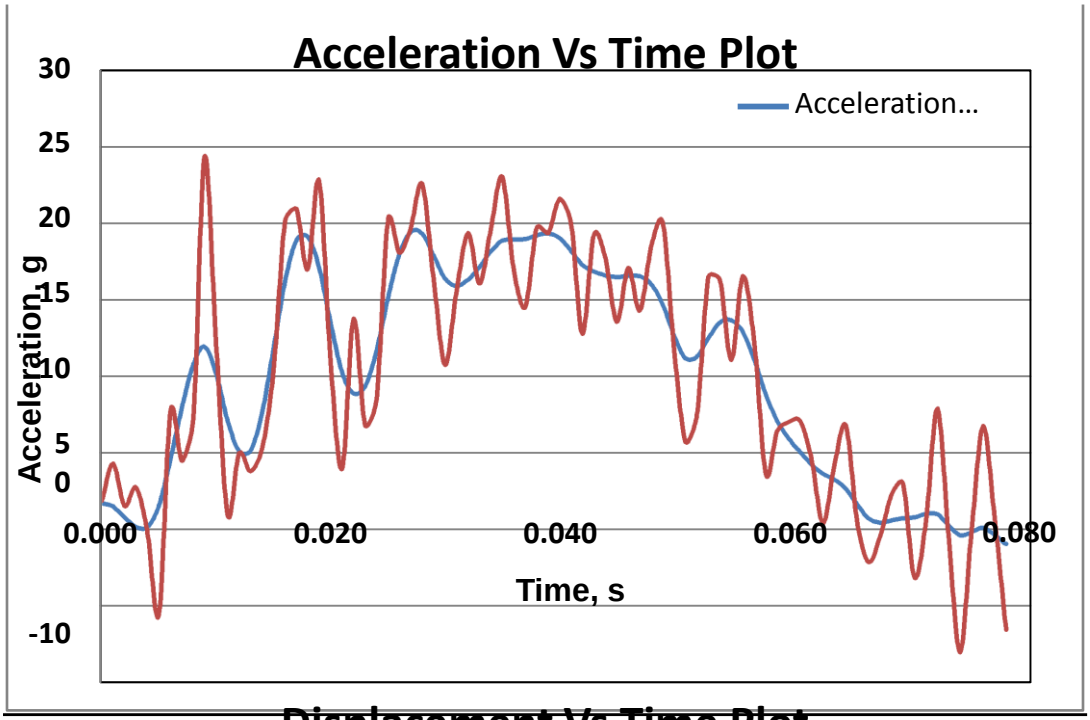
- Red lake exclusive 1.7 megapixel CMOS sensor (HG-100K only)
- Fast 5µs electronic shutter for motion blur elimination
- An optional tablet style Display Control Unit (DCU), which makes setup of remotely located
- Cameras quick and easy
- Supports up to 2.4 seconds of record time at full resolution
- Fully compatible with HG2000/HG-TX cameras
- Backup battery included

