EFFECT OF STIFFENED ELEMENT IN STRUCTURAL BEHAVIOUR OF STEEL BUILT-UP BEAM

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Abstract - Economy, ease and speed of construction are the main factors for using steel as a building material. In this paper conventional hot rolled steel I-beam sections are considered as the main flexural member of industrial buildings. The main goal is to increase the load carrying capacity of the beam with various stiffener conditions. The initiative was to identify the maximum load behavior and deflection of steel beams. The performance of such beams has been considered only for vertical loads. Hot rolled steel beam of ISMB125 with stiffener were tested to failure. The beams were simply supported at the ends and subjected to a 2 equal concentrated load applied at one third of span from both ends. The deflection at centre of beam and various failure patterns are studied. At last, a comparative study was carried out to examine that which type of beam gives best performance during loading. The numerical results indicate that the use of hot rolled I section with stiffener is an economical and advantageous choice.

Key Words: **stiffener, ISMB125, n-truss analogous girder, longitudinal stiffened girder, COUPON TEST**

1. INTRODUCTION

Any cross-section of a plate girder is normally subjected to a combination of shear force and bending moment. The primary function of the top and bottom flange plates of the girder is to resist the axial compressive and tensile forces arising from the applied bending moment. The primary function of the web plate is to resist the applied shear force. Under static loading, bending and shear strength requirements will normally govern most plate girder design, with serviceability requirements such as deflection or vibration being less critical. For efficient design it is usual to choose a relatively deep girder, thus minimizing the required area of flanges for a given applied moment. This obviously results in a deep web whose thickness t is chosen equal to the minimum required to carry the applied shear. Such a web may be quite slender, i.e. has a high d/t ratio, and may be subjected to buckling which reduces the section strength. A similar conflict may exist for the flange plate proportions. The desire to increase weak axis inertia encourages wide, thin flanges, i.e. flange with a high b/t ratio. Such flanges may also be subjected to local buckling.

1.1 Coupon Test

Generally when a steel structure is to be constructed its material properties are determined by standard testing, one such standard test is called coupon test. In this study also we have performed coupon test. This is to ensure that the stress used for design purpose is less than actual stress taken up by the material used for work, which means that the material used is safer.

1.2 Types of patterns used as Stiffener

Apart from End Bearing Stiffener or Load Bearing Stiffener generally used for construction purposes we have provided a new pattern of stiffener analogous to an N-Truss. So that we expect it to carry more load compared to an unstiffened girder and a longitudinal stiffened girder. So by experimental investigation we have compared the capacity of N-Truss Girder.

2. EXPERIMENTAL INVESTIGATION

Lab test have been conducted to determine the capacity of models of Steel Built up beams. Three beams with different conditions are tested in loading frame and comparison graphs are plotted between Load vs. Strain, Moment vs. Curvature and Load vs. Deflection. Results obtained from coupon test is also explained as follows.

COUPON TEST SPECIMEN

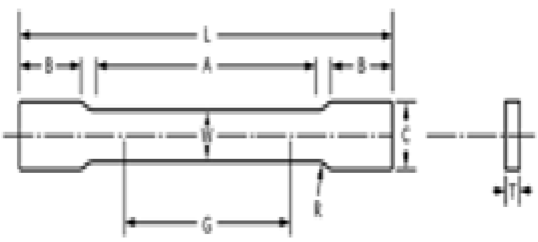


Fig 1: Before and after testing

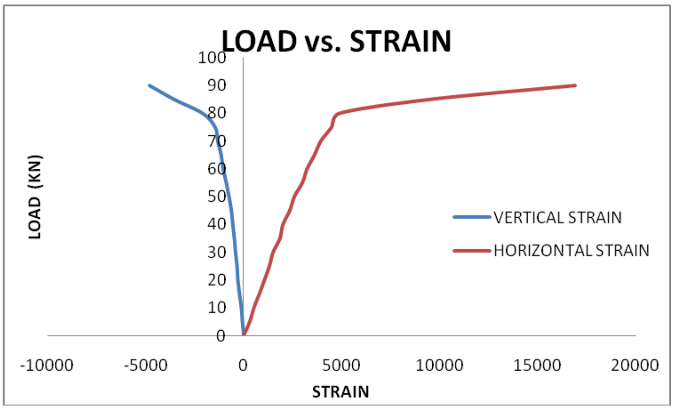


Chart -1: Load vs. Strain Coupon Test

Table -1: Coupon Test

LOAD (KN)	VERTICAL STRAIN	HORIZONTAL STRAIN
0	0	0
5	0.000031	0.000007
10	0.000052	0.000012
15	0.00008	0.000022
20	0.000106	0.00003
25	0.000131	0.000034
30	0.00015	0.000042
35	0.000185	0.000048
40	0.0002	0.000056
45	0.000235	0.000063
50	0.000258	0.000075
55	0.000299	0.000089
60	0.000323	0.000105
65	0.000361	0.000115
70	0.000393	0.000132
75	0.000448	0.000146
80	0.000489	0.00021
85	0.00095	0.000355
90	0.00169	0.00048

