Flexural behavior of composite beam using cold formed steel sections

Pooja Podar[1], Dr.Gargi Rajpara[2]
[1](Department of Civil Engineering, LDRP-ITR, Gandhinagar-Gujarat
Email: pooja_civil@ldrp.ac.in)
[2] (Department of Civil Engineering, LDRP-ITR, Gandhinagar-Gujarat
Email: grajapara@yahoo.co.in)

ABSTRACT

As per conventional method of construction composite beam constructed using hot rolled I steel section. Cold formed steel sections are available in diversity and lesser in weight. Use of cold formed sections is less in practice. It may be advantageous to use cold formed sections for commercial and multistory building which reduces overall weight and cost of structure. Hollow rectangular and hollow square cross section offers greater resistance against lateral loads like earthquake and wind loads. This study is carried out to determine analytical flexural behavior of composite beam using cold formed sections and hot rolled sections both. The same can be compared with experimental behavior of hot rolled and cold formed composite beam.
.

Keywords *– cold formed section, flexural behavior, hot rolled section, lateral loads, weight and cost of structure*

I. INTRODUCTION

Composite construction achieves important benefits by making steel and concrete work together, but these advantages can be improved if light cold formed steel sections is used instead of hot rolled sections are used. Some traditional cold formed sections are available and it is already used for industrial buildings. The main objective is therefore to explore innovative composite construction technology where light steel sections act compositely with in-situ concrete. This will lead to increase in lateral load capacity, increase speed of construction for longer spans, economy of materials and good performance in service.

II. COMPARISION OF HOT ROLLED AND COLD FORMED SECTIONS

As per recent advances, cold formed sections are widely used for industrial buildings for example Z purlin, lipped C channels, hollow sections. Cold formed sections gives higher moment of inertia as well as moment of resistance as compare to hot rolled sections of same weight and cross sectional area. For cold formed sections, it is possible to enhance the load carrying capacity (particularly in beams). There is almost no limit to the type of cross section that can be formed.

The hot rolled sections are available for limited depth and cross sections. The sample comparison is carried out as under. Cold formed sections gives higher moment of inertia as well as moment of resistance as compare to hot rolled sections of same weight and cross sectional area. Sample comparison is as follows.

TABLE:1 Comparison of sectional properties of cold formed and hot rolled section

SECTION	W Kg	A cm^2	D cm	Bf cm	I_{xx} cm^4	I_{yy} cm^4
ISMC 100	9.2	11.7	10	5	186.7	25.9
CFS 100	9.2	11.7	11.5	5	230.2	38.6

.

III. COMPARISION CASES

3.1 There are four comparison cases are considered for comparison

3.1.1. Composite beam using ISMB 500

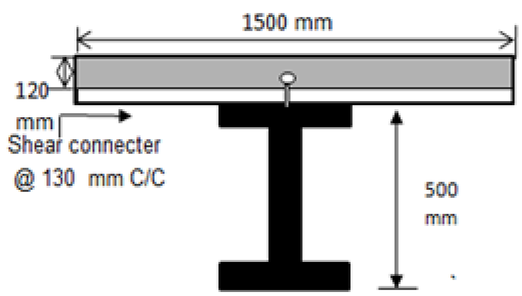

Fig.1. Composite beam (ISMB 500)

3.1.2. Composite beam using HYBOX 500

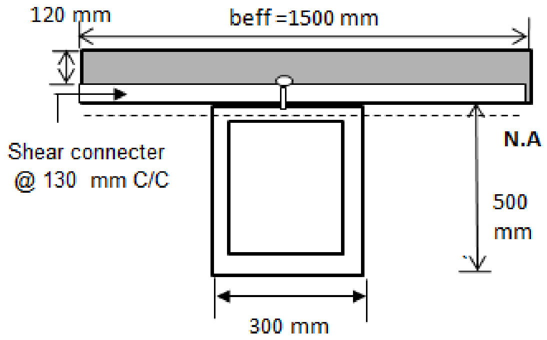

Fig.2. Composite beam (HYBOX 500)

3.1.3. Composite beam using 2 ISMC 400

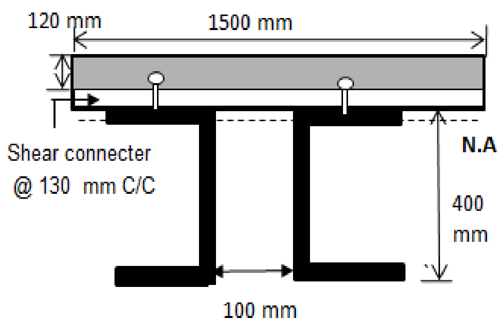

Fig.3. Composite beam (ISMC 400)

3.1.4. Composite beam using cold formed sections (2 CFS 450)

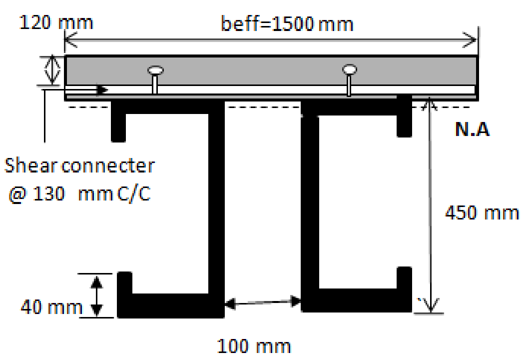

Fig.4. Composite beam (CFS 450)

IV. ANALYTICAL MOMENT OF RESISTANCE

4.1 Analytical moment of resistance is calculated along X and Y direction.

Sectional properties of Hot rolled and CFS sections are as follows.