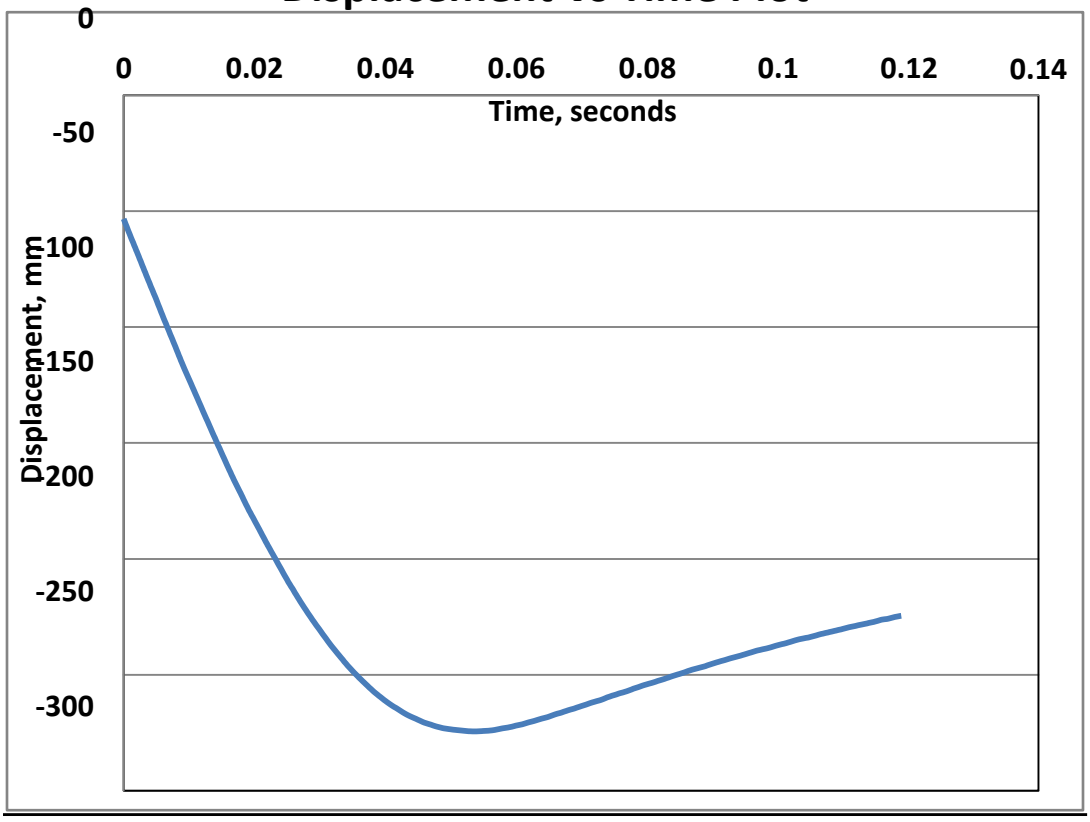
Camera Setup for tests:

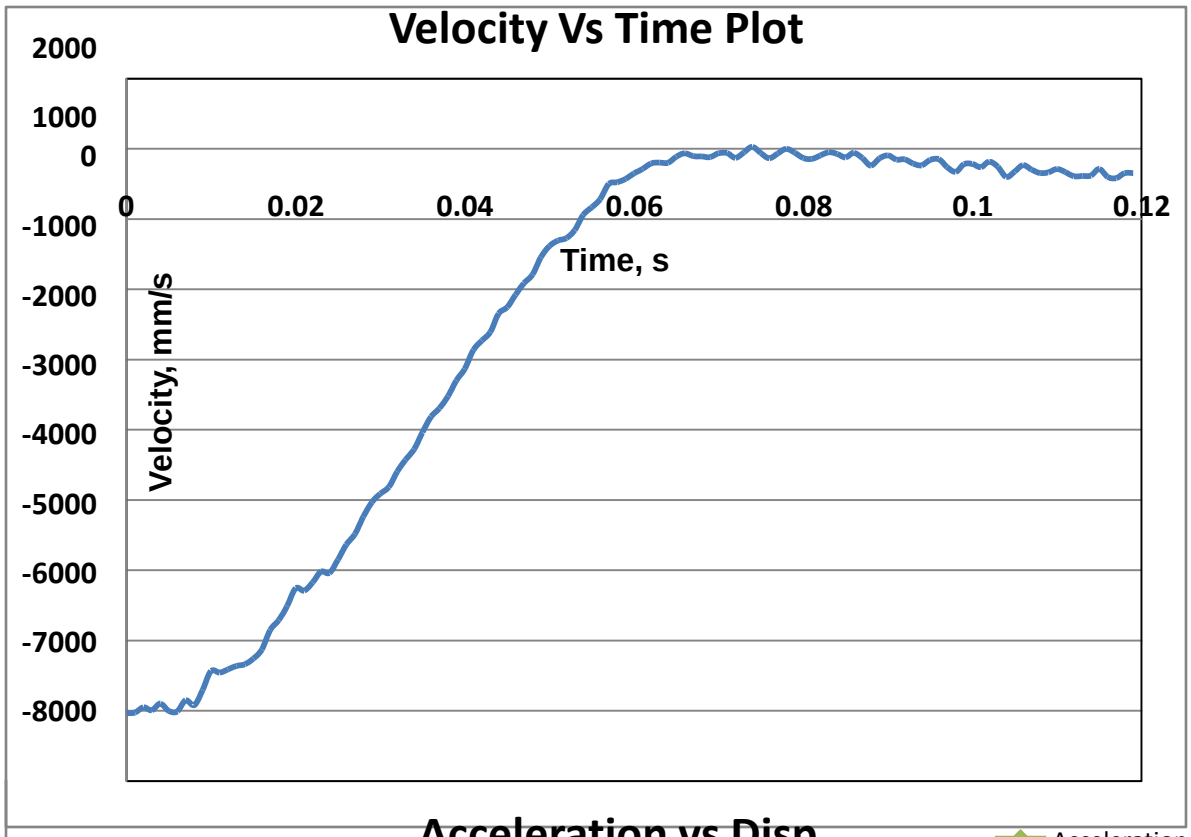
- The motion camera was setup for 1000fps speed and an aspect ratio of 4:3.
- The camera could take images at 1.7megapixels and 4X Zoom using the attachment.
- It was kept at a distance of 4.5 meters from the test area.
- The camera is calibrated with the ‘200mm marker’ stuck on a vertical scale besides the test area.
- Themarker is placed such that it is clearly visible in each of the tests.