From the graph in Chart-1 it is evident that Yield Stress of specimen used for testing is obtained at a load of 81kN which is 337.5MPa.

This states that material can withstand 337.5MPa but we have considered only 250MPa Design stress which is very safe for design. We have underestimated the design stress for a Factor of Safety of about 1.35ensuring more safety.

EXPERIMENTAL RESULTS OF BEAMS

BEAM WITHOUT STIFFENER:

Fig 2: Before and after testing un-stiffened beam

Table -2: BEHAVIOUR OF BEAM W ITHOUT STIFFENER

LOAD (KN)	Central deflection (mm)	Compression strain	Tension strain	Moment (KN-m)	Curvature
0	0	0	0	0	0
10	0.8	-0.00004	0.00002	1.669	32.1564
20	1.65	-0.00011	0.00004	2.332	80.9019
30	2.69	-0.00014	0.0001	3.5	125.8545
40	3.74	-0.00014	0.000155	4.669	196.578
50	4.63	-0.00028	0.000	5.864	220.

			244		522
60	5.03	-0.00023	0.000308	7.023	245.777
70	5.21	-0.00026	0.000342	8.205	260.548
80	5.69	-0.000296	0.000359	9.332	284.862
90	6.25	-0.000333	0.00041	10.498	301.562

Chart -2: Load vs. Strain Un-stiffened Beam

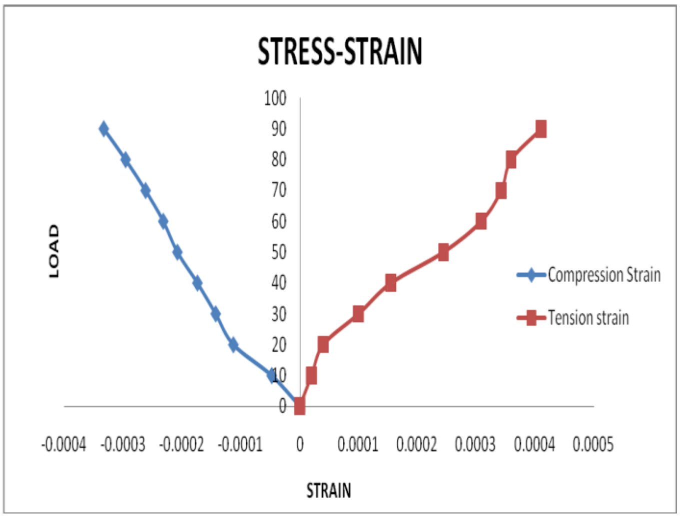


Chart -3: Load vs. Deflection Un-stiffened Beam

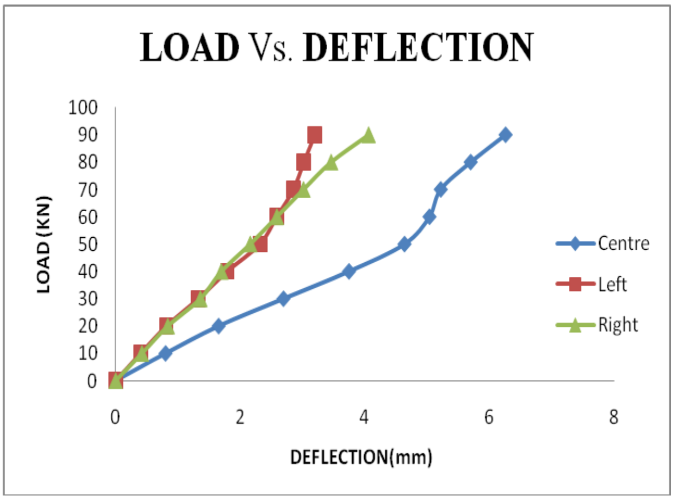
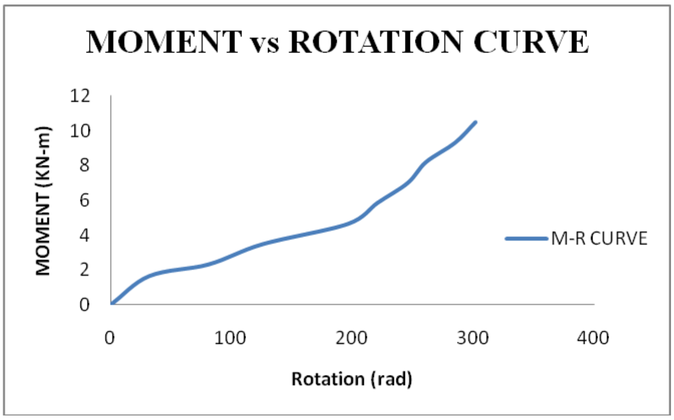


