A Brief Study on Different Stresses of Steel Structural Member as per Indian Standard Parallel Section

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Research Article

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ABSTRACT

The motive of a structural engineer is to design a structure that can withstand its demand throughout the life span. A compressive member is primarily designed to carry axial loading but it always has a possibility to fail due to bending. Here, different stresses of compression members have been observed with different effective lengths, following the Indian code of limit state methods of steel structures. As per the present Indian scenario, different sections of universal columns, which are available in the Indian market, has been taken for its high strength and variety. The designed tables and graphs are prepared for finding the capacity of cross section with various effective lengths which will be beneficial for the designer. In this paper, no attempt has been made to consider complete structure and the overall analysis of the building. Euro code and AISC code are compared with which are then preceded by a comprehensive set of explanatory notes. In this study, attempt has been made, to prepare a practical guide to the compression member are focusing on buckling stress and other stresses.

INTRODUCTION

Compressive members are one of the basic structural elements which are primarily designed to carry axial compression. In various types of compression members, the columns are ordinarily used in the buildings as vertical members to carry loads of beams, slabs etc. Columns are usually straight vertical members whose lengths are considerably greater than their cross-sectional dimensions. The safe axial load depends on the dimensions, length of the members and end conditions of the members. The various modes of failure of a column are crushing, buckling and a mixed mode of buckling and crushing [1].

MATERIALS AND METHODS

The buckling tendency of a column varies with the ratio of the length to least lateral dimension. The smallest force at which a buckled shape is possible is known as critical force. Steel plated structures are likely to be subjected to various types of loads and deformations arising from service requirements that may range from the routine to the extreme or accidental.

The mission of structural design is to design a stable structure that can withstand such demands throughout its expected life. In this paper attempt has been made to prepare a guide as per IS: 800-2007 by focusing on the problem of the designers.

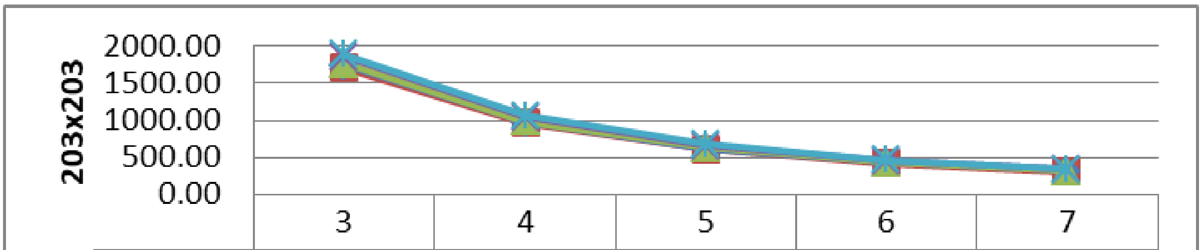
Design of compression member

A structural member which is subjected to compressive forces along its axis is called a compressive member, from the basic mechanics of materials for long columns, buckling occurs prior to developing the full material strength of member. So a sound knowledge of stability theory is necessary for designing compression member in structural steel. The strength of the column depends on the material of the column, cross sectional configuration, length of the column, ends support condition, residual stresses, imperfections [2].

RESULT AND DISCUSSION

Stability has a vital role in designing a compression member. Normally, structural analysis is based on the condition of stable equilibrium between internal and external forces. In general, long columns fail by elastic buckling. In this study, different sections of universal columns, which are available in the Indian market, has been taken. According to, it is clear that buckling stress will be increases with the sectional weight of constant effective length and will be decreases with the effective length [3]. Here in this Figure-1 203 × 203 UC sections are chosen for the examples and the unit of effective length in meter and stresses are considered in N/mm^2.

Figure 1. Buckling stress graph with the effective length of the section.



	3	4	5	6	7
46.1	1704.45	958.75	613.60	426.11	313.06
52	1739.41	978.42	626.19	434.85	319.48
60	1758.99	989.43	633.24	439.75	323.08
71	1846.43	1038.62	664.71	461.61	339.14
86.1	1886.87	1061.37	679.27	471.72	346.57

Buckling stress crosses the proportional limit after the slenderness ratio 88.84,after that section cannot follow the hooks law. But the design compressive stress is still lower than buckling stress, so, the design is safe according to the design can be applied on longer columns.

The Figure 2 shows it clearly, that design compressive stress is less than yield stress on any section of any effective length, whereas the buckling stress is much higher than design stress.

Figure 2.Comparison between design stress, buckling stress and yield stress.

