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DESIGN AIDS FOR BEAM-COLUMN DESIGN AS PER IS800:2007

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Abstract - *Steel as a building material, has been used extensively in various types of structures, such as high rise building, industrial building etc. The new code IS800:2007 is used for design of steel members. This new code include variety of elements like compression member, tension member, combined connection, flexural member, combined axial and bending design of members. The BIS has yet not published any design aids based on IS800:2007. For saving time in various design of structural steel sections, one need to have their own computer programme or design aids or spreadsheet which is based on IS800:2007. In this an attempt is made to developed graph based on excel programme spreadsheet to analyze and design beam-column, which will help structural designer to save their time in designs.*

Key Words: IS800:2007, Factored load, Factored moment, effective length.

1. INTRODUCTION

In many situations, we come across steel member subjected to combined effect of shear and bending, axial force and bending, axial force shear and bending. It is necessary to study how the structural member react when subjected to combined effect of the above forces and moments.

Structural member subjected to combined axial compression and transverse bending moment is known as BEAM-COLUMN.

1.1 STRENGTH OF BEAM-COLUMN

Beam-column represent the general load case of an element in structure with beam and axially loaded column being the limiting cases. As the bending moment on a beam column approaches to zero, it will behave like a column. When the axial force approach to zero, it will behave like a beam. As such all the factor that influences the behavior of columns and those which influence behavior of beam will obviously influence the beavioue of beam-column.

The structural designer has to ensure that the structures and facility he designs are

i. Fit for their purpose
ii. Safe
iii. Economical and durable.

Thus safety is one of the paramount responsibility of the designer. But there are too many uncertainty involved in design which are:

i. Uncertainty about loading.
ii. Uncertainty about material strength.
iii. Uncertainty about structural behavior.

Hence design is basically a trial and error process, initially a section is assumed and it is checked for its capacity to withstand the applied load. Since this take a long time if done manually. Hence an attempt is made to prepare design aids for beam-column design.

2. LITRERATURE REVIEW

Prof. Ravindra Bhimarao Kulkarni, Vikas Arjun Patil has carried detail study has been carried out on the design of flexure member and beam-column for channel sections and effort is made to prepare design aids in the form of graphs. Design charts for the design of steel sections made up of Indian standards channel section. These charts are based on IS 800:2007. The graphs have been prepared for the flexural members (laterally supported and laterally unsupported) channel sections, which can be used to select the sections directly for different effective span and the factored load, the member can withstand. These graphs can be used as designed aids for selecting steel sections.

3. METHODOLOGY

List of various steps to be followed in manual calculation:

[1] Determine factored load and factored moment,
[2] Choose arbitrary section and give section property.
[3] Section classification (whether plastic, compact, semi-compact or slender)
[4] Check for loacal capacity
   a. (Design compressive strength > compressive load
   b. Design bending strength > bending moment)
[5] Check section strength by material failure.
[6] Check for buckling resistance in bending
[7] Check for combined bending and axial compression.

Since these steps are tedious and time consuming hence design aids are necessary for reducing time consumption.
List of steps followed in preparing design aids:

[1] Preparing excel program spreadsheet.
[2] Preparing graph for factored load against factored moment for different effective length.

Example: Design a steel beam-column of effective length 3.5m subjected to factored axial load of 1520 kn and factored moment of 36 kn-m. Design the beam-column.

Solution:-

from manual calculation

Let us take ISHB400@759.29 N/M

Section property

Area A= 9866 mm^2 , depth h = 400 mm , flange width b_f= 250

Thickness of flange t_f = 12.7mm, web thickness t_w = 9.1mm

Root of radius = 14 mm, moment of intertia $I_z = 28083.5\times10^4$ mm^4, $I_y= 2728.3\times10^4$ mm^4, plastic section modulus Z_{pz} = 1556.33×10^3 mm^3, elastic section modulus $Z_{ez}= 1404.2\times10^3$ mm^3, $Z_{ey} = 218.3\times10^3$ mm^3

Radius of gyration r_z = 168.7 mm, r_y = 52.6 mm.