Chart -4: Moment vs. Curvature Un-stiffened Beam



From Load Vs Deflection curve it is evident that Central deflections for corresponding Load is very high compared to deflection at L/3 points.

This moment curvature curve indicates the nominal behavior of a Plane un stiffened beam.

Load vs. strain curve suggests that tension strain is more in this case compared to compression strain.

BEAM WITH LONGITUDINAL

STIFFENER:

Fig 3: Before and after testing Longitudinal stiffened beam

Table -3:BEHAVIOUR OF LONGITUDINAL STIFFENED BEAM

LOAD (KN)	Central deflection (mm)	Compression strain	Tension strain	Moment (KN-m)	Curvature
0	0	0	0	0	0
10	0.59	-0.00001	0.000	1.165	38.1

			017		202
20	1.22	-0.00003	0.000 062	2.32	81.6 512
30	1.79	-0.00005	0.000 079	3.26	126. 485
40	2.43	-0.00012	0.000 112	4.59	164. 596
50	3.11	-0.00013	0.000 133	5.45	214. 485
60	3.59	-0.00016	0.000 155	7	265. 154
70	4.22	-0.00018	0.000 16	8.62	304. 140
80	5	-0.00021	0.000 179	9.25	325. 145
90	5.49	-0.00024	0.000 209	10.45	336. 151

