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Parametric Analysis of Steel beam using Roark's Computer Aided Design

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Abstract— *Steel is widely used in construction and other applications because of its high tensile strength and low cost. Iron is the basic component of steel. Composition of steel mainly consists of iron and other elements such as carbon, manganese, silicon, phosphorus, sulphur, and alloying elements. It was observed as the elastic modulus of high strength steel and iron steel ,the deflection of the steel in case of the cast iron compared to the 5% less while using high strength steel by roak's analysis .A large number of elements in wide ranging percentages are used for the purpose of alloying of steels. Variations in chemical composition of steels are responsible for a great variety of steel grades and steel properties. Each element that is added to the basic steel composition has some effect on the properties of the steel and how that steel reacts to the processes of working and fabrication of steels. The chemical composition of steel also determines the behaviour of steel in different environments. Steel standards define the limits for composition, quality and performance parameters for various steel grades. Iron is a chemical element with symbol Fe (from Latin: ferrum) and atomic number 26. It is a metal in the first transition series. The deflection of the iron steel l was obtained based on the Roark analysis less compared to other type of steel. The mechanical properties of steel govern directly the deflection steel beam and the value reducing continuously to the fixed l end of the steel beam. The deflection of the high strength steel was obtained based on the Roark analysis was 5% at the 12.0m from the fixed end of the beam and the value reducing continuously to 10% at the distance 9.96m from the fixed l end of the steel beam compared to iron steel.*

Keywords— *Elastic moment, rotation capacity and deflection of hinges for beams, lateral force-resisting systems.*

I. PROBLEM IDENTIFICATION

a) The cantilever beam subjected to a concentrated load of 100 KN at a distance of 2.0m from the free end, length of the cantilever beam is 12.0m and modulus of elasticity of iron is 205 G Pa with a moment of inertia is 600000 cm^4.

Input Information

Length, L =	12.0	m
Elastic Modulus, E =	205	GPa
Moment of Inertia, I =	600000	cm^4
Load, P =	100	kN
Length, a =	2.0	m

b) The cantilever beam subjected to a concentrated load of 100 KN at a distance of 2.0 m from the free end, length of the cantilever beam is 12.0 m and modulus of elasticity of structural steel is 195 G Pa with a moment of inertia is 600000 cm^4

Input Information

Length, L =	12.0	m
Elastic Modulus, E =	195	GPa
Moment of Inertia, I =	600000	cm^4
Load, P =	100	kN
Length, a =	2.0	m

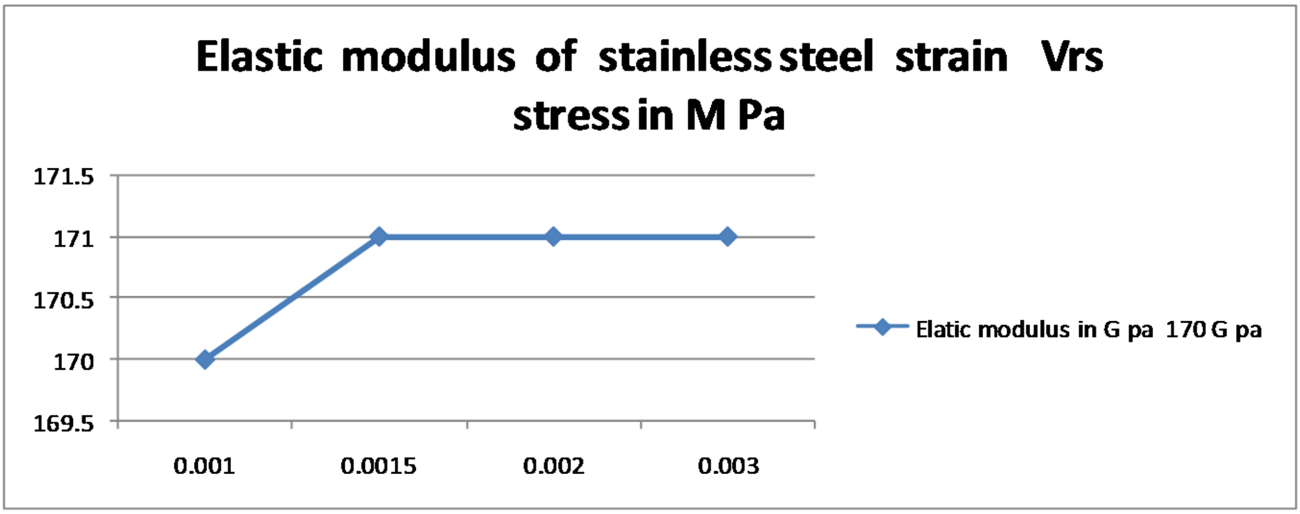
c) The cantilever beam subjected to a concentrated load of 100 KN at a distance of 2.0 m from the free end, length of the cantilever beam is 12.0 m and modulus of elasticity of stainless steel is 170 G Pa with a moment of inertia is 600000 cm^4

