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STUDY ON FATIGUE ANALYSIS OF AN I BEAM

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Abstract- In the field of civil engineering beams, girders, columns and other structural members facing cyclic loading, "fatigue" happens to be one of the most important threat and thus has been taken into consideration simultaneously throughout the technical development of the field. Due to fatigue the structural shape is hindered with passing of time and this causes safety concerns. In this research paper, the fatigue analysis of an I beam is carried out. The analysis is performed via software approach using Ansys Workbench. All the basic parameters have been taken into consideration.

Keywords: Fatigue, Ansys, Finite Element Method.

1. INTRODUCTION

It is noteworthy to find the material life relying upon the working conditions. Plan assumptions, material properties and loading conditions are powerful in deciding the material life. Almost ninety percent of structural damage occurring in structural elements are brought about by fatigue. As a rule, fatigue is the principle failure cause, comprising of commencement, engendering and last crack. Particularly in beam segments, the engendering stage possesses a significant piece of the components all out life. The procedures of casting, welding and machining may upgrade the essentialness of proliferation stage by starting little deformities that act as neighbourhood stress concentrators. These might be miniaturized scale voids, non-metallic incorporations, unpleasantness in surface, sudden changes in cross-area, extinguishing splits or pounding breaks.

Thus, factors for example, high temperature, consumption, excessive loading, residual stresses, stresses under combined loadings, stress concentrations consolidated loadings, surface quality and metallographic structure are viable in crack development. In parts exposed to cyclic loading, the quantity of cycles is more viable than the extent of the heap. The microstructure of the material displays changes because of continued loading. The harm may happen much underneath the static yield quality. Fatigue crack instigation has been concentrated in the past using stress–strain approaches have been generally acknowledged and used to anticipate the fatigue life of an indented part. The local stress–strain approaches by and large incorporate a pressure examination and a fatigue investigation. The fatigue examination is to decide the nearby stress by an inexact method, for example, the finite element method (FEM). The fatigue examination is directed by utilizing a fatigue damage standard dependent on the anxiety yield from the pressure investigation. Crack mechanics-based methodologies can be utilized to clarify the indent fatigue conduct dependent on a substantial physical contention. Be that as it may, there is no broadly acknowledged method for fatigue split development from an indent, particularly considering both close to limit small crack and large crack. Confirmation of the crack mechanics-based methodology for various materials and indent geometries is constrained.

2. METHODOLOGY

2.1 Finite Element Analysis

The fatigue analysis is performed using Ansys workbench software. First of all we provide the basic input data that is the cross section details of the I beam. Then we draw the basic sketch design and solid design of the beam using Ansys Design modeler.

For this study we have considered an I beam. Fatigue analysis is performed for cantilever as well as fixed support condition of beam.

Considered geometry of an I beam: The dimension considered for analysis is same for both fixed and cantilever beams analysis.

