



Nonlinear FE Simulation of Steel Structures Under Extreme Loadings

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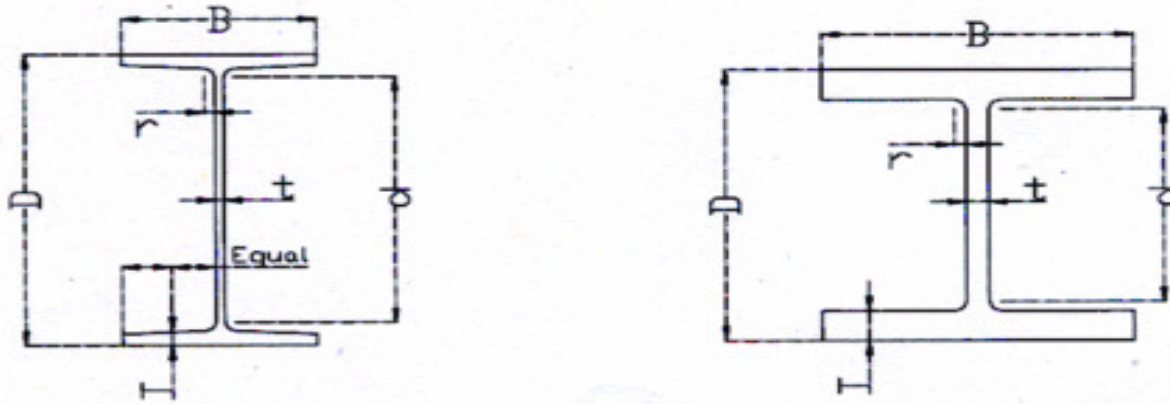
Introduction

- The composite structure and composite steel connections are both common and popular forms of construction used around the world in recent years.
- From the continuous research worldwide it has been gradually accepted that the structure behaviour is well understood under static and gravity loadings.
- However, their behaviour under fire, dynamic, blast and other forms of extreme loading are much less researched.

Research Summary

- The research mainly has focused on numerical simulation by FEA and DEA techniques for structural connections, beams, slabs and frames via the robust validation by experimental data collected from the collaborated research programmers.

3D Modelling of Flush Endplate Composite Connection

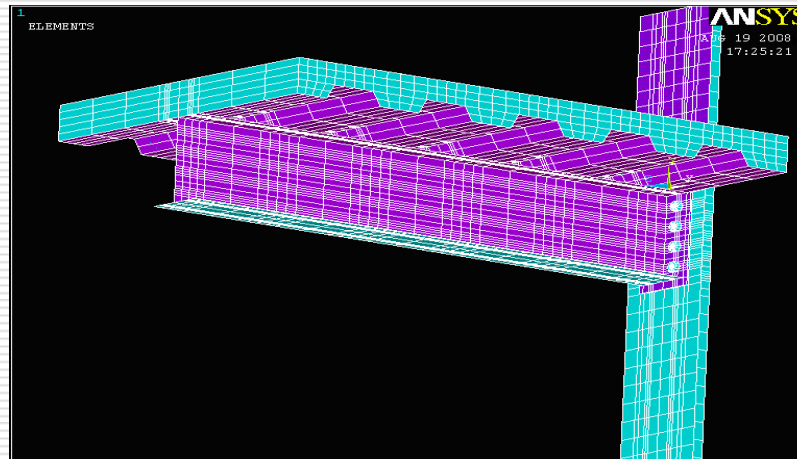
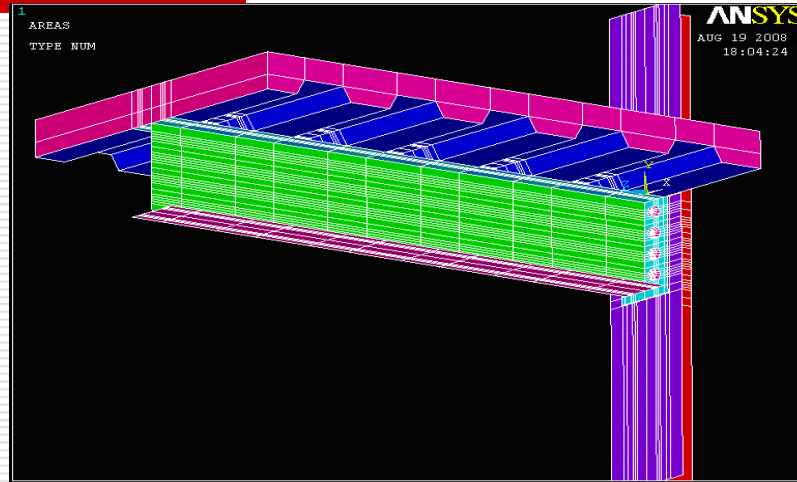