Input Information

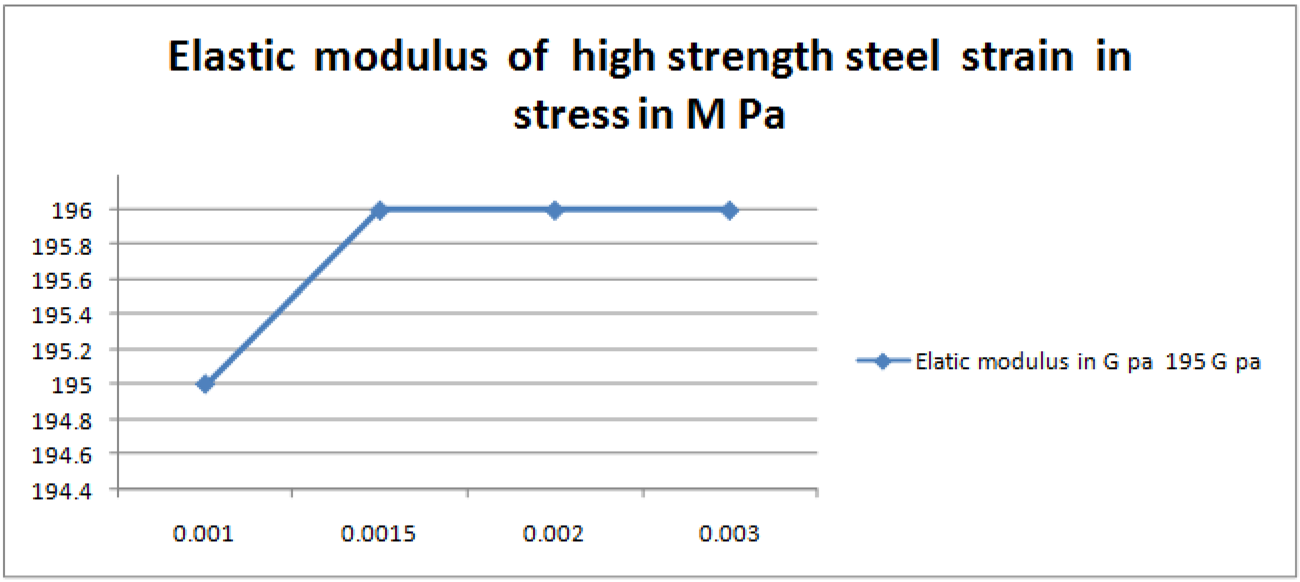
Length, L =	12.0	m
Elastic Modulus, E =	170	GPa
Moment of Inertia, I =	600000	cm^4
Load, P =	100	kN
Length, a =	2.0	m