Section classification:

Flange outstand b = b_f /2 = 250/2 =125 mm

$b/t_f = 125/12.7 = 9.84 < 10.5$

compact section

$d/t_w = 346.6/9.1 = 38.1 < 84$

compact section

Check for local capacity

Design compressive strength $N_d = 9866\times250/1.1$

= 2242.27 kn

Design bending strength $M_{dz} = 1556.33\times10^3\times250/1.1$

= 353.71 kn-m

Section strength by material failure

About y-axis

$K I_y/ r_y = 66.54$

About z-axis

$K I_z/ r_z = 20.75$

Design compressive strength in buckling

P_{dy} = 1688.96 kn

P_{dz} = 2226.76 kn

Check for buckling resistance in bending

Design bending strength

$M_{dz} = \beta_b Z_{pz} f_{bd}$

$= 1\times1556.33\times10^3\times226.4$

= 352.35 kn-m > 36 kn-m

Check for combined axial and bending moment

as per IS800:2007 clause 9.3.2.2

value of interaction equation = .785 < 1

section is safe

The design charts have been prepared factored load Vs factored moment for different effective span for ISHB sections:

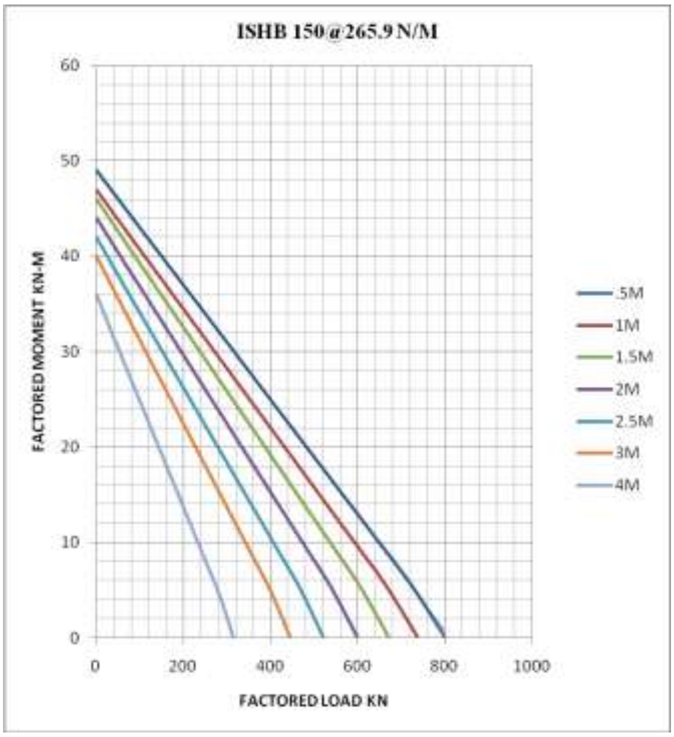

Chart -1: factored moment Vs factored load ISHB150@265.9 N/M