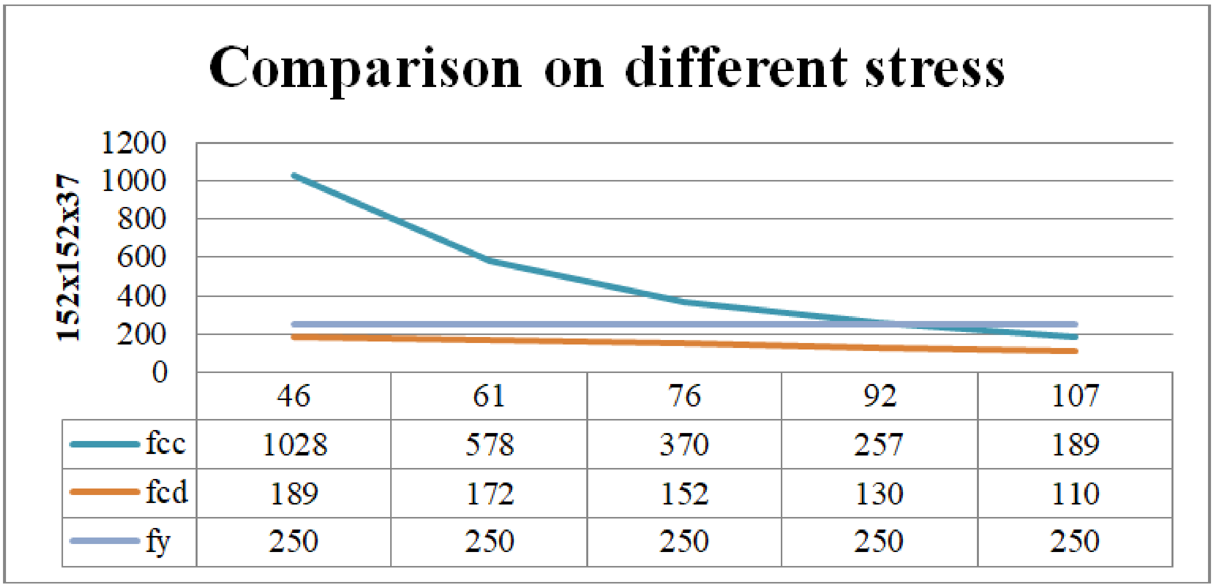
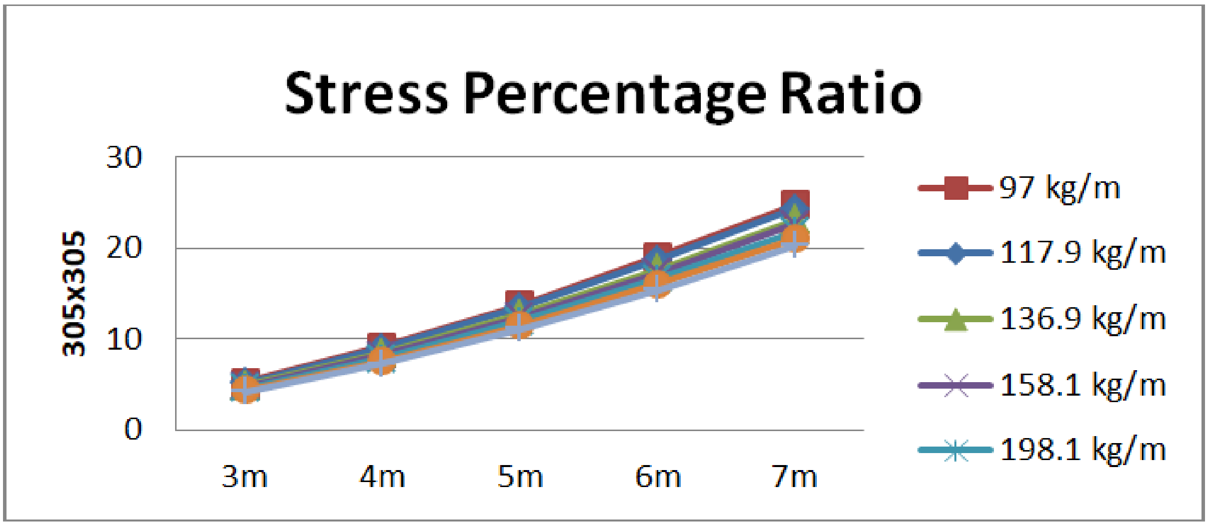


Figure 3. Percentage of design stress on the basis of buckling stress.