Table-2.1 Details of Solid View of the I Beam

Components	Dimension in mm
W1	200
W2	200
W3	400
t1	20
t2	20
t3	20

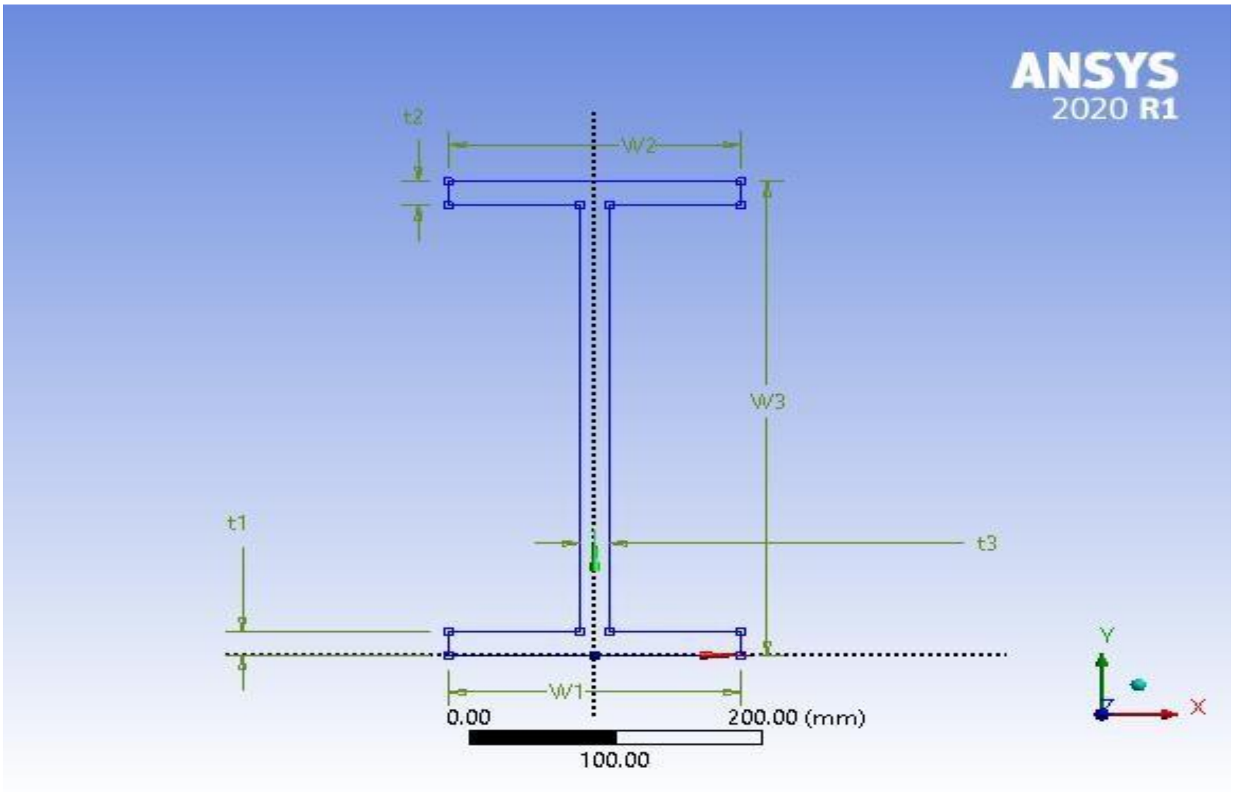

Fig. 2.1 Front View of I Beam

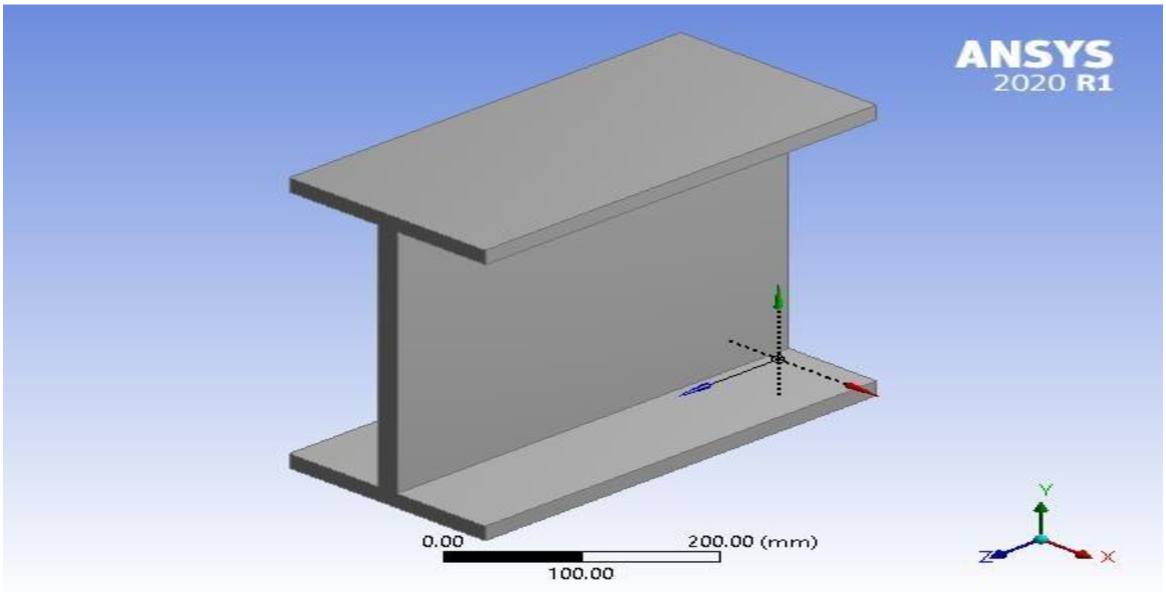

Fig. 2.2 Solid View of the I Beam

Table-2.2 Physical Properties

Bodies	1
Volume	6.08e+06 mm^3
Surface area	6.544e+05 mm^2
Faces	14
Edges	36
Vertices	24
A	15200 mm^2

Ixx	3.6683e+08 mm^4
Ixy	-8.4703e-10 mm^4
Iyy	2.6907e+07 mm^4
Iw	9.5771e+11 mm^6
J	2.081e+06 mm^4
CGx	0
CGy	200 mm
SHx	0.014226 mm
SHy	200 mm

2.2 Analysis

The fatigue analysis will be performed in the Mechanical tool of Ansys workbench software. Following are the steps required to perform the respective analysis:

I. Mesh

II. Static structural

- ➢ Introducing Supports in the beam
- Applying Forces in the beam

III. Solution

- Total Deformation
- Equivalent Stress
- Fatigue tool
- Safety Factor

2.2.1 Mesh

In the mesh analysis the span angle center has been changed to fine and the smoothing has been adjusted to high. Below is image showing meshing for both cantilever and fixed beams.