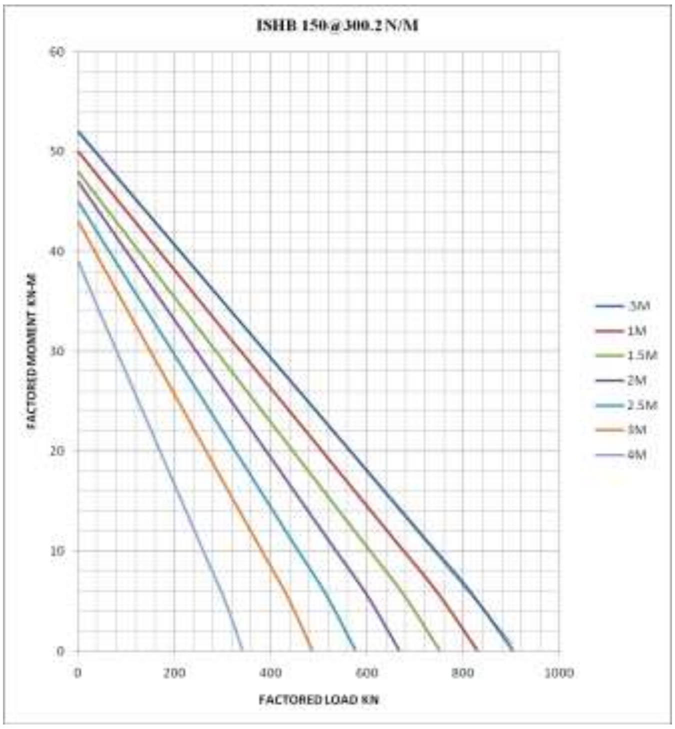

Chart -2: factored moment Vs factored load ISHB150@300.2 N/M

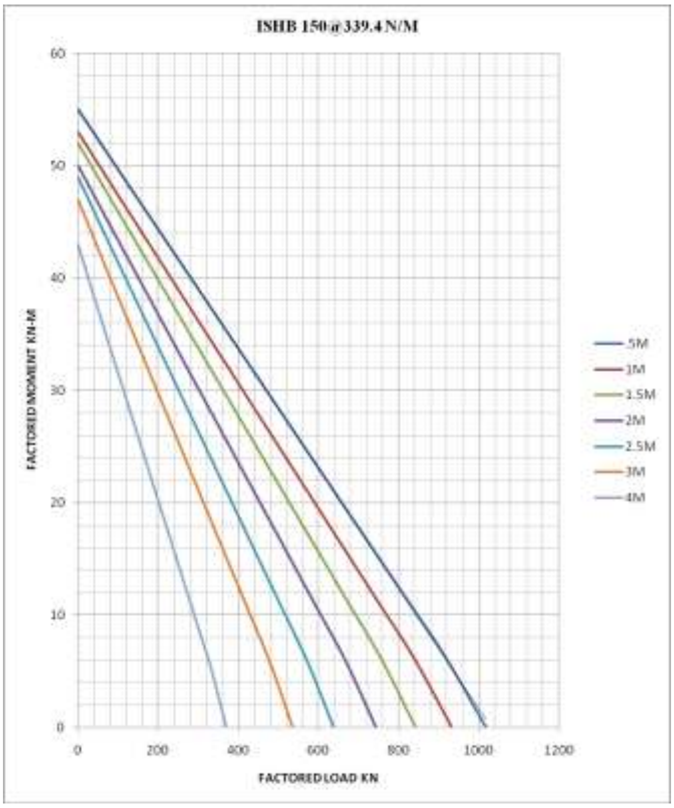

Chart -3: factored moment Vs factored load ISHB150@339.4 N/M

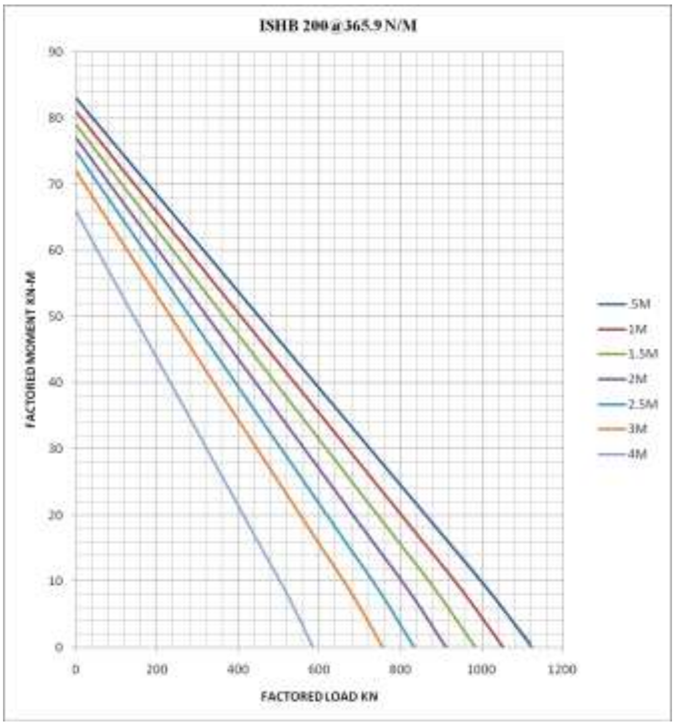

Chart -4: factored moment Vs factored load ISHB200@365.9 N/M

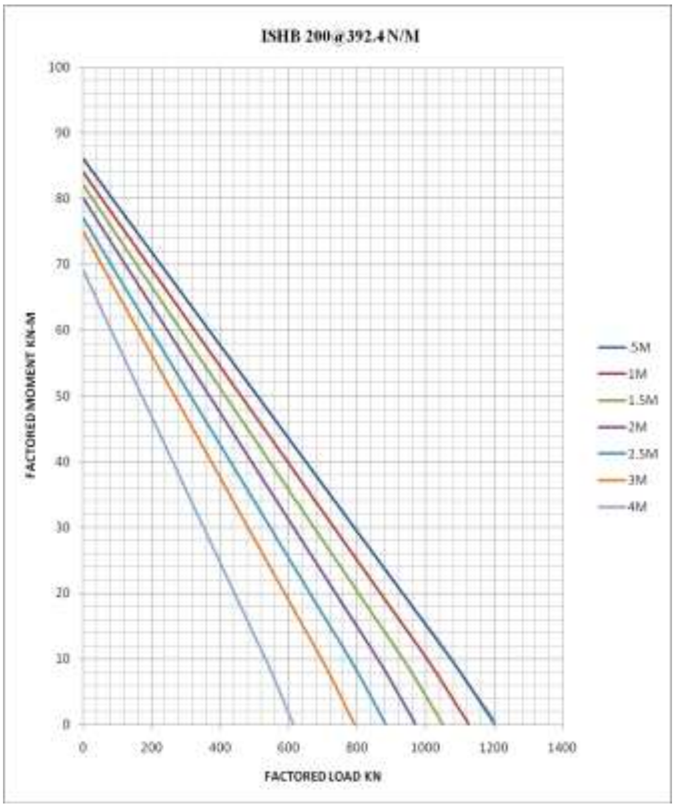

Chart -5: factored moment Vs factored load ISHB200@392.4 N/M

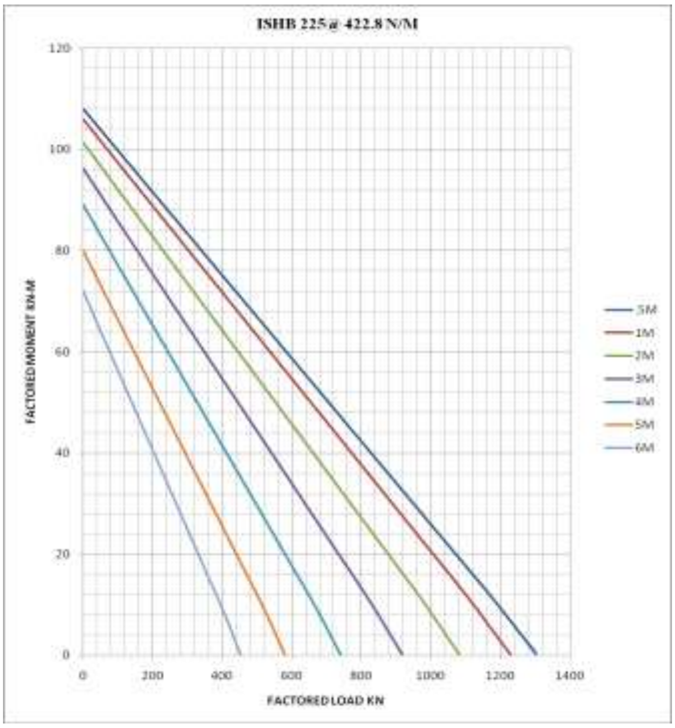

Chart -6: factored moment Vs factored load ISHB225@422.8 N/M

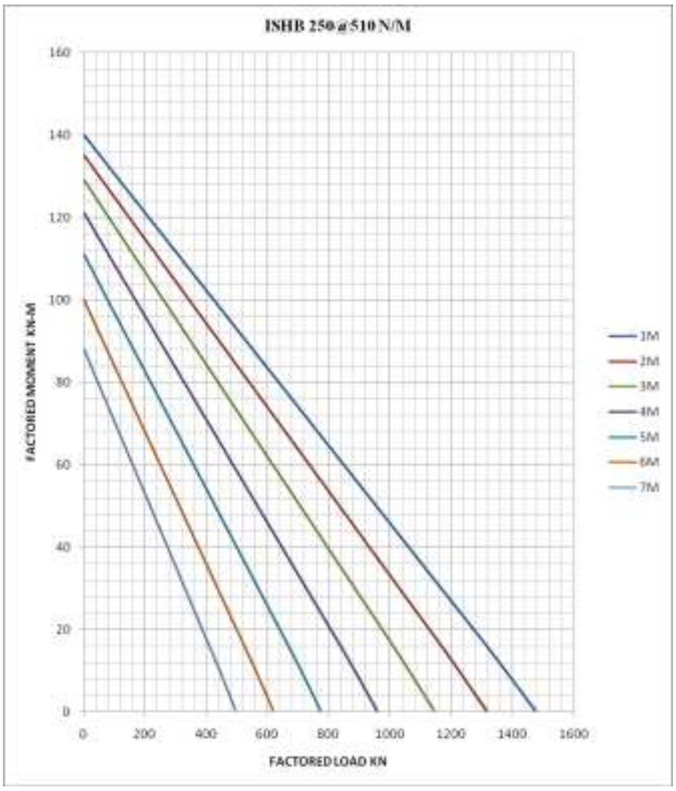

