FEA and Experimental Validation of a Captain Seat

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A B S T R A C T

A captain seat used in 2nd row seating of a motor vehicle needs to be tested for child safety. FMVSS 225 concerns about safety standard maintained in re spect to restraint systems used. FEA analysis is conducted on the captain seat as per the loading conditions and the pull test stated by the safety standard FMVSS 225 now these analytical results are validated by physical test. This test conditions are in close relation to finite element methods practices. Which will further bring to conclusion that the captain seat is safe to use as required by the safety standard. There are different test also under FMVSS 225 but we are validating only for the pull test for a captain seat with top tether.

Keywords: FMVSS 225, Restraint systems, SBA, SFAD, Structural integrity

1. Introduction

The captain seat of the project is analyzed according to the pull test stated in the Federal Motors Safety Standard for children (225) restraint system. Now these FEA tests need to be validated in co-relation to physical test.

2. Study of Safety Regulations

FMVSS225

Federal Motor Vehicle Safety Standard (FMVSS) 225 standard establishes requirements for child restraint anchorage systems to ensure their proper location and strength for the effective securing of child restraints, to reduce the like this of the anchorage systems failure, and to increase the like this that child restraints are properly secured and thus more fully achieve their potential effectiveness in motor vehicles.

Experimental Validation

This chapter includes the experimental validation for BIW (Body in White) SBA Bracket. The SBA Bracket is tested for tension test, which gives the good co-relation results of experimental tensile test and finite element analysis
To get exact results of SBA Bracket test, experimental specimen test was conducted. For test purpose BIW SBA Bracket of seat frame was selected which is shown in Figure No.1.

Figure 1 Component of SBA bracket

To identify the properties of SBA Bracket sheet material tensile test was conducted at clients location due to confidential code of conduct. The pictures shown in fig.1 is shared by the client for validation purpose as per the agreement.

2.1 Test Specimen

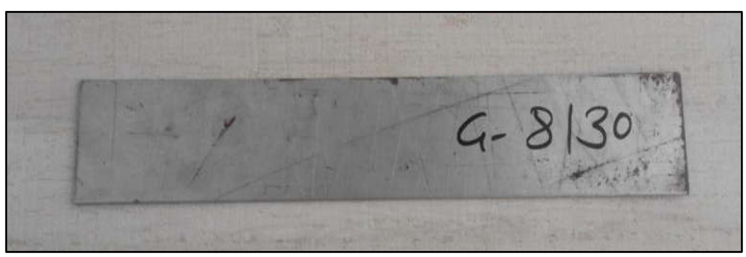

Figure 2 Test Specimen

To conduct tensile test on UTM machine cut pieces of size 300mm X 20mm X 2mm was cut for plane surface of SBA Bracket as shown in Figure No.2.

2.2 Tensile test procedure

To represent actual behavior of specimen, BIW component of actual SBA Bracket is used. From this component, exact size of specimen required for tensile test is taken by machining operation. For test purpose, 300mm X 20mm X 2mm thick BIW sheet selected. Specimen after ultimate tensile test (UTM) to measure elongation the center portion of specimen is divided in to two equal parts of 40mm.

Table 1 Specimen data

Sr. No.	Parameters	Value	Unit
1	Specimen Shape	Flat	-
2	Thickness	2.06	mm
3	Width	20.02	mm
4	Gauge Length	80	mm
5	Area	41.24	mm^2

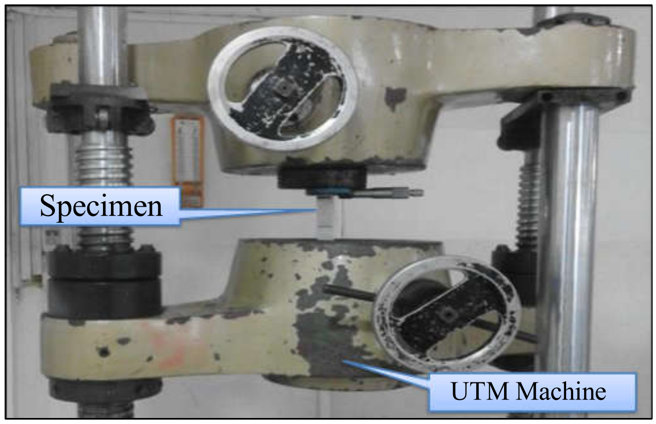

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Figure 3 Tensile test on UTM

Above figure shows the actual Tensile Test Setup on Universal Test Machine. The test specimen is hold between two jaws of universal test machine. When load is applied the moveable jaw is goes to downward direction. Load is applied up to specimen braking condition and during test plot the graph in software automatically as like load vs displacement, stress vs strain.

Figure 4 Specimen after test

Above figure shows the specimen after ultimate tensile test. This component is use for record the elongation of gauge length and observation of fracture.