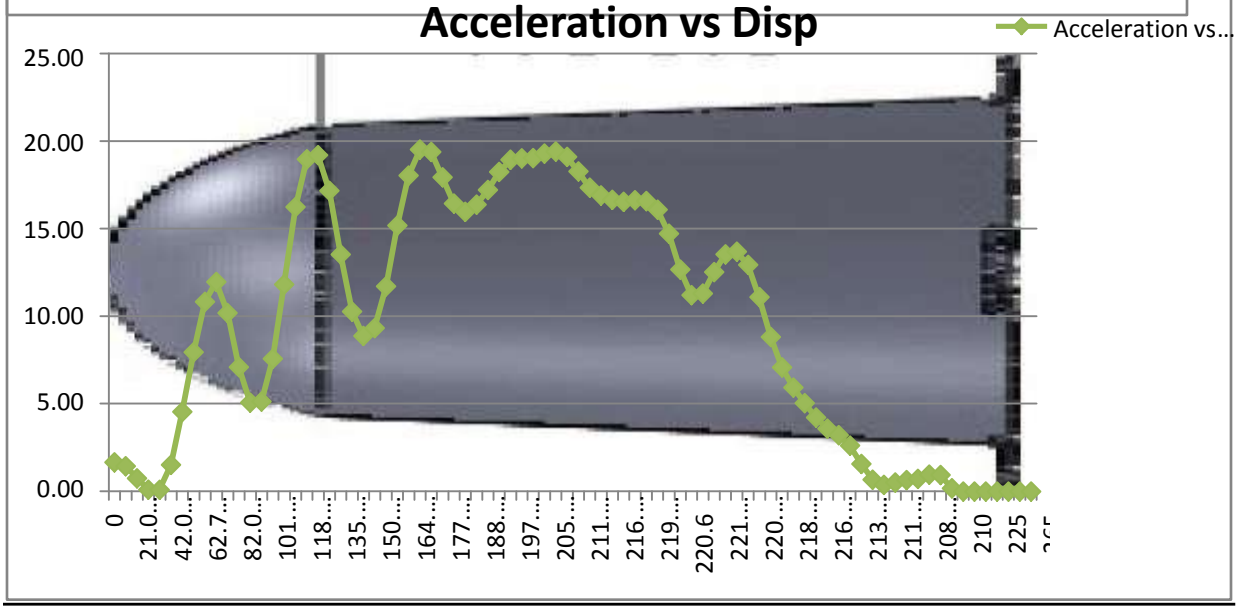
Test Rig

Results


Acceleration Vs Time Plot
Acceleration...
30
25
20
15
10
5
0
-10
Acceleration, g
0.000
0.020
0.040
0.060
0.080
Time, s


Displacement Vs Time Plot
0
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
Time, seconds
-50
-100
-150
-200
-250
-300
Displacement, mm