Chart -7: factored moment Vs factored load ISHB225@422.8 N/M

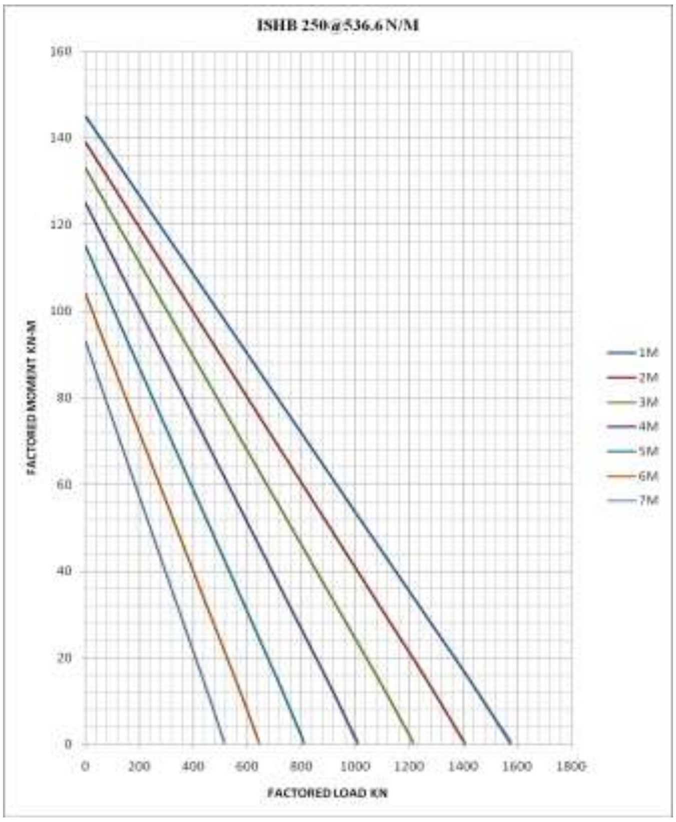

Chart -8: factored moment Vs factored load ISHB250@536.6 N/M

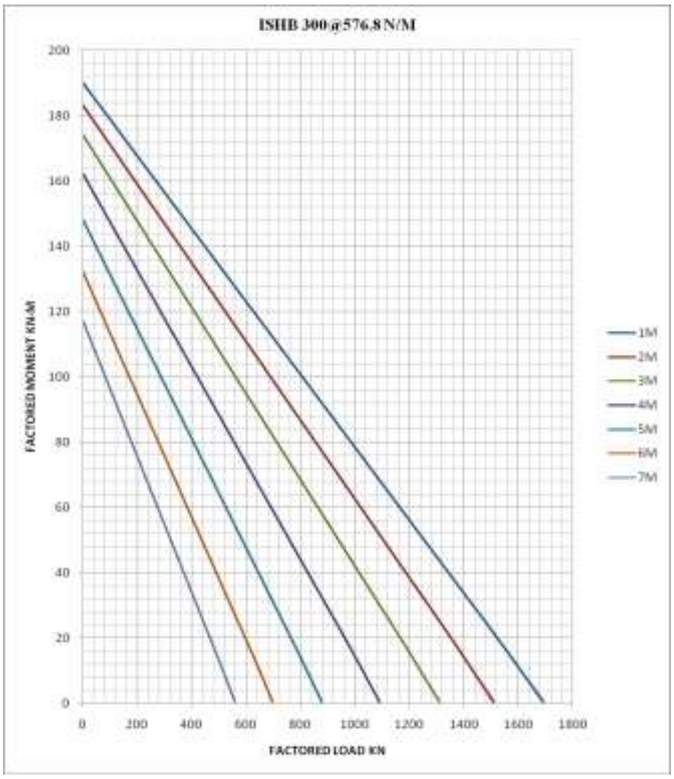

Chart -9: factored moment Vs factored load ISHB300@576.8 N/M

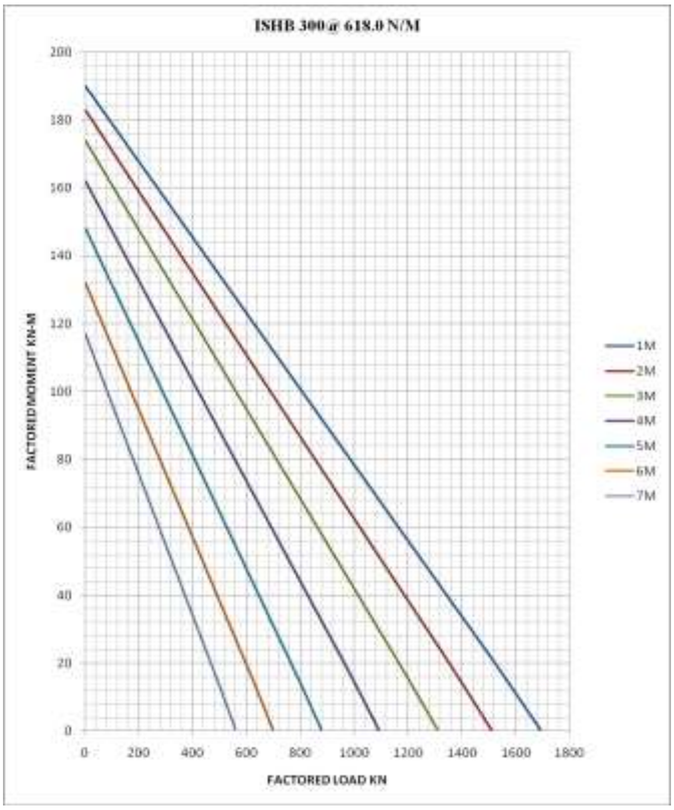

Chart -10: factored moment Vs factored load ISHB300@618.0 N/M

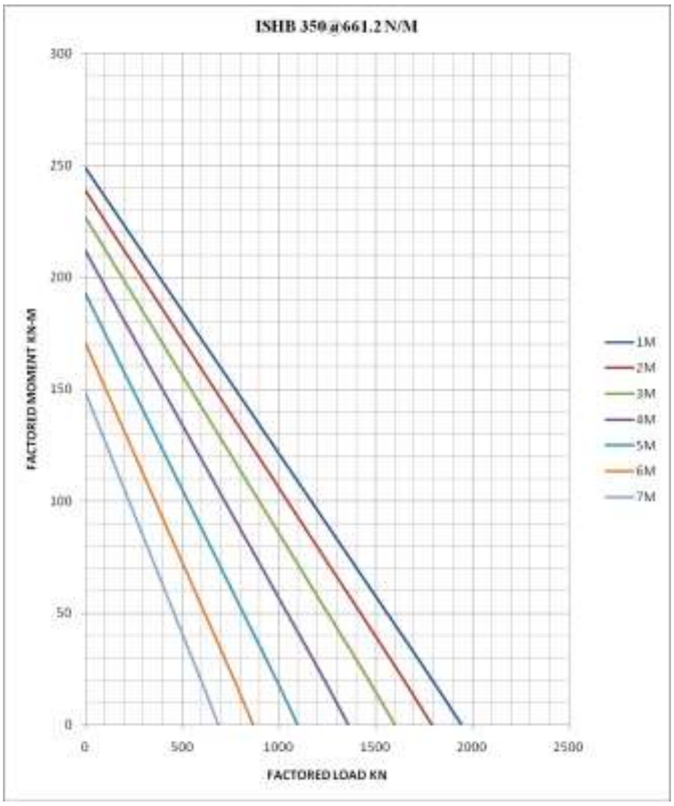

Chart -11: factored moment Vs factored load ISHB350@661.2 N/M

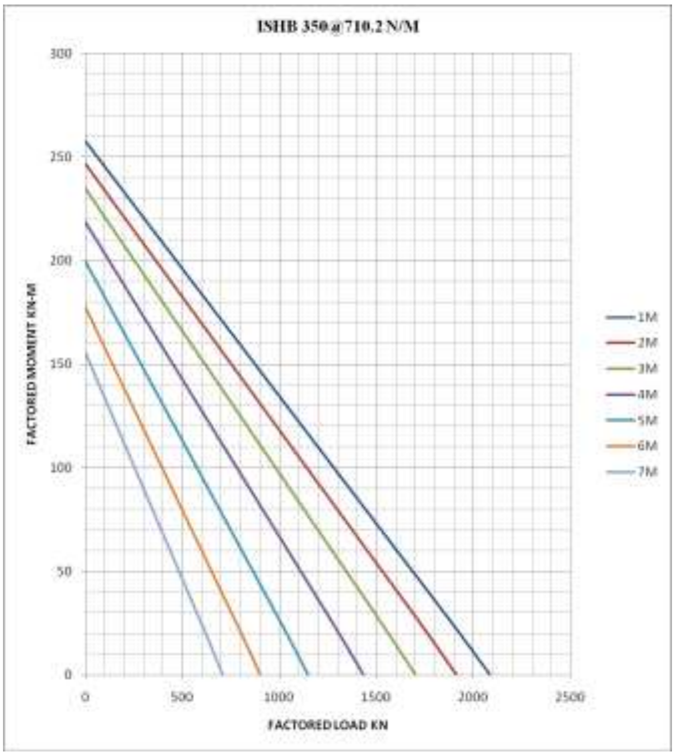