Chart -5: Load vs. Strain Un-stiffened Beam

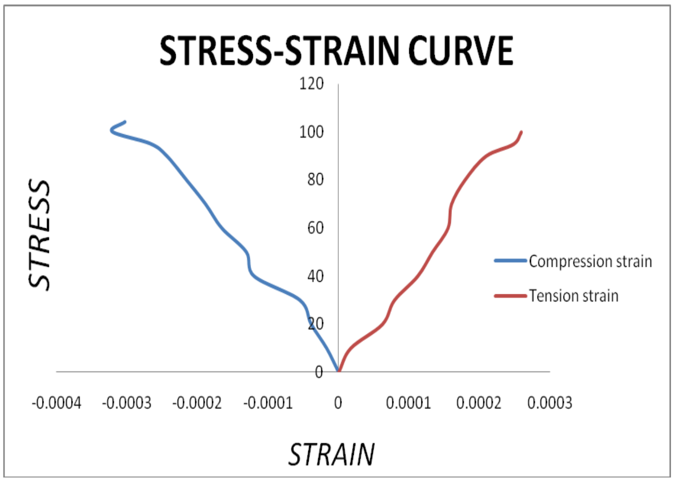


Chart -6: Load vs. Deflection Un-stiffened Beam

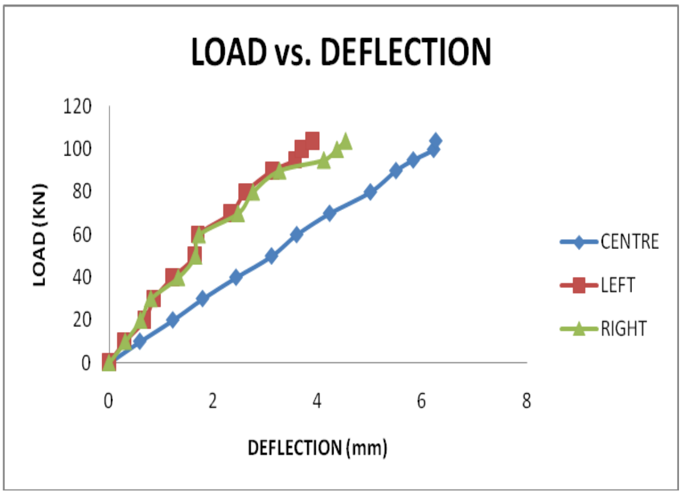
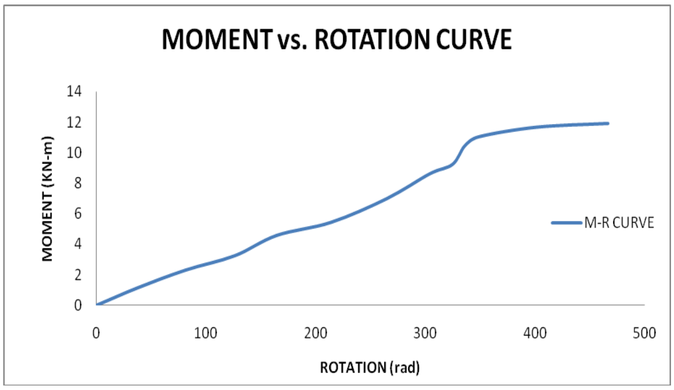


Chart -7: Moment vs. Curvature Un-stiffened Beam



From Chart 6 Load Vs Deflection curve shows that deflection at L/3 point is gradually less above 2mm deflection point because from that point stiffener completely takes its action This moment curvature curve from Chart 7 indicates that usage of stiffener have increased the moment resisting capacity by 2 kNm.

Load vs. strain curve suggests that about 20 kN more load is taken up by the Stiffener.

N-TRUSS ANALOGY

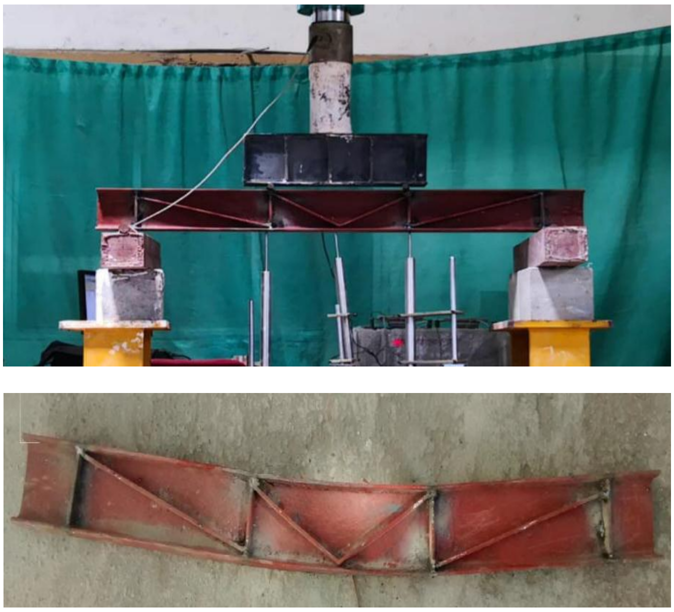


Fig 2: Before and after testing N-TRUSS analogy beam

Table -2: BEHAVIOUR OF BEAM WITH N-TRUSSED STIFFENER

LOAD (KN)	Central deflection (mm)	Compressio n strain	Tension strain	Moment (KN-m)	Curva ture
0	0	0	0	0	0
10	0.55	-0.000029	0.00005	1.16	24.31

20	1.08	-0.000059	0.00008	2.29	48.15
30	1.58	-0.000129	0.00010	3.5	71.15
40	2.11	-0.000139	0.00012	4.45	95.12
50	2.65	-0.000158	0.00014	5.81	121.1
60	3.18	-0.000192	0.00028	7.35	143.5
70	3.69	-0.000215	0.00034	8	165.1
80	4.22	-0.000239	0.00038	9.35	192.5
90	4.76	-0.00025	0.00043	10.42	215.5
100	5.29	-0.00026	0.00044	11.45	239.1
110	5.49	-0.00027	0.00050	12.69	245.4
120	5.77	-0.00029	0.00054	14	289.4
128	5.98	-0.000344	0.00059	14.89	354.9