Element	Section designation	Mass per Meter kg/m	Depth of Section D mm	Width of Section B mm	Thickness		Area of section A cm ²
					Web t mm	Flange T mm	
Beam	305x165x54	54	310.4	166.9	7.9	13.7	68.8
Column	305x305x97	96.9	307.9	305.3	9.9	15.4	123

Dimensions of UB and UC sections

3D Modelling of Flush Endplate Composite Connection

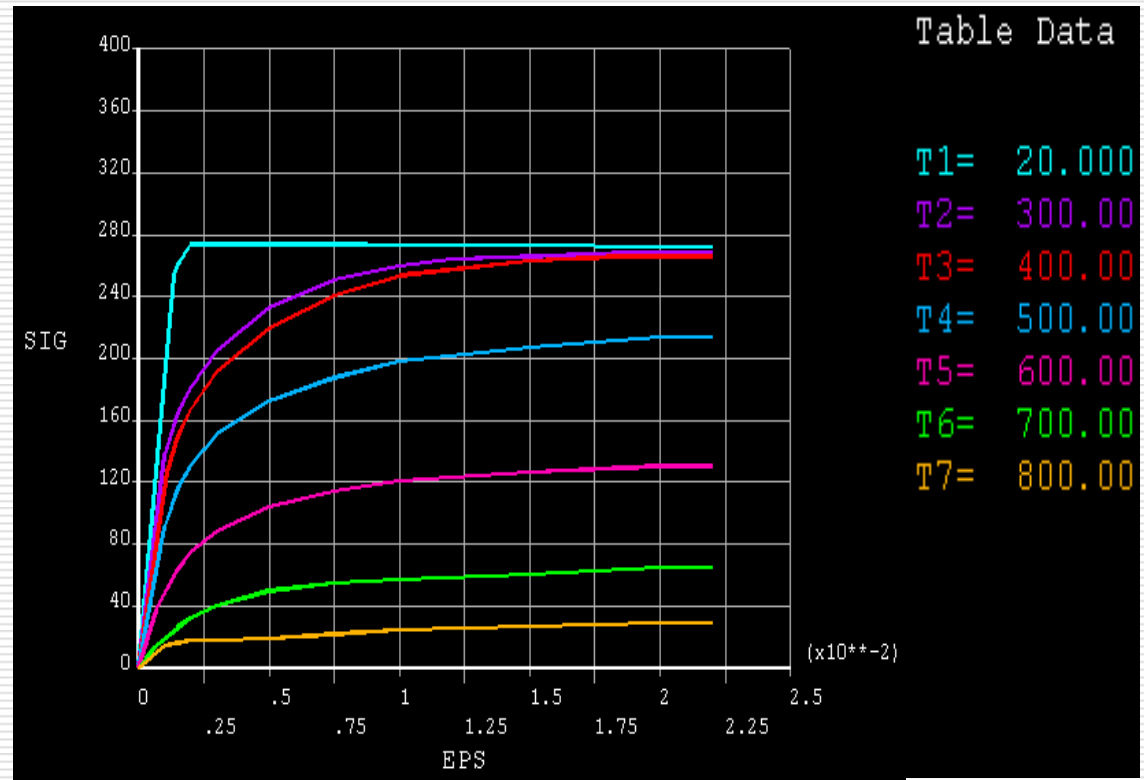
Shell Element
Solid Element
Link Element
Contact Element



Material Properties (for steel)