Chart -12: factored moment Vs factored load ISHB350@710.2 N/M

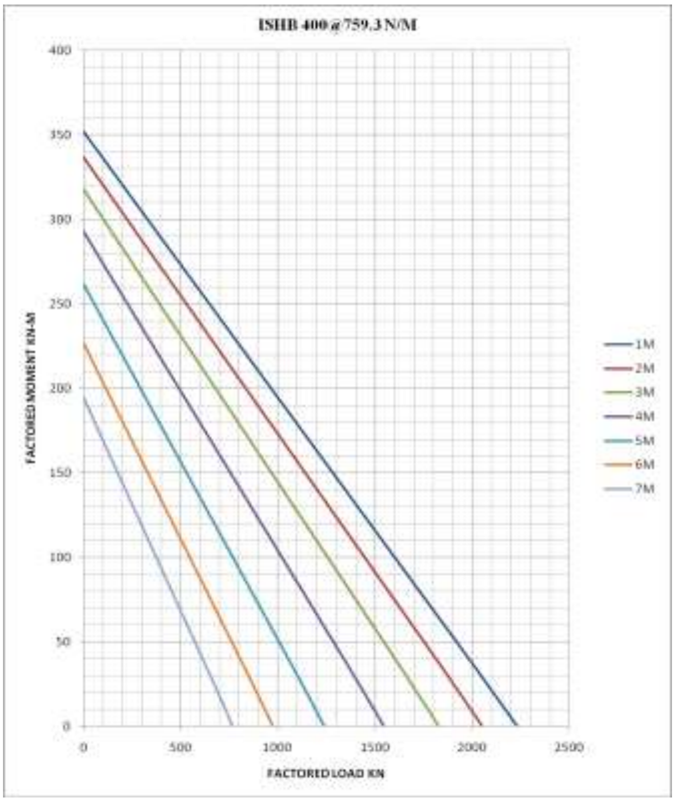

Chart -13: factored moment Vs factored load ISHB400@759.3 N/M

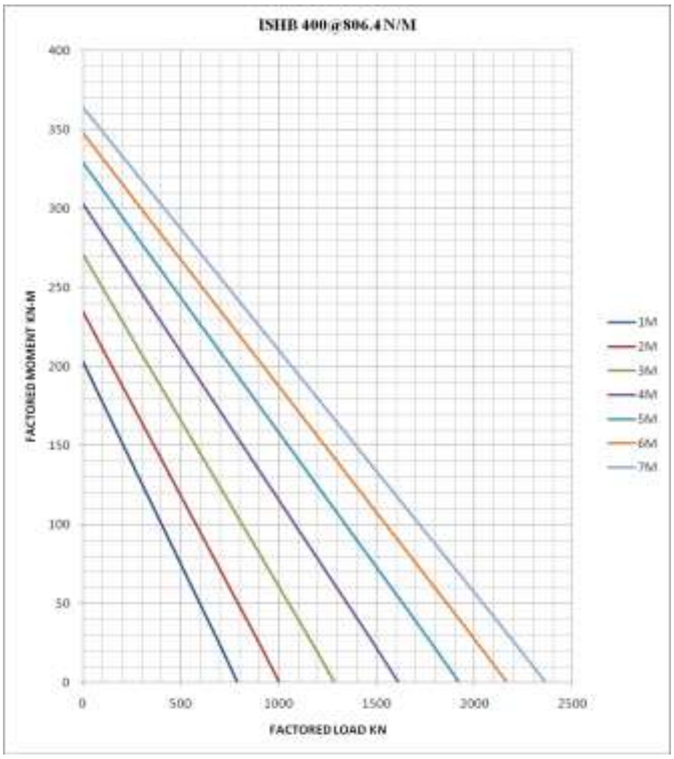

Chart -14: factored moment Vs factored load ISHB400@806.4 N/M

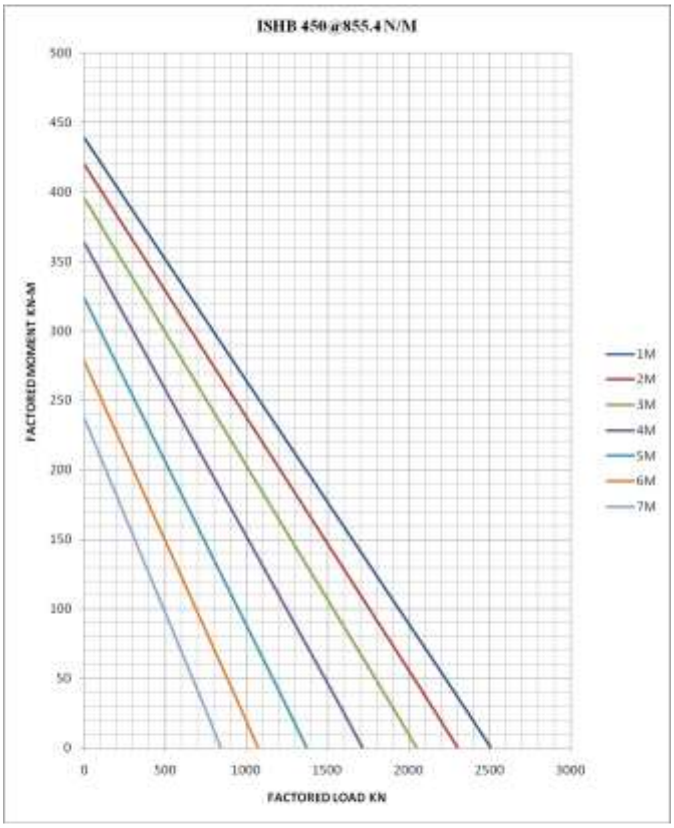

Chart -15: factored moment Vs factored load ISHB450@855.4 N/M

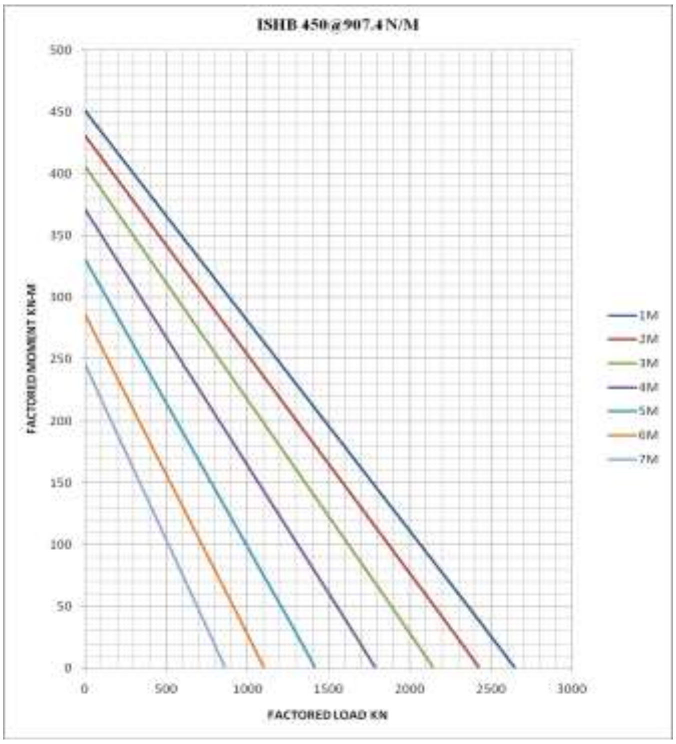

Chart -16: factored moment Vs factored load ISHB450@907.4 N/M

Example: Design a steel beam-column of effective length 3.5m subjected to factored axial load of 1520 kn and factored moment of 36 kn-m. Design the beam-column.

Solution:-

FACTORED LOAD = 1520 KN

FACTORED MOMENT = 36 KN-M

From chart-13 select section ISHB400@759.3 N/M

For load 1520 KN and Effective length 3.5 m

Moment carring capacity = 40 KN-M

Hence

section is safe

4. CONCLUSIONS

Design charts for the design of steel sections made up of INDIAN STANDARD BEAM SECTION. These design charts are presented based on 800-2007.

The graphs have been prepared for the ISHB section for plastic and compact section with uniaxial condition. Graph obtained is a sloping straight line which can be used to select the section directly for different effective span and the factored load and moment, the member can withstand. These graph can be used as designed aids for selecting steel sections.

Since, manual calculation are tedious and time consuming hence these charts are helpful for designer as it reduce time consumption and complex manual complex.

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BIOGRAPHIES

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