II. EXPERIMENTAL DATA INTERPRETATION FOR ELASTIC MODULUS OF ELASTICITY

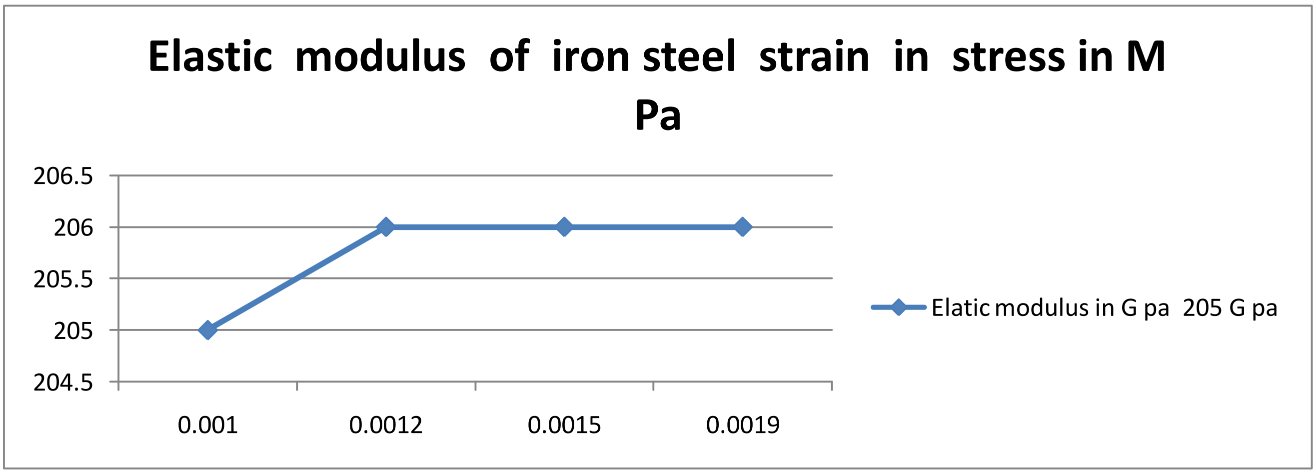
(a) *Elastic Modulus of Stainless Steel, Strain Vrs Stress*



(b) Elastic Modulus of High Strength Steel, Strain Vrs Stress



(c) Elastic Modulus of Iron, Strain Vrs Stress



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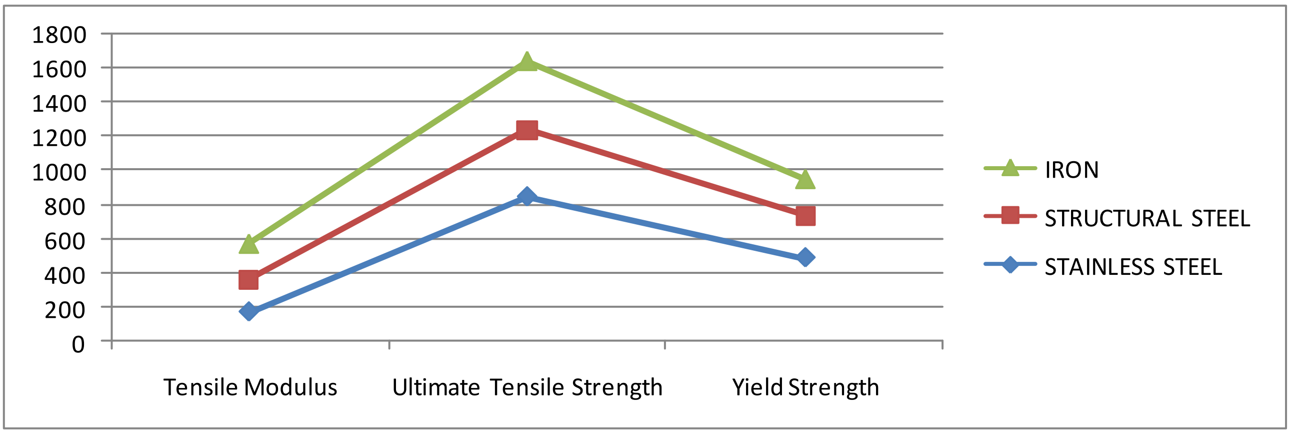
III. Comparison of Elastic Modulus Of Stainless Steel, Iron and High Strength Steel