2.3 Experimental test results

Tensile Test IS 1608:2005

Table 2 Specimen testing in UTM

Sr. No.	Description	Observed Value
1	Specimen Shape	Flat
2	Width (mm)	20.02
3	Thickness (mm)	2.06
4	Area (mm^2)	41.24
5	Gauge Length (mm)	80.00
6	Yield Load (kN)	11.36
7	Ultimate Load (kN)	14.74
8	Final Length (mm)	104.10
9	Yield Stress (N/mm^2)	275.45
10	Ultimate Tensile Strength (N/mm^2)	357.41
11	%Elongation	30.13
12	Fracture	WGL (With in Gauge Length)

During the test original gauge length of 80 mm at center and final gauge length of 104.10 mm. This shows Total elongation of 24.10 mm at ultimate load of 14.74 kN. It includes the test value of yield load 11.36 kN, ultimate load 14.74 kN, yield stress 275.45 N/mm^2, ultimate stress 357.41 N/mm^2 and elongation 30.13%.

2.3 Stress Vs Strain during tensile test

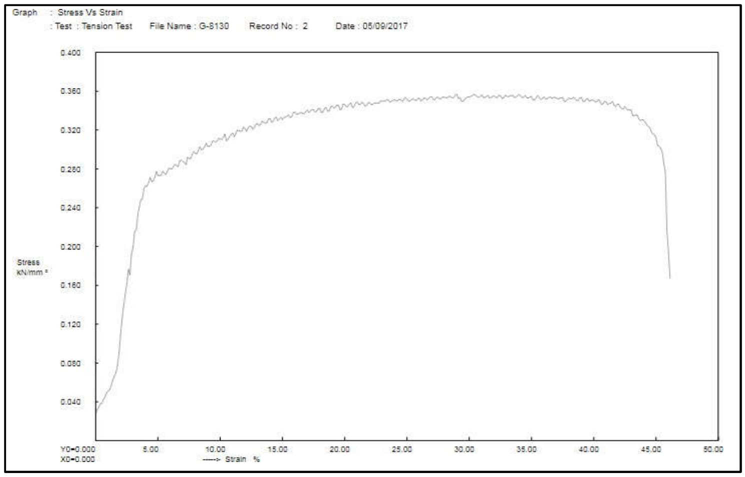

Figure 5 Experimental result stress vs strain

Above figure shows the specimen tensile test experimental results of stress vs strain. It is observed that yield stress is 275.25 N/mm2 and ultimate tensile strength is 357.41 N/mm^2.

3. FE Tensile test

To get most realistically results of FE simulation, FEA solver Ls-Dyna is used. The exact specimen size is prepared for IS 1608 tensile test. The test gave data related to engineering stress, strain curves, Syt, Sut and elongation.

Table 3 specimen data

Sr. No.	Parameters	Value	Unit
1	Specimen Shape	Flat	-
2	Thickness	2.06	mm
3	Width	20.02	mm
4	Gauge Length	80	mm
5	Area	41.24	mm^2

3.1 Specimen FE model

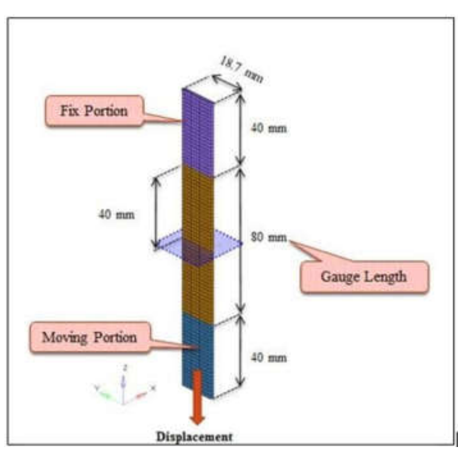

Figure 6 FE specimen dimensions

The above figure shows specimen details in FE model. The gauge length is 80 mm, moving and fixed portion is 40 mm and thickness is 2mm. At middle of specimen create a plane for observation of displacement.

