Experimental and Theoretical Investigation on Flexural member and analysis by ANSYS

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***Abstract*- The deflection of steel structure depends on flexural strength of a member. Most of the steel structure fails under flexure. So the structure should be designed to sustain maximum flexural strength. In this exploit we deal with the study of flexural member by using various sections.Mainly flexural members depends upon five aspects such as shear force, bending moment, deflection and apart from these three aspects, it also depends upon web buckling/crippling and web bearing. In our research, we have selected laterally unsupported beam. Incase of. laterally unsupported beam, the web portion will not be laterally restrainedwhich leads to buckling failure on the web. In order to avoid this failure two structures were casted and it is tested. Two sections which we used are I-section and channel sections connected back-to-back with steel plates at top and bottom flanges. And analysis is made by three methodologies i.e., Theoretical analysis, experimental testing by using two point load and software analysis is made by using ANSYS.**

Keywords- Deflection, Flexural strength, Web buckling, Web bearing, ANSYS

I. INTRODUCTION

A. Flexural beam

A member in a structure is subjected to both tension and compression within its depth is called flexural member. In a beam, the flexural member of steel structures is designed to carry both uniform and concentrated loads. This member can act as a primary structural element in case of a beam-column frame or it can be presume to support the slabs or the joist-slab.

In a slab, the flexural member befalls in one or two directions. In a girder, a flexural member presumes to endorse beams and designed

B. Behaviour of flexural member in steel

Shearing forces are unaligned forces pushing one part of a body in one specific direction and another part of the body in the opposite direction. When the forces are aligned into each other, they are called compression forces. If a plane is passed through a body, force acting along this plane is called a shear force. In case of laterally unsupported beam the maximum shear force will occur at the web section. The web portion should be designed in such a way that it should withstand maximum shear force. While shear failure is usually found with long beam spans carrying uniform loads. The bending force takes a long time to break something and therefore it leads to low safety factor. The most common or simplest structural element subjected to bending moments is the beam. The bending moment at a section through a structural element may be defined as "the sum of the moments about that section of all external forces acting to one side of that section". In case of bending in laterally unsupported beam it should withstand the maximum moment and it should be designed with maximum moment capacity and it should be greater than the moment acting on the structure. And the capacity of the beam is identified as per codal provisions. For steel structures **IS800:2007** and **SP6** is used.

The deflection at any point on the axis of the beam is the distance between its position before and after loading. Buckling is characterized by a sudden sideways deflection of a structural member. In case laterally unsupported beam the deflection and buckling will be larger when compared to laterally supported beam. This can be minimized by increasing the thickness of the web. Deflection criteria are checked as per codal provisions and it is verified with the actual deflection.

C. Sections used as flexural member

The steel sections used such as columns, beams, slabs, walls, tunnels, chimneys and silos can be used to improve the flexure and shear behaviour. Apart from this, I-section, Built-up channel section and Built –up Angle section can also be adopted. In I- sectional beam, the thickness of web will be less so there occurs web buckling. In Built-up channel section, the thickness of web will be more when compared to I-sectional beam. So there will be possibility of reduction in web buckling failure. In case of Built-up angle section, there will be higher thickness of the web. Due to the root radius the web buckling failure occurs.

II. THEORETICAL ANALYSIS

In our exploit we are considering two sections such as I-sectional beam and Built-up channel section. In both sections, for a laterally unsupported beam initially we have brooded the maximum shear force and maximum bending moment. Then the required plastic section modulus is determined to select a suitable section from **IS800:2007** with its properties. Patently we have selected the following sections such as ISMB250 and 2ISMC100. After selecting a suitable section it is blistered for adequacy, shear capacity, moment capacity, deflection, web buckling and web bearing. The two sections which we had selected is analysed manually. The following are the results of those two sections:

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Sl.No	Properties	I-section beam	Double channel section with plates at top and bottom flanges
1.	Weight	563 N	512 N
2.	Shear force	75 kN	75 kN
3.	Bending moment	30 kNm	30 kNm
4.	Actual Deflection	0.45 mm	1.85 mm
5.	Allowable deflection	5 mm	5 mm
6.	Web buckling	235.98 kN	329.66 kN
7.	Web bearing	256.78 kN	150.88 kN

III. EXPERIMENTAL ANALYSIS

In our experimental method, we have selected two point loads. Overall length of the beam is 1.5 m and effective length is 1.2 m. The supports are placed at the distance of 0.15 m or 15 cm from both the ends. The salient points are marked for placing of support and also for placing of proving ring, dial gauge, etc. Proper supervision and checking is done before testing the specimen. A centre point is marked and the proving ring is placed above the specimen. The position of dial gauge is below the centre of the specimen. The following are the readings that should be taken from the proving ring and dial gauge. The proving ring is mainly used for the amount of load that is applied on the specimen. The dial gauge is used to find out the deflection of the specimen. Following figures shows the arrangement of the specimen and the table shows the variation of load and deflection from the corresponding specimen.

Fig.1: I-sectional beam

Fig.2: I-sectional beam loaded on the demec loading frame

I. Software analysis

In our exploit we have analysed our beam through ANSYS software. ANSYS is software used for analysing purpose only. The structural elements and thermal elements can be analysed through ANSYS. In this software we cannot create models but we can analyse the models with the help of other software's like solid works, staad-professional, 3D Max, etc. In our case we have created the models in solid works and analysed in ANSYS software. Initially we have to import the image and make into a structurally solid element. Then the corresponding two point loads have to be initiated and then finally the deflection of the I-sectional beam and double channelled welded section is enrooted. The following are the displacement results of those two sections analysed in ANSYS.