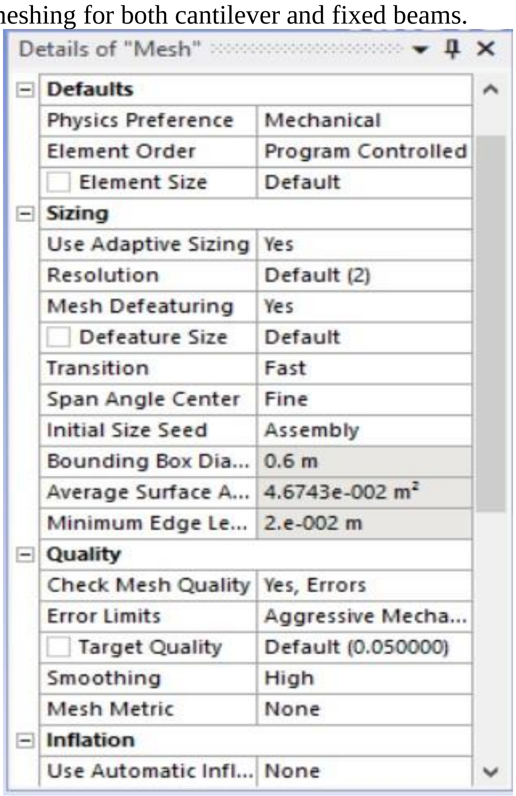

Fig. 2.3 Meshing for both Cantilever and fixed Beams

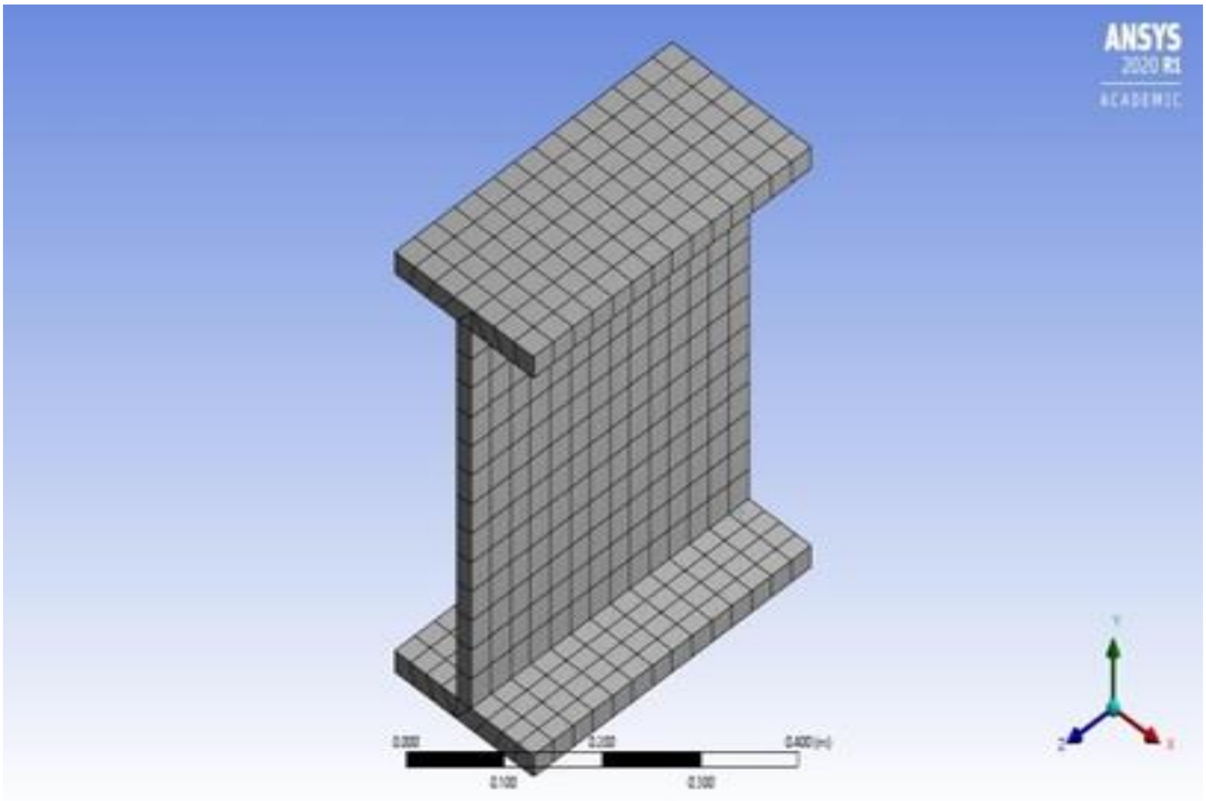

Fig. 2.4 View of the I Beam

2.2.2 Static Structural

2.2.2.1 Introducing Supports

In the static structural analysis, for steel beam fixed support have been introduced at one end for cantilever condition and at both ends for Fixed condition.

2.2.2.2 Application of Forces

The beam has been subjected to force at one end for cantilever condition and for fixed condition the force is applied at top flange. The intensity of force kept is -2000N at Y axis.
Below are the images showing the application of forces and supports for both cantilever and fixed condition of the I beam.