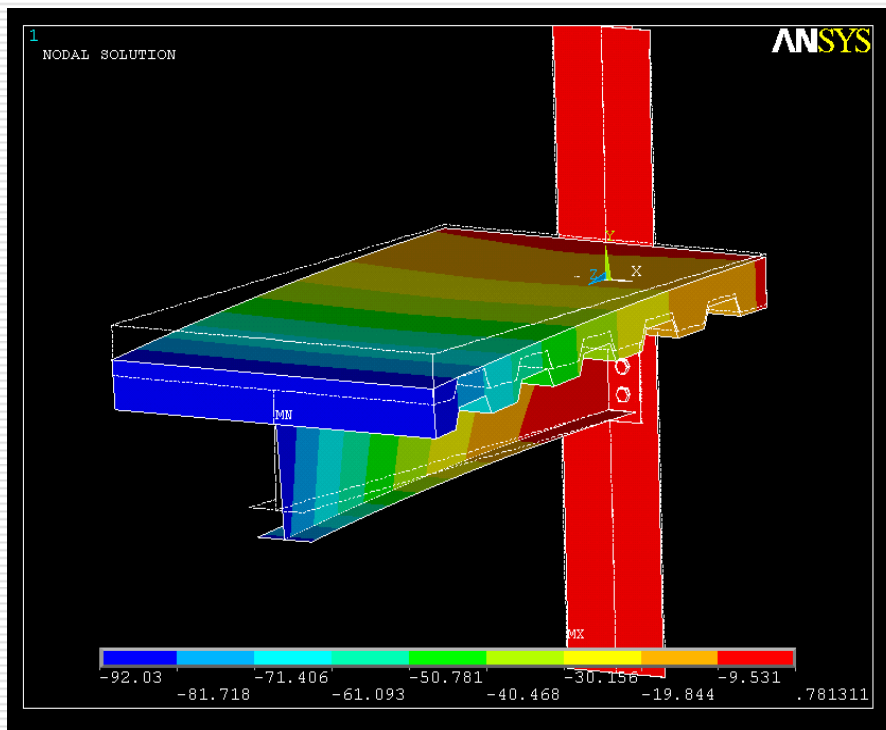
□ Mechanical Properties

The stress-strain behaviour of steel at high temperatures is essentially different from that at ambient temperature, without a clear yield plateau but strain hardening occurring all the way in the plastic range.



Stress-strain Data for Grade 43A Steel at Elevated Temperatures

Structural Field Analysis



Deflection UY

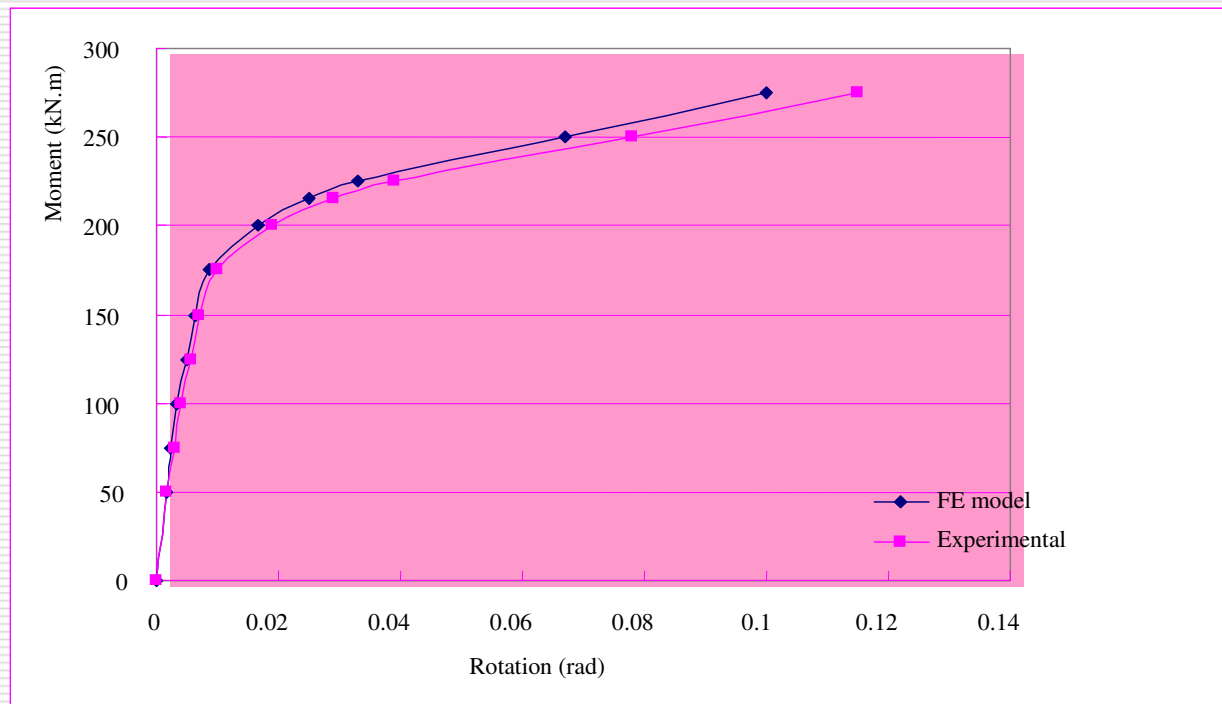
Time s	Maximum deflection (mm)
0	0.422646
1200	4.446
2400	7.039
3600	12.028
4800	16.036
6000	51.098
6600	83.198
7200	92.03