TABLE: 2 Sectional properties of hot rolled and CFS section

Section	t_f	t_w	W(kg)	A (cm^2)	I_{xx} (cm^4)	I_{yy} (cm^4)
ISMB 500	17.2	10.2	86.9	110.7	45218	1369
HYBOX 500x300	6.3	6.3	73.5	93.6	34346	15777
2 ISMC 400	15.3	8.6	98.8	125.8	30165	4283
2 CFS 450	8	8	92.69	118.0	33802	4985

4.2 Analytical Moment of resistance

Analytical Moment of resistance is calculated using Eurocode: 4 includes following cases.

Case: 1
Neutral Axis (NA) is located in Slab
Case: 2
Neutral Axis (NA) is located in flange of steel beam:
Case: 3
Neutral Axis (NA) is located in Web of steel beam:

4.3 Moment of Resistance along X

Moment of resistance along X is calculated using Euro code 4 using following equation.

$$M_{plrx} = R_c\,(h_c/2 + hp) + R_s \times h/2 - \frac{(R_s - R_c)^2}{4 \times B} \quad (1)$$

4.4 Moment of Resistance along Y

Moment of resistance along Y is calculated using using following equation.

$$M_{plry} = \frac{R_c \times b_{eff}}{4} + R_s \times \bar{x} - \frac{(R_s - R_c)^2}{4 \times B \times p_y} \quad (2)$$

b_{eff} = Effective width of slab
Effective width of flange = $\frac{(2 \text{ x effective span})}{8}$
Rs = Resistance of steel section
Rc = Resistance of concrete slab
Mpl_{rx} = Moment of resistance X direction
$Mplr_y$ = Moment of resistance Y direction
p_y = Depth of Neutral axis.
Effective span of beam = 6m

The moment of resistance of beam is calculated using above equations. Calculation results are as follows.

TABLE: 3 Moment of resistance and shear capacity of composite beam

Designation	Moment of Resistance and Shear			
	M_{xx} (kN.m)	M_{yy} Composite section (kN.m)	M_{yy} Steel section (kN.m)	V (kN)
ISMB 500	1029.52	299.83	43.33	869.324
2 ISMC 400	955.32	398.68	142.18	1172.735
HYBOX 500x300	1003.3	445.07	188.571	1229.756
2 CFS 450	996.54	398.94	142.44	1227.282

V. CONCLUSION

As per conventional practice, for composite beam, available hot rolled sections are used. It is advantageous to use cold formed section which is having less weight and gives higher moment of inertia in Y direction. Moment of resistance X direction is more or less similar but there is huge difference in moment of resistance in Y direction. As cold formed section can be fabricated according to requirement, so it is possible to shift neutral axis accordingly. As per analytical calculation results ,box sections gives higher moment of resistance in Y direction and shear resistance as compare to conventional hot rolled I Section.

REFERENCES

[1]. Lan Chung ,Jong-Jin Lim , Hyeon-Jong Hwang , and Tae-Sung Eom, *Review of Design Flexural Strengths of Steel–Concrete Composite Beams for Building Structures*, May 2016

[2]. Dr. D.R. panchal, Advanced Design of Composite Steel-Concrete Structural element, International *Journal of Energy Research*, 2014, 124-138.

[3]. M. A. Youns, S.A. Hassaneen, M.R. Badr And E.S. Salem, Composite Beams of Cold Formed Steel Section and Concrete Slab, *International journal of Engineering development and research,*2016,165-177

[4]. Naveena Treesa Joseph, Jerison Scariah James, Priya Philip, Flexural Performance of Concrete Filled Steel Tube Beams, *International Journal of Engineering Research & Technology,*2016,444 – 446.

[5].Arivalagan Soundararajan, Kandasamy Shanmugasundaram , Flexural Behavior Of Concrete-Filled Steel Hollow Beam Sections ,*Journal of Civil Engineering and Management*, 2010, 107-11.

[6]. Sung-WonYooa, Jinkyo F.Choo, Evaluation of the flexural behavior of composite beam with inverted-T steel girder and steel fiber reinforced ultra high performance concrete slab, *Engineering and structures*,2016,1-15.

[7]. Saleh Omar Ahmed Bamaga*, Structural Behavior of Composite Beams with Cold Formed Steel Section,* University Teknologi, Malaysia, 2013.