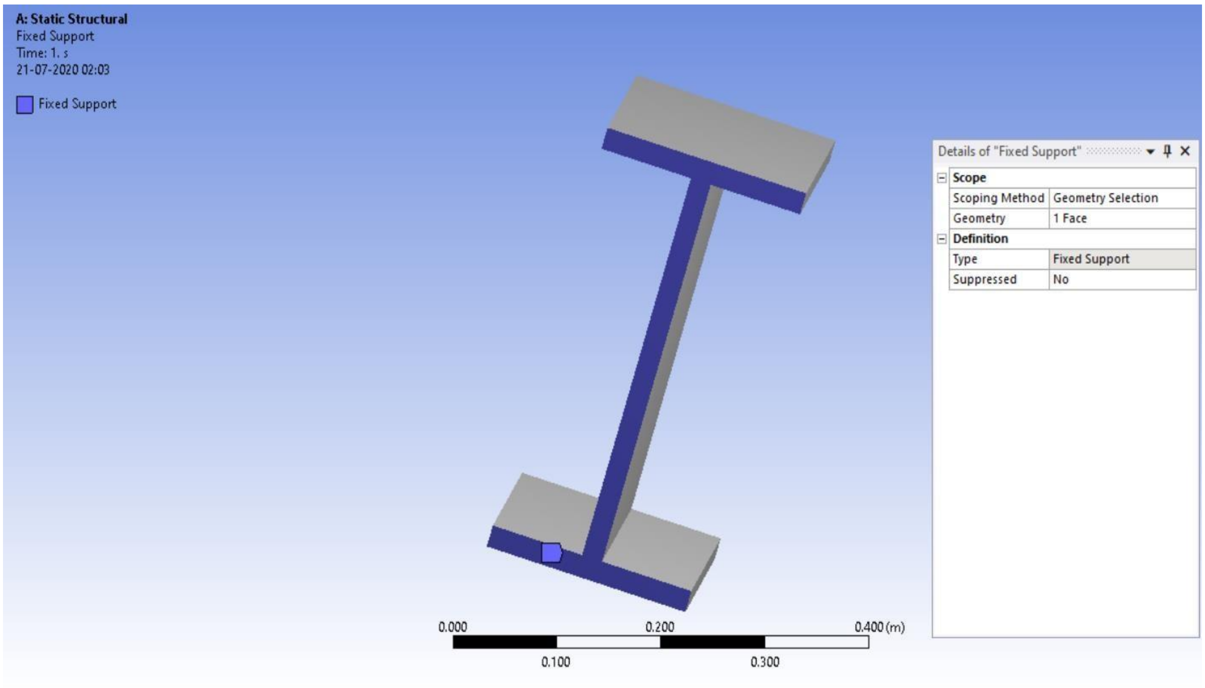

Fig. 2.5 Support at One End for Cantilever Steel Beam

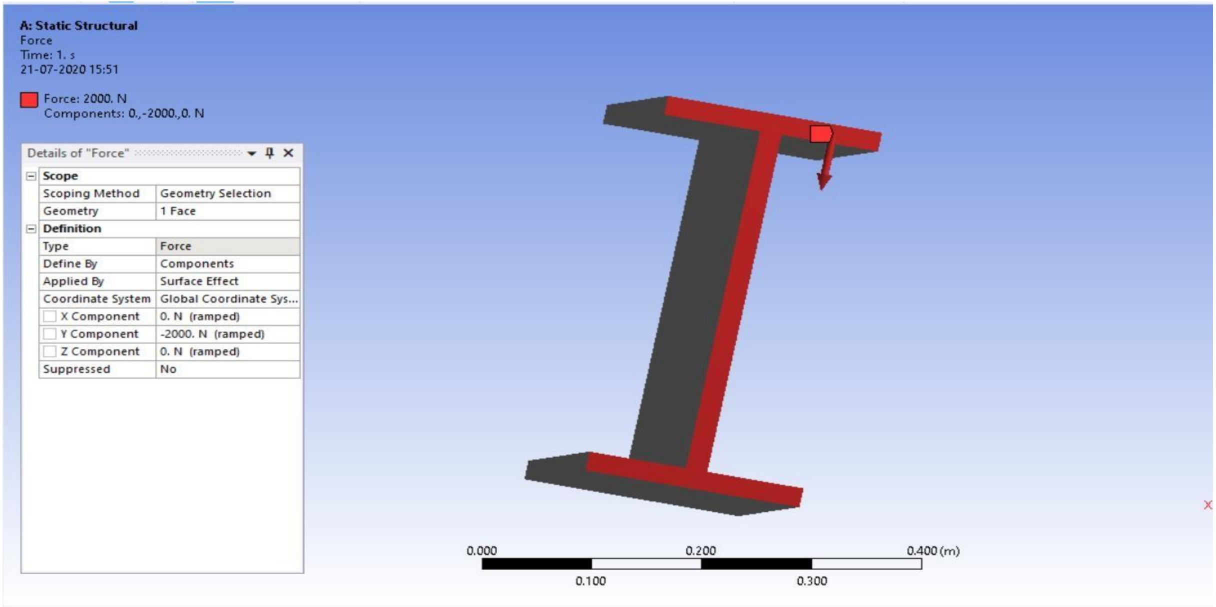

Fig. 2.6 Force at Cantilever Beam

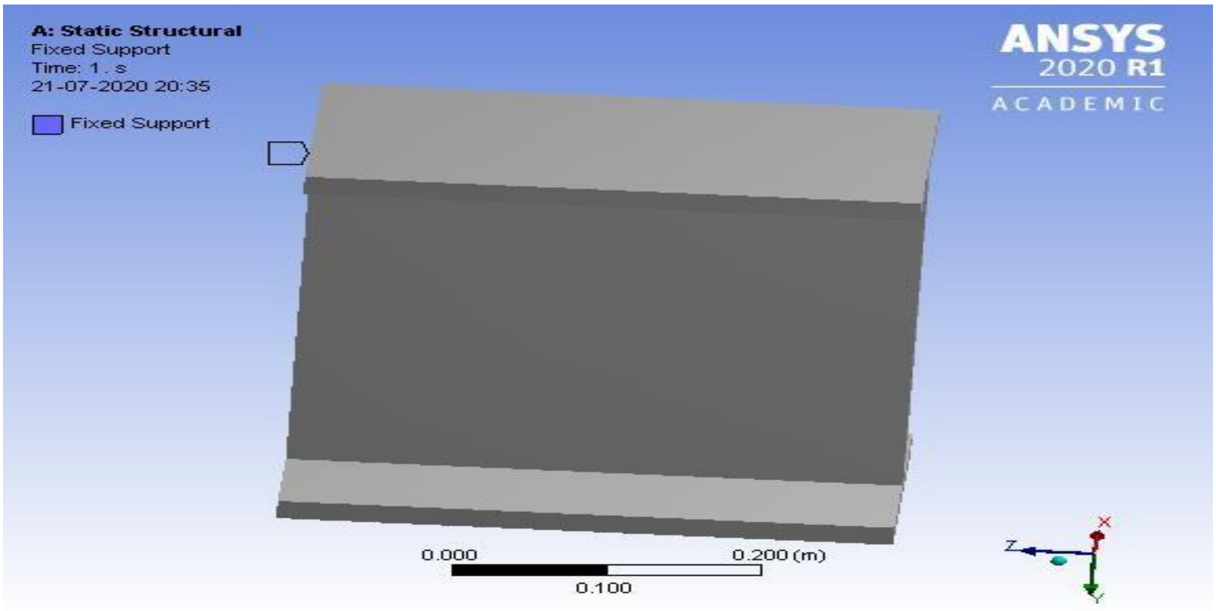