Chart -2: Load vs. Strain N-TRUSSED stiffener

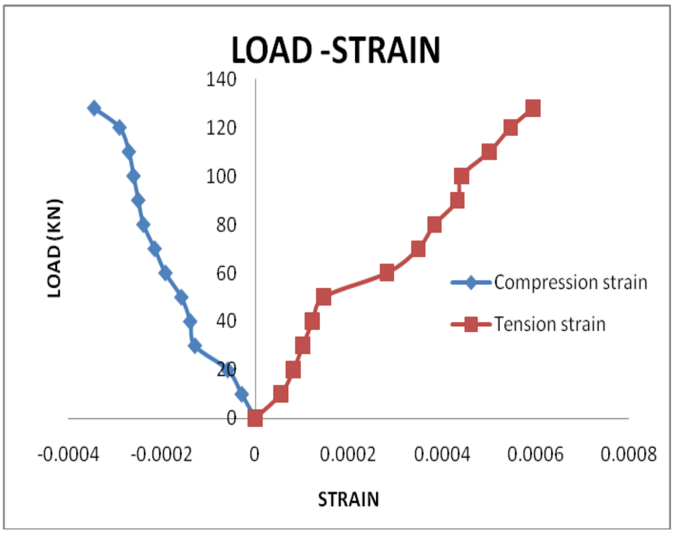


Chart -3: Load vs. Deflection N-TRUSSED stiffener

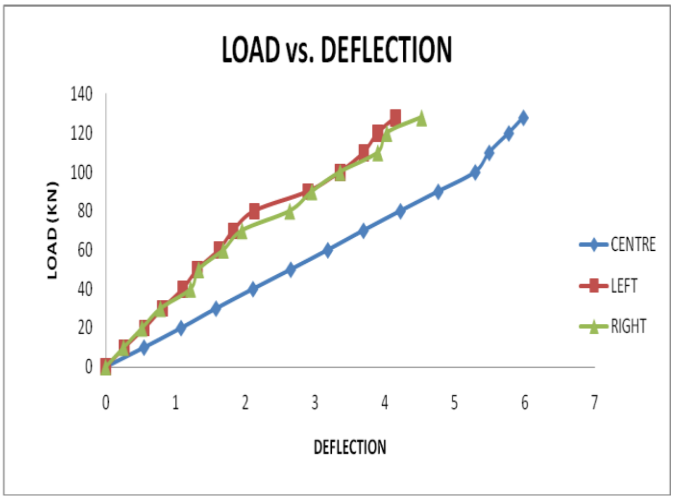
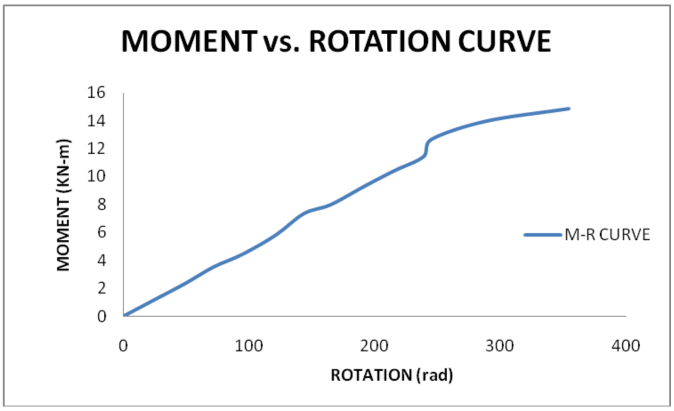


Chart -4: Moment vs. Curvature N-TRUSSED stiffener



From Load Vs Deflection curve it is evident that deflection at L/3 point is more or less same in left and right side of beam, which shows beam has been deflected symmetrically in this stiffener pattern.

This moment curvature curve indicates that moment carrying capacity of this section has been increased comparatively.

Load vs. strain curve suggests that tension strain at load of about 60kN is constant showing yield state of beam and later load carrying capacity has gradual rise.

3. CONCLUSIONS

The load carrying behavior of N-TRUSS beam is 42.2% higher than Un stiffened beam, 23.04% higher than Longitudinally stiffened beam. The deflection behavior of Plane beam is 4.8% higher than N-TRUSS beam. N-TRUSS beam is preferable for high strength purpose. Though this pattern is slightly costlier, its Load carrying capacity is preferably high. For execution of such patterns in site Flexural Rigidity scale shall be adopted between model and prototype of sections. The above results are completely compared and concluded theoretically, analytically and experimentally.

REFERENCES

I. M. Young, the Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

II. M. M. Alinia, Maryam Shakiba (2018) Shear Failure Characteristics of Steel Plate Girders Dietrich Design Group Internal Report, April, 2002.

III. Yu C, Schafer BW, Local buckling tests on cold-formed steel beams, Journal of Structural Engineering, ASCE, 129(2017) 1596-606.