IV. Materials Properties of Stainless Steel, Structural Steel and Iron

	Stainless Steel	Structural Steel	Iron
Tensile Modulus 10^9 *N/m*^{2,} ***G Pa***	170	195	205
Ultimate Tensile Strength 10^6 *N/m*^{2,} ***M Pa***	850	390	415
Yield Strength 10^6 *N/m*^{2,} **M Pa**	490	245	215

V. Computer Aided Formulation and Empirical Relation

A distributed load beginning with the value Wa at X= a and ending with the value WL at the end X=L , the shear ,moments and deflection are given below ;

$$Va(x,a,Wa ,WL) = RA – Wa < x\text{-}a >^1 -(WL – Wa)/2(L\text{-}a) < x\text{-}a>$$

$$Ma((x,a,Wa ,WL) = MA – RA\ x < x\text{-}a >^2 - (WL – Wa) /6(L\text{-}a) < x\text{-}a>$$

$$Yo ((x,a,Wa ,WL) = YA – \theta\ x +(MA^* X^2) /2EI +(RA^* X^2) /6\ EI – Wa/24EI < x\text{-}a >4 - (WL – Wa) /120EI (L\text{-}a) < x\text{-}a>^1$$

In which the constants are defined by boundary .

RA =0 , MA =0 and

$$\Theta A = Wa^*(L\text{-}a)^2 / 6EI + (WL\text{-}Wa)^* (L\text{-}a)^2 /24EI$$

$$YA = Wa^*(L\text{-}a)^3(3L+a) / 24EI + (WL\text{-}Wa)^* (L\text{-}a)^3(4L+a) /24EI$$

and the singularity functions are defined by

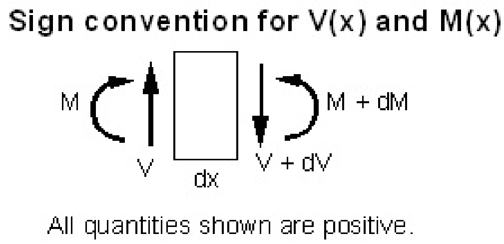
< x-a > n = < x-a > n when x = a
Or x > a And O , when x < a

The deflection of the beam caused by a loading extending from $x = a_1$ to $x = a_1 + a_2$ can be found by superposition

Y (X, Wa) = Y0 (x, a 1,Wa 1 ,W12) = Y0 (x ,a 1,Wa 2,WL12)

where the value of the load at the end of beam is found from similar triangles to be

w12 = W 1 + (W1- W2)* (L-a1) /a2



VI. Result and Discussion

A) Variation of Deflection of Cantilever Beam Using Stainless Steel, High Strength Steel and Iron

a) The deflection of the stainless steel was obtained based on the Roark analysis was -42.5mm at the 12.0m from the fixed end of the beam and the value reducing continuously to - 1.96mm at the distance 9.96m from the fixed l end of the steel beam .

b) The deflection of the high strength steel was obtained based on the Roark analysis was -37.07mm at the 12.0m from the fixed end of the beam and the value reducing continuously to - 1.66mm at the distance 9.96 m from the fixed l end of the steel beam .

c) The deflection of the iron steel l was obtained based on the Roark analysis was -35.23mm at the 12.0m from the fixed end of the beam and the value reducing continuously to - 1.58 mm at the distance 9.96m from the fixed l end of the steel beam .

d) It was observed as the higher elastic modulus , the deflection of the steel become reflected less and with the iron steel, -35.23 mm much more capacity in respect of deflection by roak's analysis.

e) It was observed as the elastic modulus of high strength steel and cast iron steel, the deflection of the steel become -35.23 mm in case of the cast iron compared to the -37.07 mm high strength steel by roak's analysis.