Fig. 2.7 Support at Fixed Beam

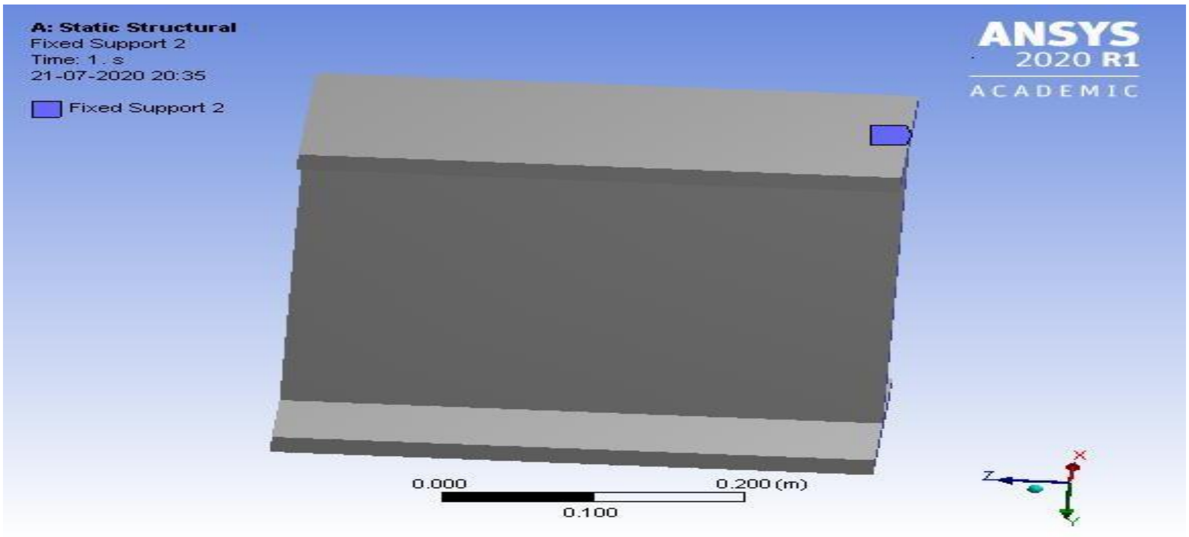

Fig. 2.8 Support at Fixed Beam

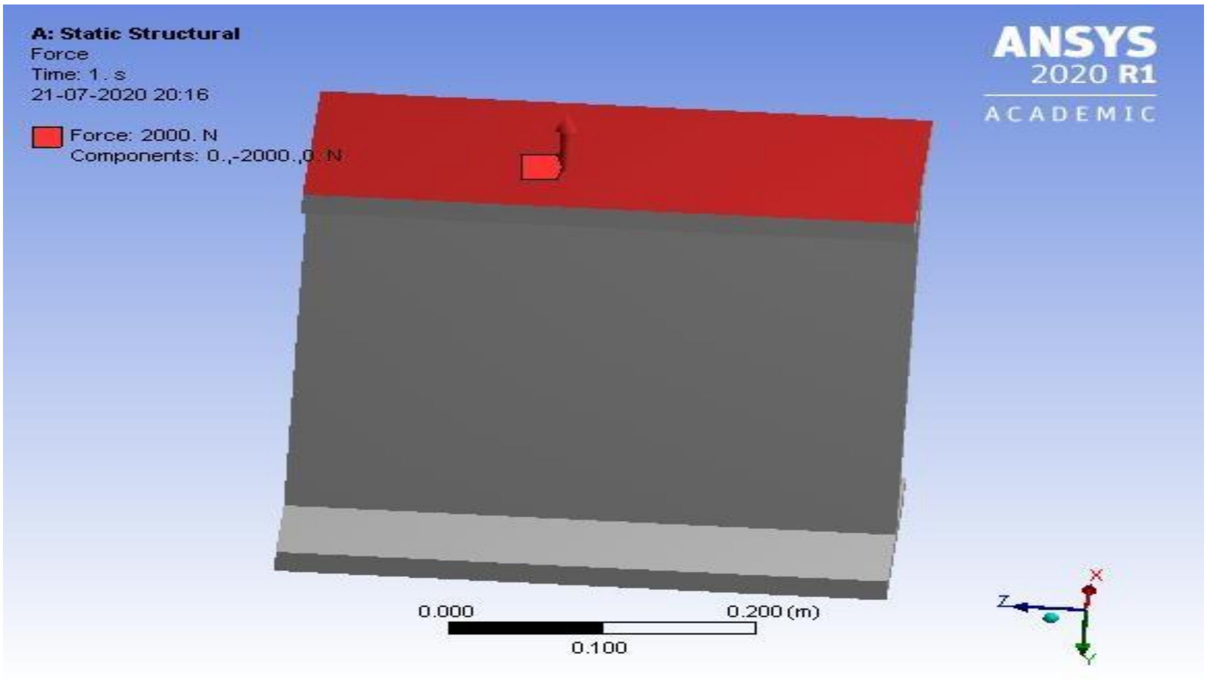

Fig. 2.9 Applied Force at Fixed Beam

2.3 Solution

2.3.1 Total Deformation

The total deformation under applied force is shown in this option. Below are the figures showing total deformation for cantilever and fixed beam.