The development of the maximum vertical displacement UY

Structural Field Analysis

Moment: M

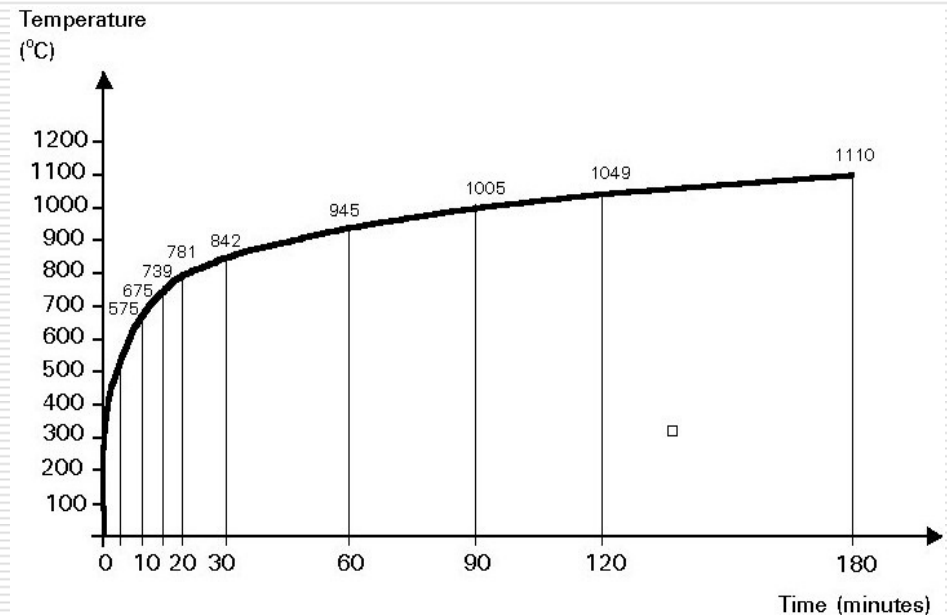
Rotation: Φ



Moment rotation curves of experimental and FE model

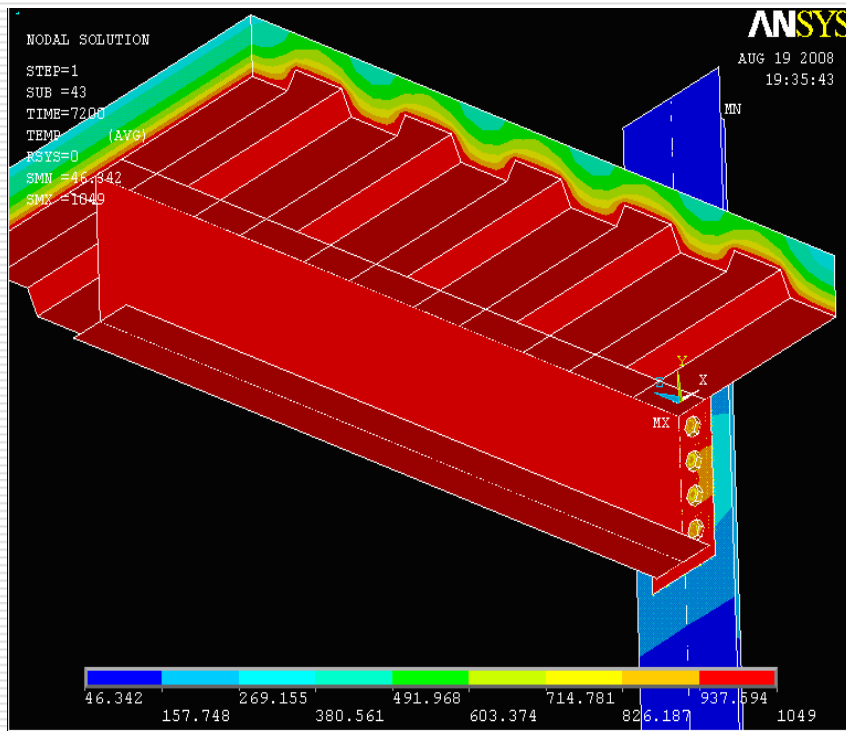
Thermal Field Analysis

International standards are based on the standard fire defined by the heat exposure given by the ISO 834 curve. In this curve, three hours temperature is presented. But normally in fire situation two hours analysis is enough, in this research, two hours fire analysis is considered.