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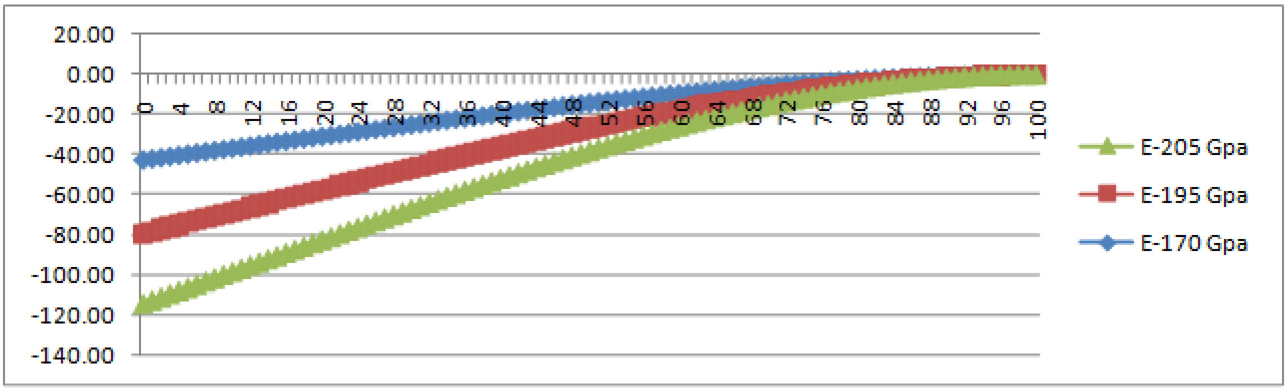
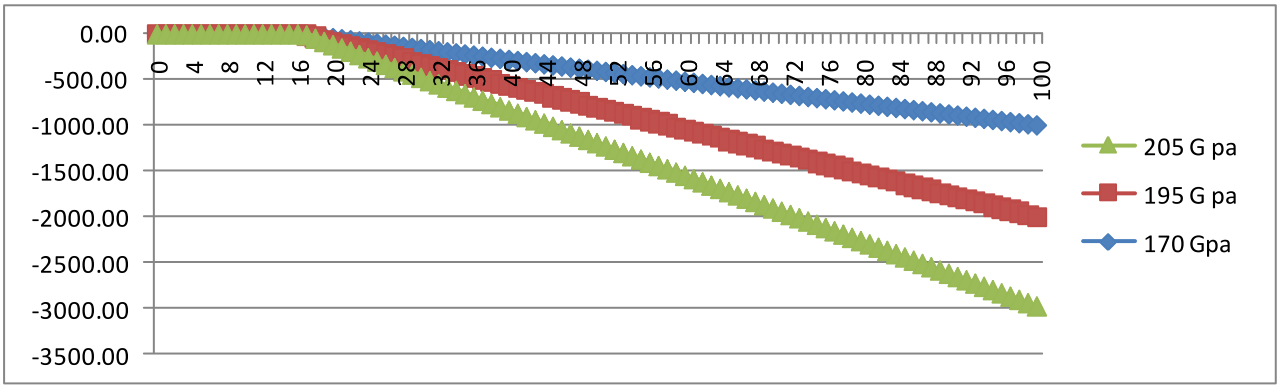