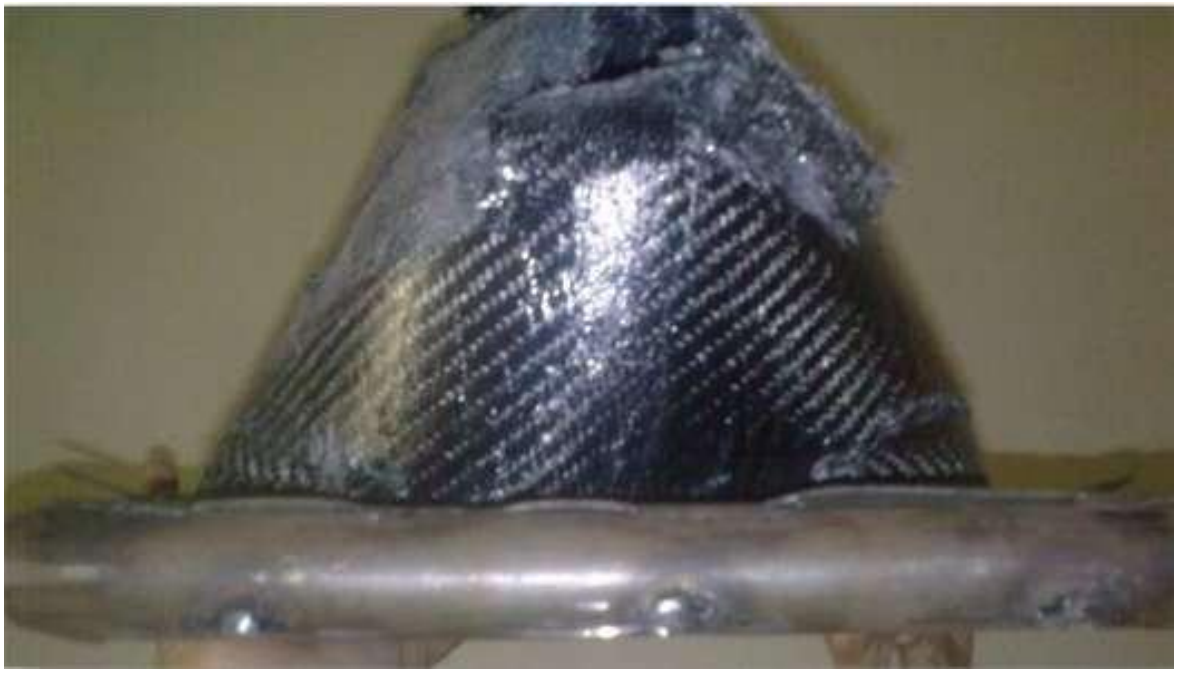

Velocity Vs Time Plot
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
-8000
0
0.02
0.04
0.06
0.08
0.1
0.12
Time, s
Velocity, mm/s


Acceleration vs Disp
Acceleration vs...
25.00
20.00
15.00
10.00
5.00
0.00
0
21.0...
42.0...
62.7...
82.0...
101....
118....
135....
150....
164....
177....
188....
197....
205....
211....
216....
219....
220.6
221....
220....
218....
216....
213....
211....
208....
210
225

Before Test Photograph

After Test Photograph

Deflection of Anti-Intrusion Plate < 1inch



Conclusion

- Peak deceleration – 19.53 g's.
- Average deceleration – 9.94 g's.
- Anti-Intrusion Plate Deflected by <1inch.
- Impact successfully absorbed the required energy.

Test Authentication

ARAI
Progress through Research

The Automotive Research Association of India
(Research Institution of the Automotive Industry with the Ministry of Heavy Industries & Public Enterprises, Govt. of India)

CAE/ARJ/14(V2)/2011 23 March 2011

TO WHOMSOEVER IT MAY CONCERN !

This is to certify that the below mentioned students of K.J. Somaiya College of Engineering, Mumbai, as a part of their FSAE Race Car Project, have successfully and safely conducted the 'Drop Testing of Impact Attenuator' on 23rd March 2011 at the ARAI test facility with all precautions.

i) Saurabh Gandhi
ii) Soumil Shah

The pictures of the impact attenuator tested at ARAI on 23rd March 2011 are given below

Aluminium with Foam

Glass Fibre

Carbon Fibre with Foam

For any clarifications/ queries, please contact the undersigned.
For the A.R.A.I.

A.R. JOSHI
DY. DIRECTOR & HEAD – CAE

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