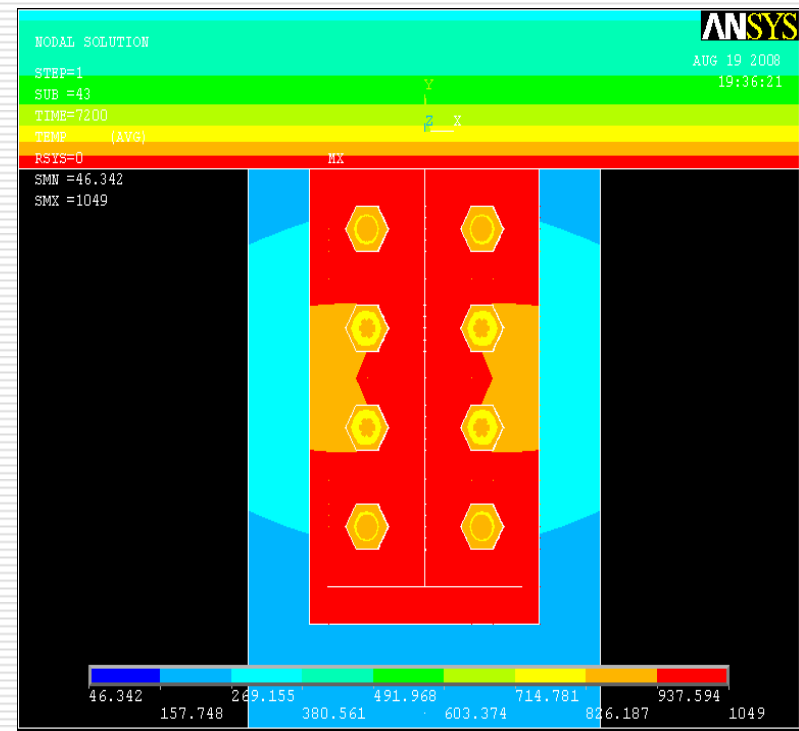


ISO 834 fire curve

Thermal Field Analysis

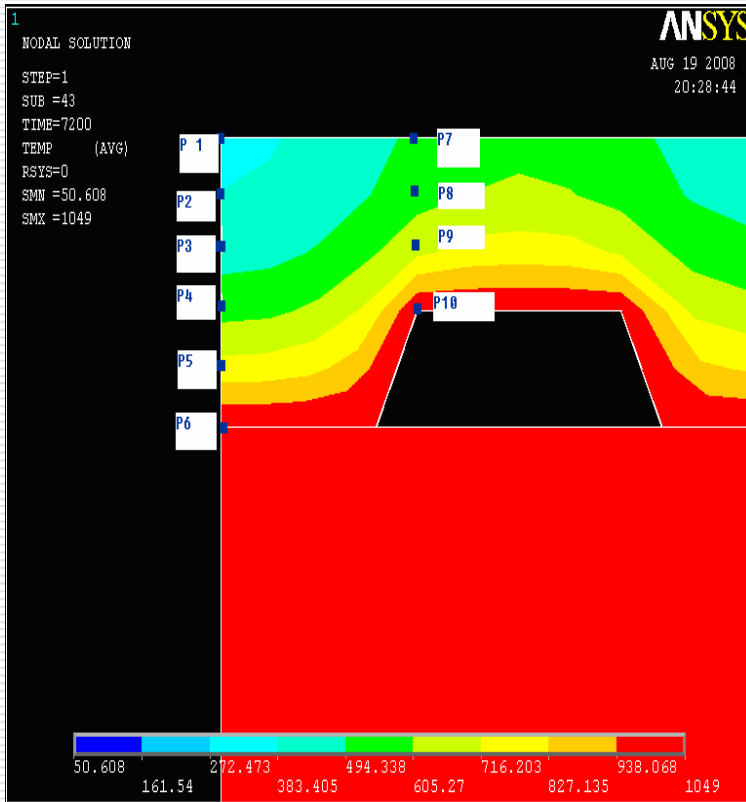


Temperature distribution after two hours



Temperature distribution in endplate after two hours

Thermal Field Analysis



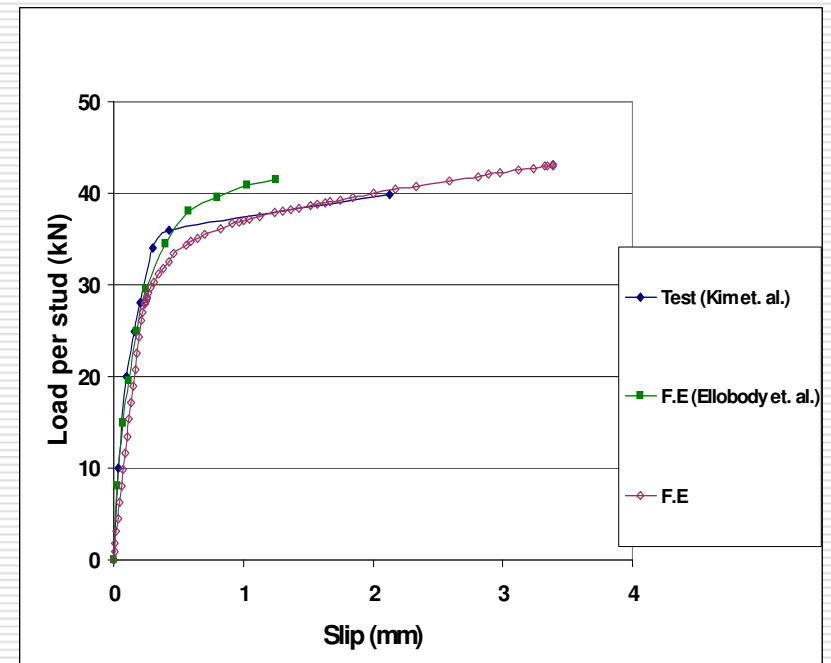
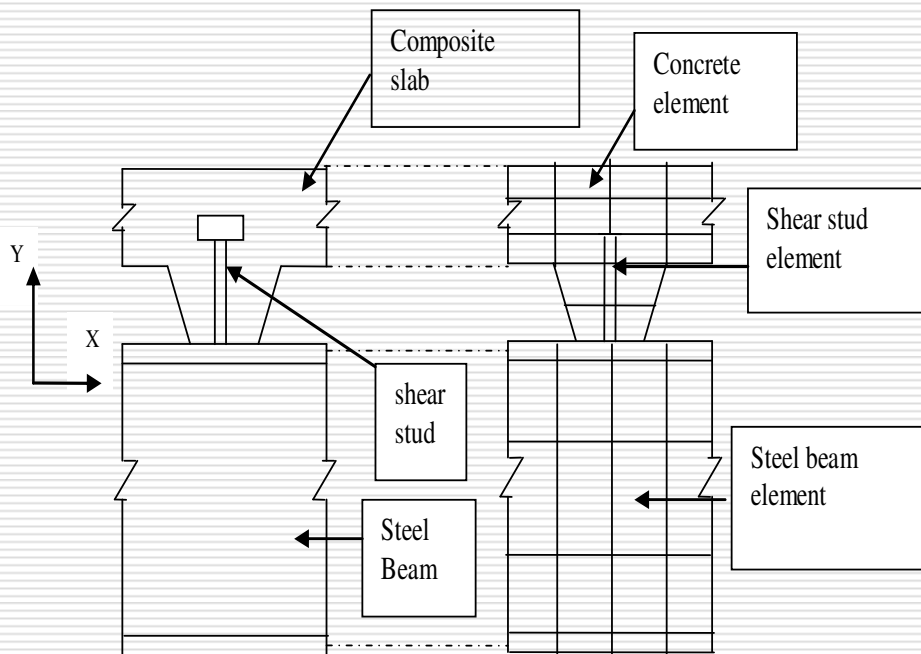
point	1min	16 min	34 min	52 min	70 min	88 min	106 min	120 min
1	20.34	22.39	59.78	125.18	194.29	259.93	302.62	364.37
2	19.68	25.75	74.57	144.24	214.75	280.77	341.47	385.19
3	19.99	45.23	125.08	205.64	279.65	346.52	406.69	450.02
4	20.28	109.54	230.68	324.03	401.37	468.07	526.82	568.15
5	23.93	282.95	436.33	535.63	610.59	671.67	723.46	758.93
6	232.25	740.2	859	923.54	968.4	1002.48	1030.32	1049
7	20.18	53.43	157.27	253.13	335.95	407.95	471.36	515.68
8	19.25	90.43	203.83	300.59	382.63	453.36	515.35	558.78
9	24.43	224.84	359.69	456.66	534.39	599.58	655.68	694.25
10	232.2	740.2	859	923.54	968.4	1002.48	1030.32	1049