Fig.3: Double channelled section with steel plates at top and bottom flanges

Fig.4: Double channelled section placed on demec loading frame

Table 1: ISMB250

Sl.No	Load (kN)	Deflection (mm)
1.	5	0.49
2.	10	0.84
3.	15	1.03
4.	20	1.42
5.	25	1.63
6.	30	1.92
7.	35	2.21
8.	40	2.55
9.	45	2.84
10.	50	3.13
11.	55	3.41
12.	60	3.67
13.	65	3.80
14.	70	4.16
15.	75	4.35

Table 2: 2ISMC100

Sl.No	Load (kN)	Deflection (mm)
1.	5	0.59
2.	10	0.86
3.	15	1.02
4.	20	1.34
5.	25	1.68
6.	30	1.92
7.	35	2.16
8.	40	2.43
9.	45	2.86
10.	50	3.15
11.	55	3.42
12.	60	3.76
13.	65	3.95
14.	70	4.12
15.	75	4.34

I. *Result comparison*

The result comparison is done between all the three methodologies namely theoretical analysis, experimental analysis and software analysis. Mainly the results are compared for their deflections of those two sections in various analyses. The following are the result comparison:

A. *Analysis of ISMB250*

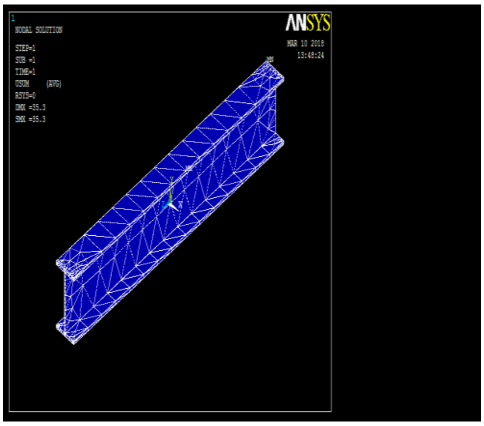

Fig.5: I-sectional beam before deflection

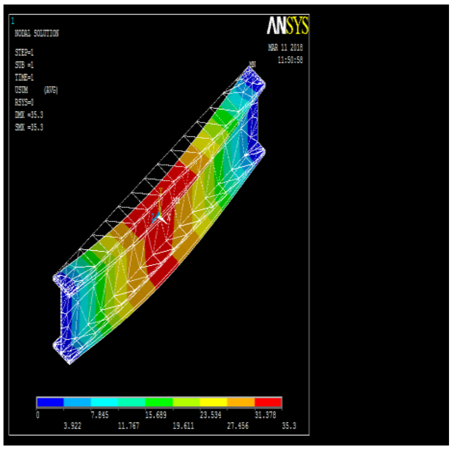

Fig.6: I-sectional beam after deflection

A. *Analysis of double channelled section with steel plates at top and bottom flanges*

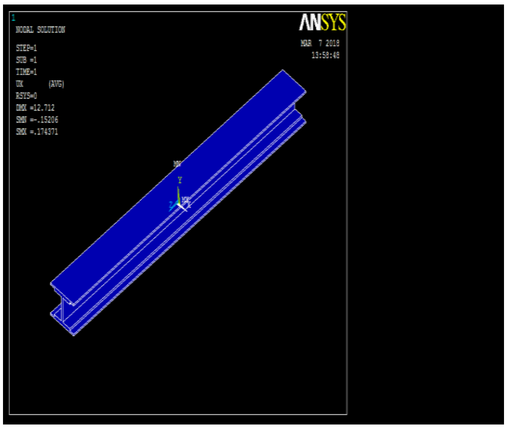

Fig.7: Double channelled section before deflection

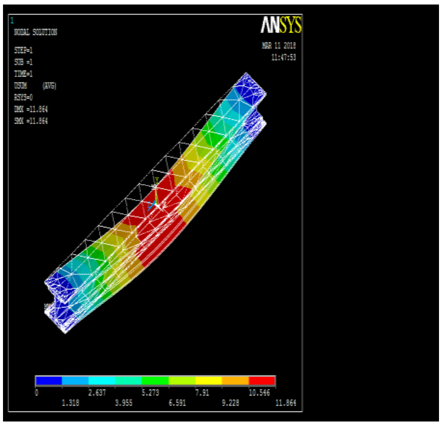

Fig.8: Double channelled section after deflection

Table 3: Result comparison

Sno	Property	Theoretical Analysis		Experimental Analysis		Software Analysis	
		I	2C	I	2C	I	2C
1	Ultimate load (in Tons)	15	15	16	18	15	15
2	Bending moment (in kNm)	30	30	30	30	30	30
3	Shear Force (in kN)	75	75	75	75	75	75
4	Deflection (in mm)	0.49	1.85	4.35	4.34	3.24	1.16

II. CONCLUSION

1. The basic characteristics of flexural members and properties of flexural member is studied and codal provisions for the flexural member is identified.
2. The basic criteria in which flexural member can fail due to web buckling. In case of laterally supported beam as it is stiffened on both the sides the web buckling failure will be lesser when compared to laterally unsupported beam which is not stiffened on both the sides.
3. In many cases, the laterally unsupported beam is adopted. In laterally unsupported beam the web buckling occurs due to thickness of web.
4. In order to increase the thickness of the web, the double channel sections are connected back to back with plates connected at top and bottom flanges, and another beam is made with I-section.
5. The comparison is done between these two beams by using three methodologies namely theoretical analysis, experimental analysis and software analysis.
6. In all the above analysis the double channel section has a greater ultimate capacity than I-section. And also cost and weight of the doubled channel section is less and it is stronger than the I-section beam.
7. The study can further done by using four angle section connected back to back. But in angle sections due to root radius is connecting portion at web, the section will not be able to withstand heavier load.
8. In case of flexural member instead of using I-section the double channel section can be preferred for the greater web–buckling capacity.

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