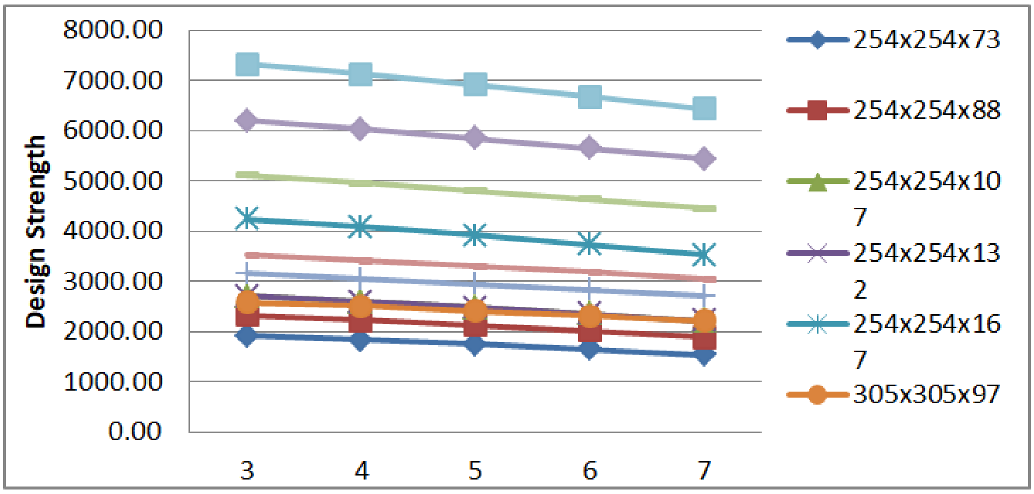


From Figure 3 and Table 1, shows the percentage ratio of design stress and buckling stress.i.e., the ratio of design compressive stress, on the basis of buckling stress, in percentage. Here, 305x305 section shows that, with the increases of weight, percentage ratio decreases and with the length, percentage increases. It is observed that design stress is considered 4-25 percent of buckling stress, the chances of failure due to different stresses will be lower upto the design stress [4].

Table 1. Design compressive strength of different sections of universal columns.

Design strength (KN)						
section	Wt (kg /m^2)	3m	4m	5m	6m	7m
152 × 152 × 23	23	546.58	492.28	429.36	363.73	303.12
152 x 152 x 30	30	721.2	653.88	575.52	492.3	413.59
152 x 152 x 37	37	890.99	809.86	715.29	614.19	517.69
203 x 203 x 46	46.1	1169.2	1100.82	1022.35	933.36	836.9
203 x 203 x 52	52	1321.7	1245.66	1158.55	1059.73	952.33
203 x 203 x 60	60	1466.12	1385.23	1292.94	1188.26	1073.76
203 x 203 x 71	71	1744.77	1652.14	1546.88	1427.55	1296.42
203 x 203 x 86	86.1	2118.06	2007.5	1882.11	1740.02	1583.58
254 x 254 x 73	73.1	1913.36	1834.23	1746.93	1649.44	1541.09
254 x 254 x 88	88.9	2332.2	2237.58	2133.43	2017.33	1888.34
254 x 254 x 107	107.1	2704.72	2599.55	2484.37	2356.5	2214.61
254 x 254 x 132	132	2745.06	2641.5	2528.5	2403.43	2264.83
254 x 254 x 167	167.1	4243.15	4088.4	3920.24	3734.76	3529.57
305 x 305 x 97	97	2588	2505.6	2417.45	2321.65	2216.7
305 x 305 x 117	117.9	3153.3	3054.32	2948.63	2833.93	2708.44
305 x 305 x 136	136.9	3524.85	3418.57	3305.57	3183.48	3050.39
305 x 305 x 198	198.1	5116.54	4968.8	4812.45	4644.33	4461.8
305 x 305 x 240	240	6209.54	6034.71	5850.15	5652.26	5437.91
305 x 305 x 282	282.9	7330.52	7129.28	6917.4	6690.81	6446

Figure 5. Design strength of different sections of universal columns.



Now, according to compression member design is considered safe. So, here the design aid is prepared with the table and graph. Where it shows, the maximum safe design compressive strength (in N) of different section (available in Indian market) with their varying effective length. It will be very easy to find the safe design for new designer with the help of this table and graph [5].

CONCLUSIONS

Buckling stress crosses the yield stress at the value of slenderness ratio 88.84. As per from the design point of view, for axial loading column slenderness ratio considered up to 180 which can withstand the design stress without failure. The design stress is 4-25 percent of buckling stress. It is easy to find the safe design for new designer with the help of this table and graph. The code is nearly same as EURO code except the z-direction consideration of the section but the values of the designs are nearly same. In AISC code design strength formula depends on the value of λc.

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