Temperature of selecting points at different time steps

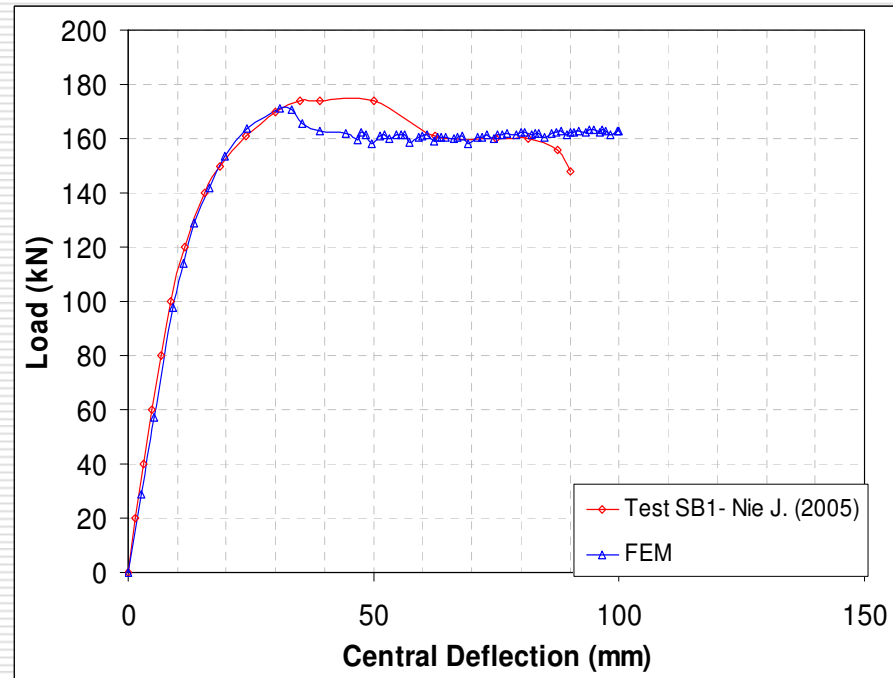
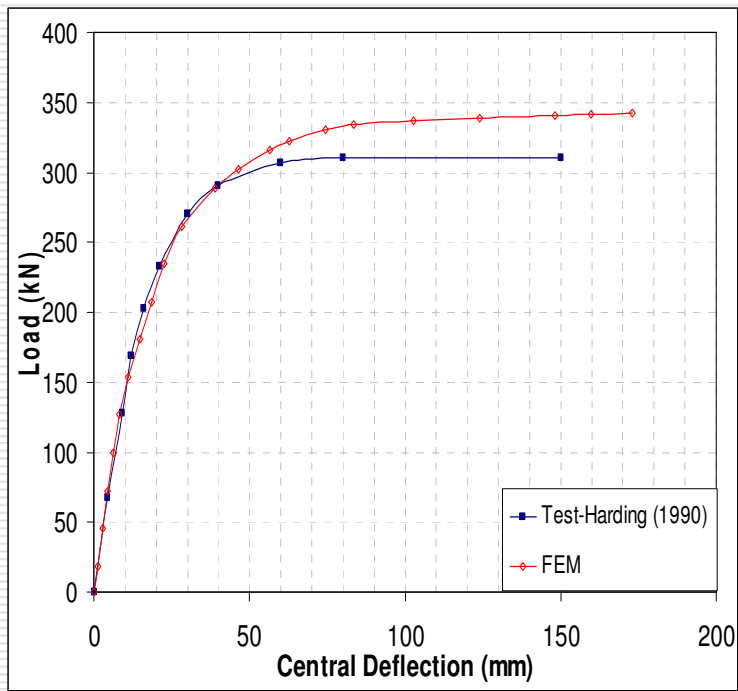
Location of selecting points with slab

3D- Finite Element model of the composite beam using deformed metal decking with welded-through shear studs

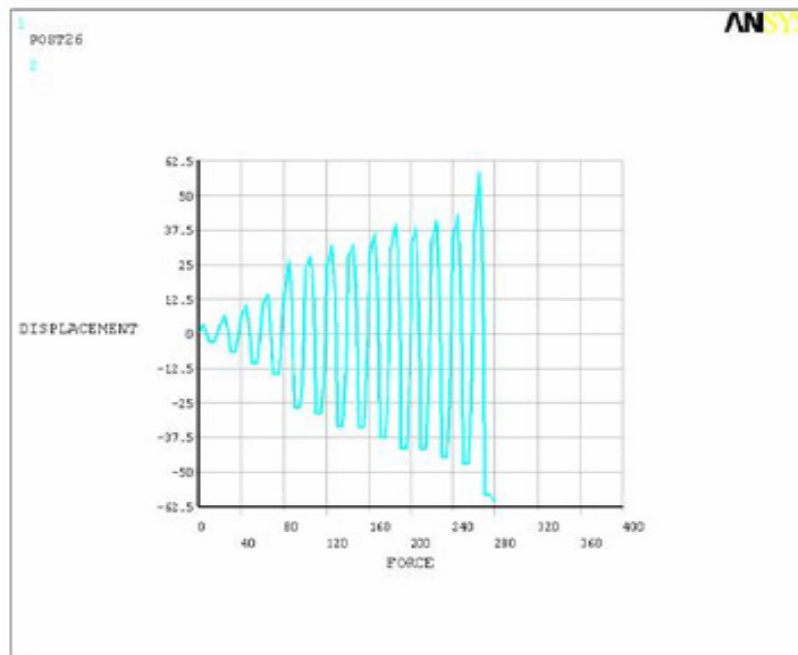
(By Shahrizan Baharom)