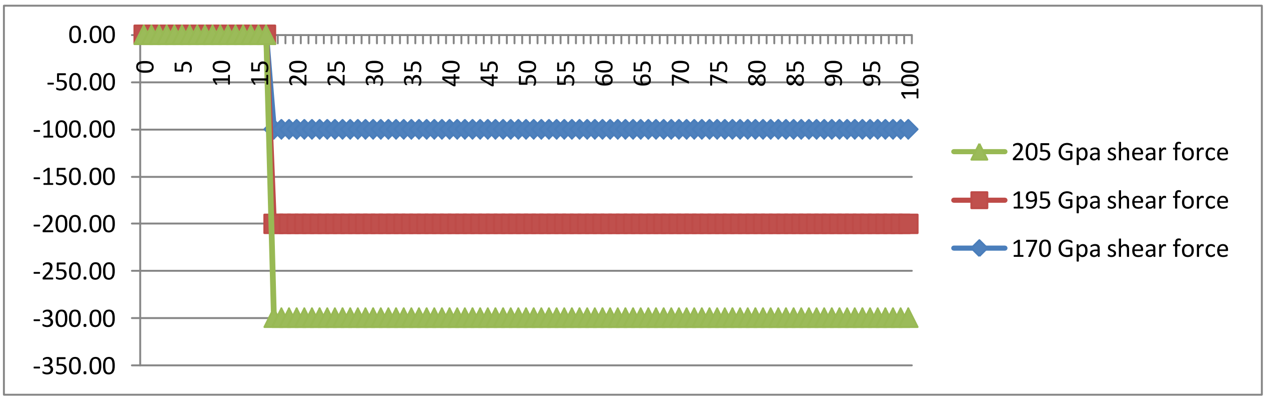
B) Variation of Moment of Cantilever Beam Using Stainless Steel, High Strength Steel and Iron

a) The moment of the stainless steel were obtained based on the Roark analysis -1000 KN m at the fixed end of the beam and the value reducing continuously till end of the steel beam.
b) The moment of the high strength steel were obtained based on the roark analysis -1000 KN m at the fixed end of the beam and the value reducing continuously till end of the steel beam .
c) The moment of the iron steel steel were obtained based on the Roark analysis -1000 KN m at the fixed end of the beam and the value reducing continuously till end of the steel beam.
d) It was observed as the higher elastic modulus, the moment of the steel does not have any change compared to the other type of the steel as observed through graphical representation of Roark's analysis.



C) Variation of Shear Force of Cantilever Beam Using Stainless Steel, High Strength Steel and Iron

a) The shear force of the stainless steel were obtained based on the Roark analysis -100 KN at the fixed end of the beam and the value reducing continuously till end of the steel beam.
b) The shear force of the high strength steel were obtained based on the Roark analysis -100 KN m at the fixed end of the beam and the value reducing continuously till end of the steel beam.



c) The shear force of the iron steel steel were obtained based on the Roark analysis -100 KN m at the fixed end of the beam and the value reducing continuously till end of the steel beam.
d) It was observed as the higher elastic modulus, the moment of the steel does not have any change compared to the other type of the steel as observed through graphical representation of Roark's analysis.

VII. Conclusions

a) The deflection of the stainless steel was obtained based on the Roark analysis was 20% more compared to iron steel at the 12.0m from the fixed end of the beam and the value reducing continuously to 30% more at the distance 9.96m from the fixed l end of the steel beam compared to iron steel .
b) The deflection of the high strength steel was obtained based on the Roark analysis was 5% at the 12.0m from the fixed end of the beam and the value reducing continuously to 10% at the distance 9.96m from the fixed l end of the steel beam compared to iron steel.
c) The deflection of the iron steel l was obtained based on the Roark analysis less compared to other type of steel. The mechanical properties of steel govern directly the deflection steel beam and the value reducing continuously to the fixed l end of the steel beam.
d) It was observed as the higher elastic modulus, the deflection of the steel become reflected less and and more capable to resist the deflection by roak's analysis.
e) It was observed as the elastic modulusof high strength steel and iron steel ,the deflection of the steel in case of the cast iron compared to the 5% less while using high strength steel by roak's analysis.
f) The moment for stainless steel, High strength steel and iron steel were obtained same at the fixed end of the beam and the value reducing continuously till end of the steel beam and is independent of elastic modulus of steel.
g) The shear for stainless steel, High strength steel and iron steel were obtained same at the fixed end of the beam and is independent of elastic modulus of steel.

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