3.2 Tensile test Simulation stages

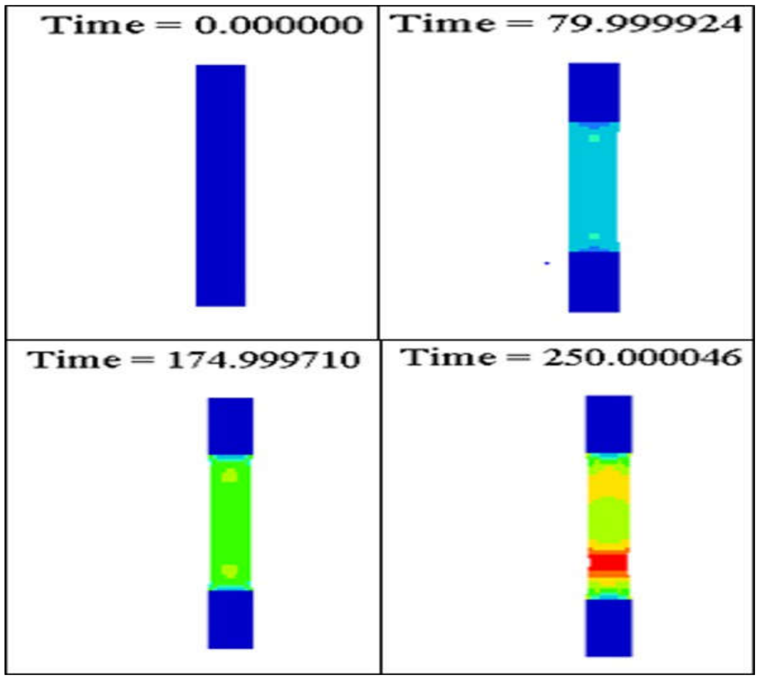

Figure 7 Tensile test specimen stages

To continue for simulation as per physical test fea model is prepared shown in Figure No 6. The values obtained from test are applied to model. Curves of stress- strain is applied as an input material card. Simulation of specimen is shown in the Figure No.7.

3.3 Stress vs Strain during FEA test

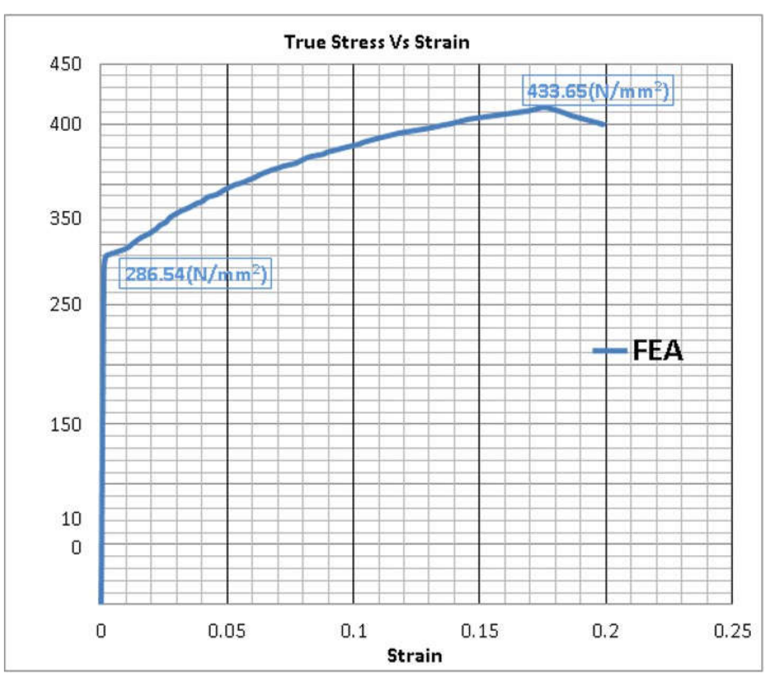

Figure 8 FEA result true stress vs strain

Above figure shows the specimen FEA results True Stress versus Strain. It is observed that yield stress is 286.54 N/mm2 and ultimate tensile stress is 433.65 N/mm^2.

4. Fe & Physical Test Correlation

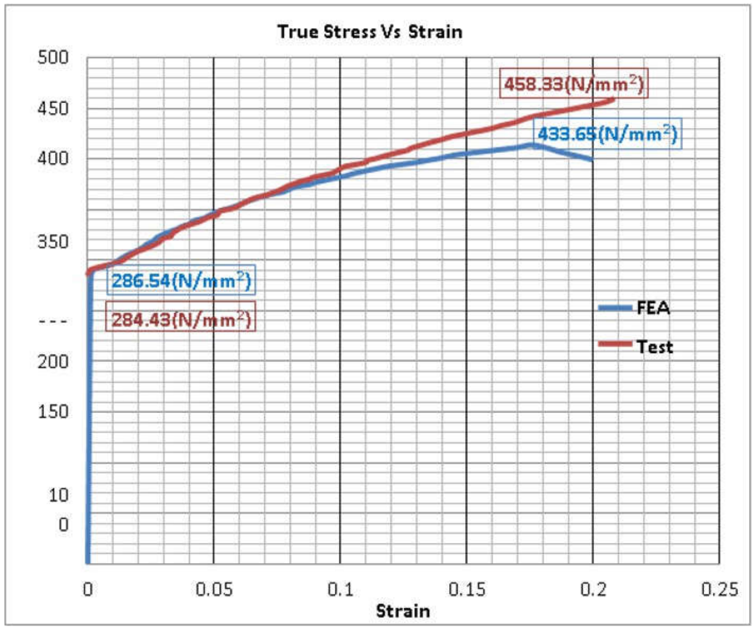

Figure 9 FEA & Physical test correlation

Above figure shows the specimen Finite Element Analysis and Physical Test Co- relation for comparing results.

Sr. No.	Parameter	Physical Test Value [True Stress = Engg. Stress X (1+Engg. Strain)]	FEA Value	% Error
1	Yield Stress (N/mm^2)	284.43	286.54	0.73 %
2	Ultimate Tensile Strength (N/mm^2)	458.33	433.65	5.38 %

Table 4 FEA & Physical test correlation

The above Table No.6.4 gives the comparison between experimental and FEA results. We can derive a conclusion that there is very close gap between the results, which concludes the specimen is validated.

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