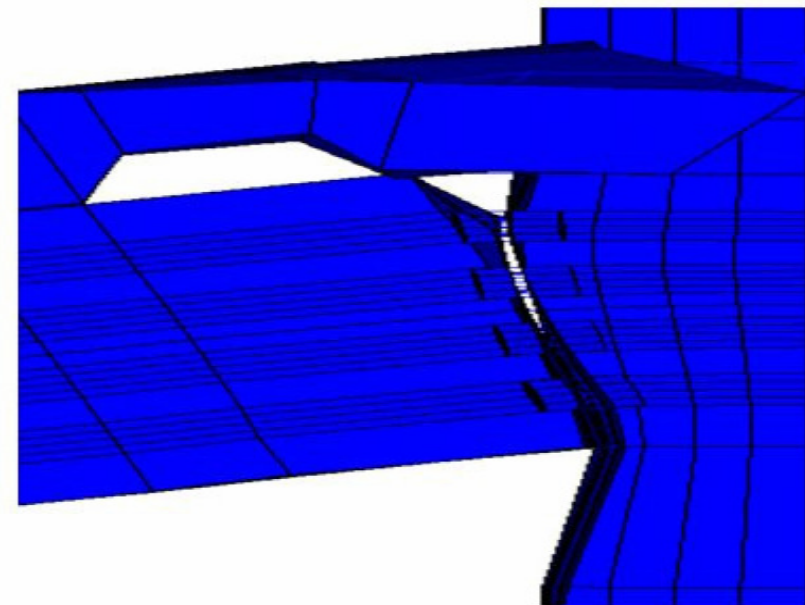
Validation



Modelling of Composite Structures Under Dynamic Loading (By J.D. Parshamesh)



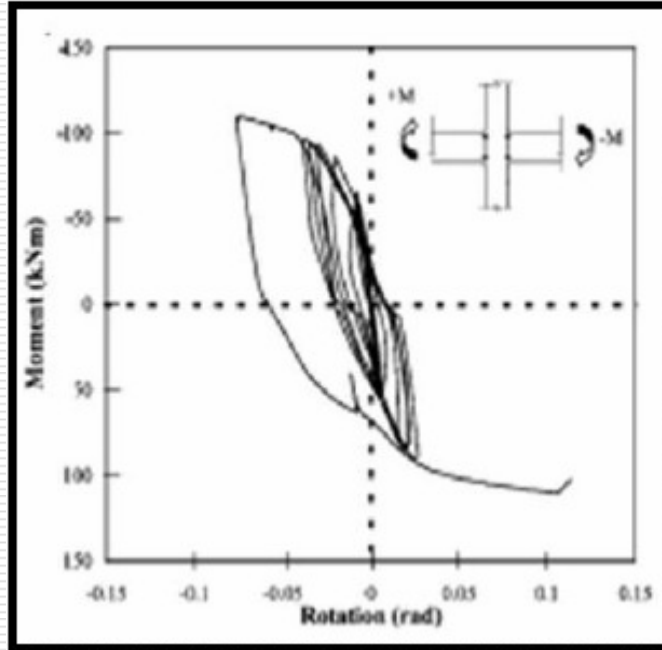
Dynamic loading



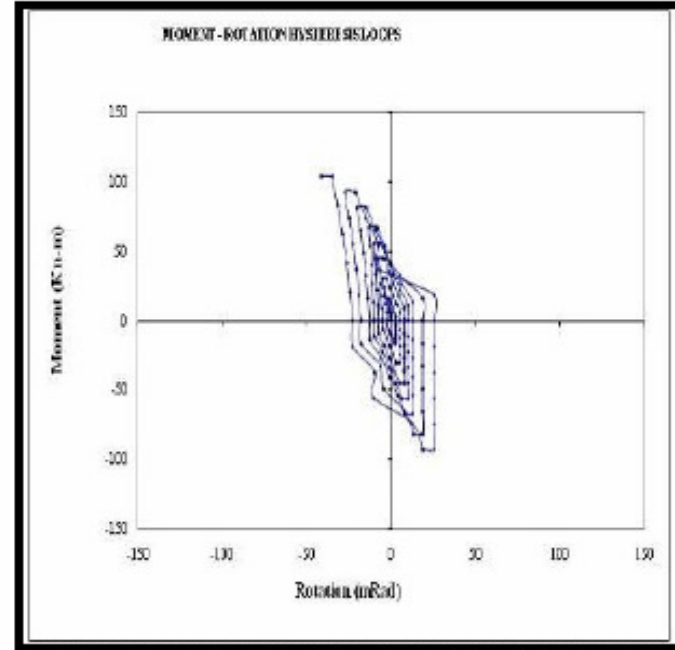
Deformed shape

Comparison between experiment and Numerical Modeling

Experimental Data



Numerical Modelling



Thank you!