Table-2.3 Total Deformation for Cantilever

Minimum	0.m
Maximum	5.0194e-006 m
Average	1.0762e-006 m

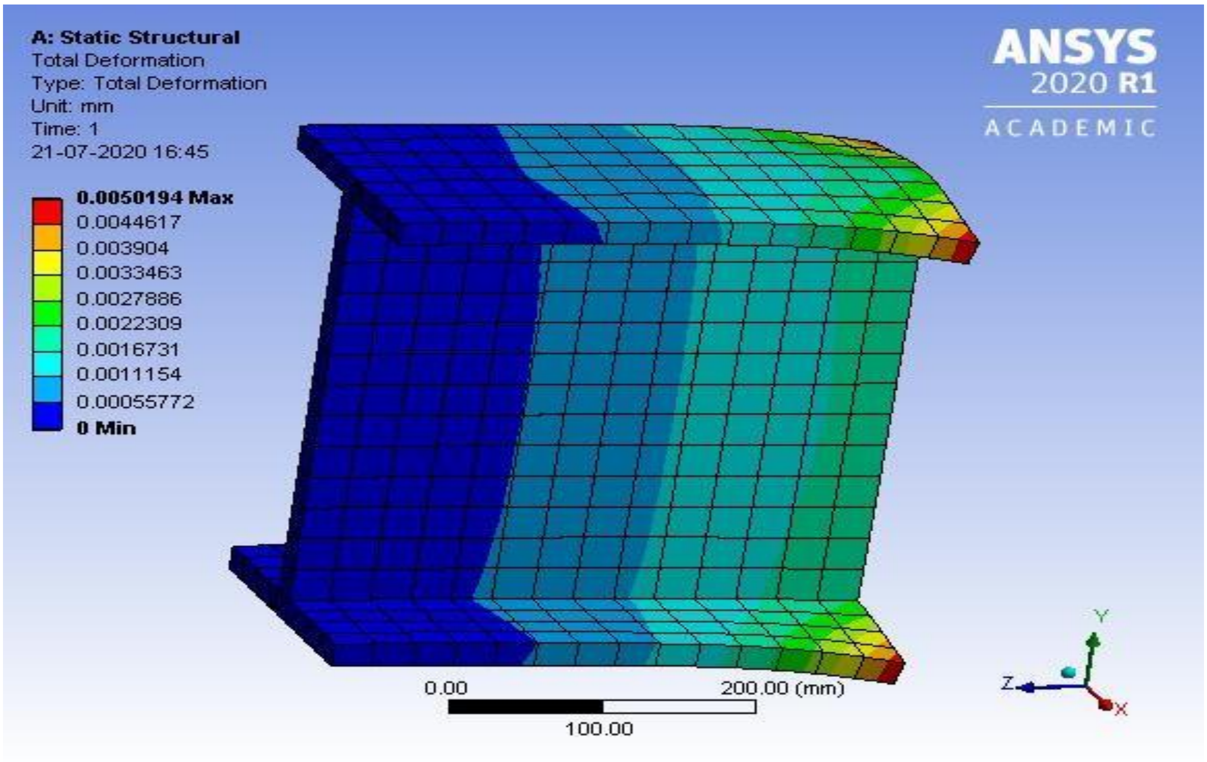

Fig. 2.10 Total Deformation for Cantilever Beam

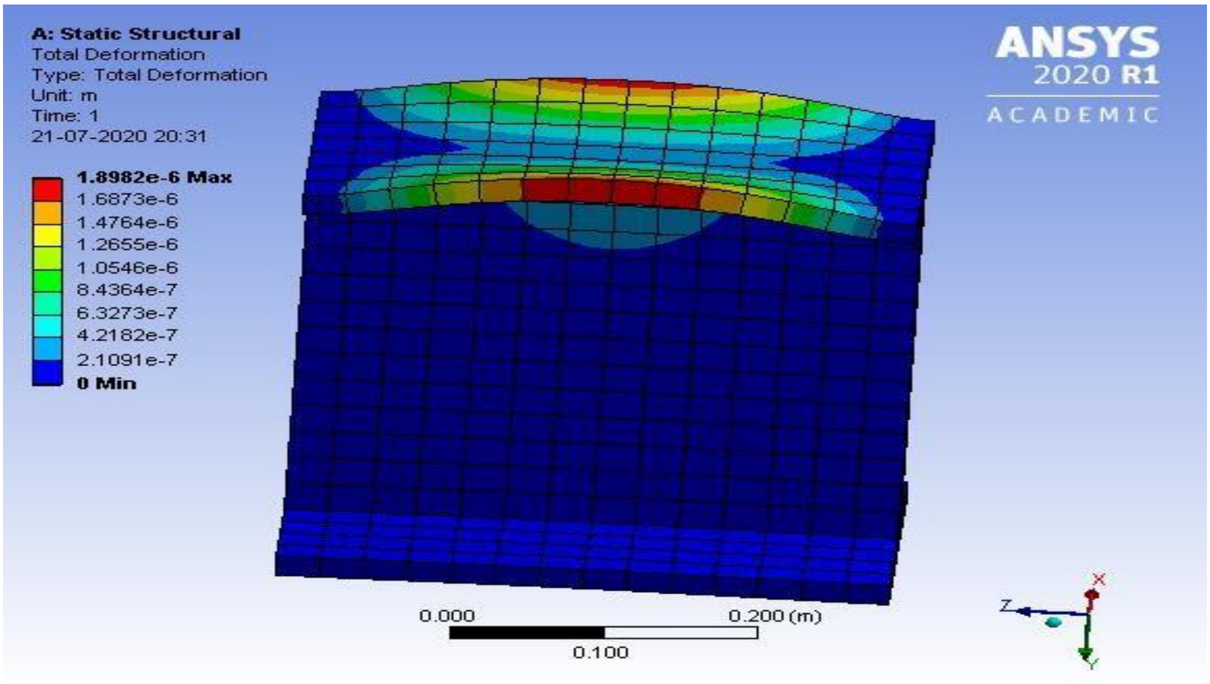

Fig. 2.11 Total Deformation for Fixed Beam

Table-2.4 Total Deformation for Fixed Beam

Minimum	0.m
Maximum	1.8982e-006 m
Average	2.2307e-007 m

2.3.2 Equivalent Stress

Equivalent stress for cantilever and fixed beam is shown below:

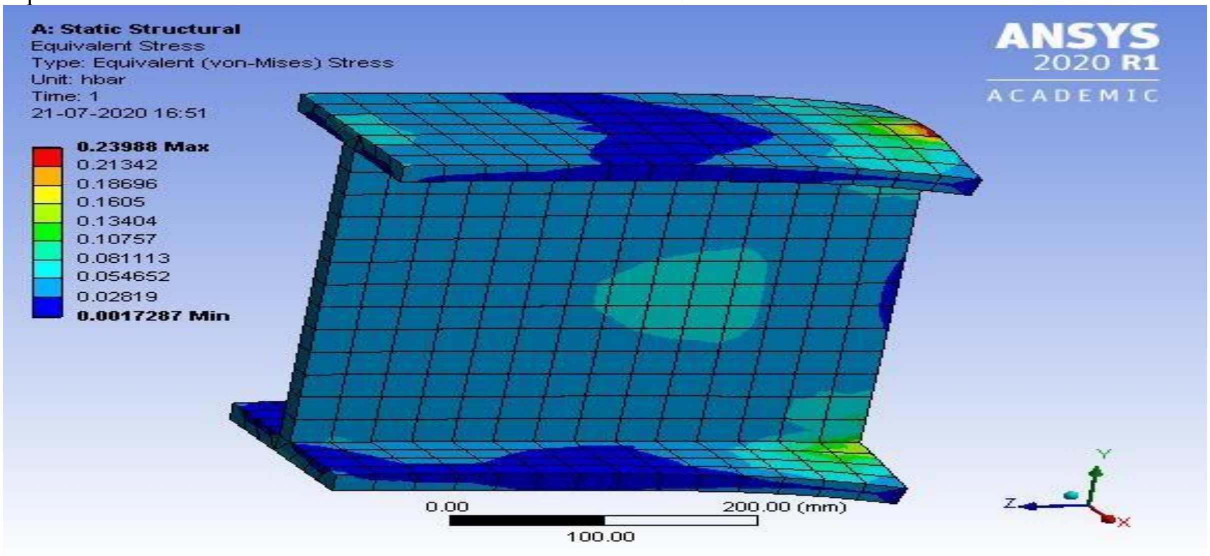

Fig. 2.12 Equivalent Stress for Cantilever Beam

Table-2.5 Result of Equivalent Stress for Cantilever I Beam

Minimum	17287 Pa
Maximum	2.3988e+006 Pa
Average	4.4628e+005 Pa

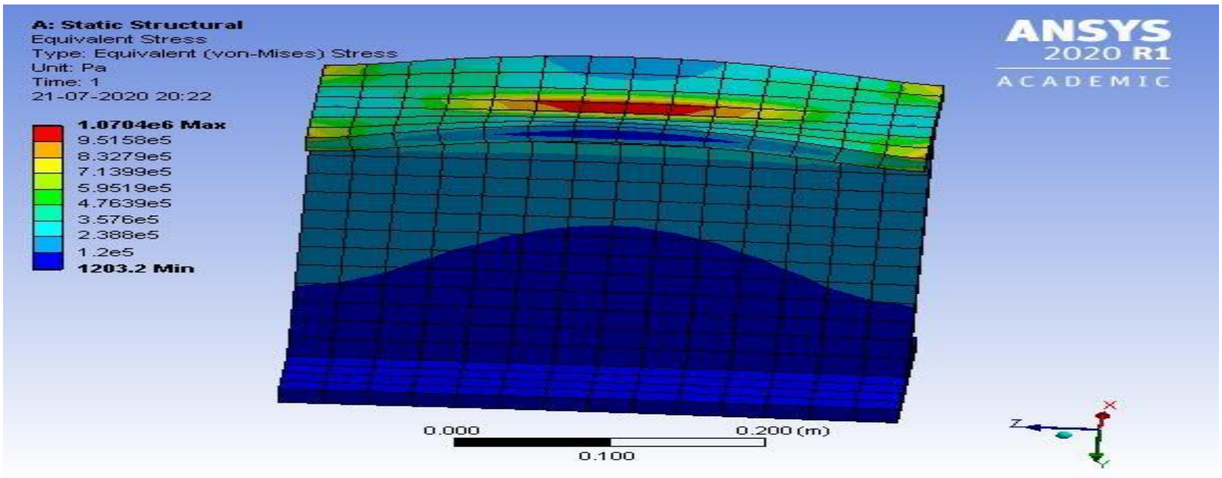

Fig. 2.13 Equivalent Stress for Fixed Beam

Table-2.6 Result of Equivalent Stress for Cantilever I Beam

Minimum	1203.2 Pa
Maximum	1.0704e+006 Pa
Average	1.7965e+005 Pa

2.3.3 Fatigue Tool

The solution of fatigue analysis is shown below for both cantilever and fixed beam:

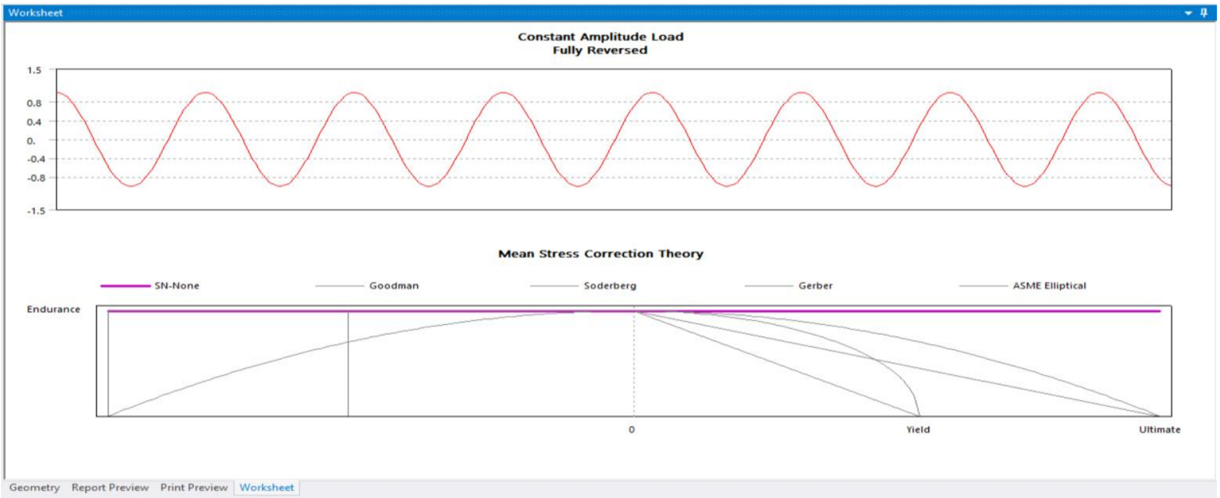

Fig. 2.14 Fatigue Analysis Tool for Cantilever

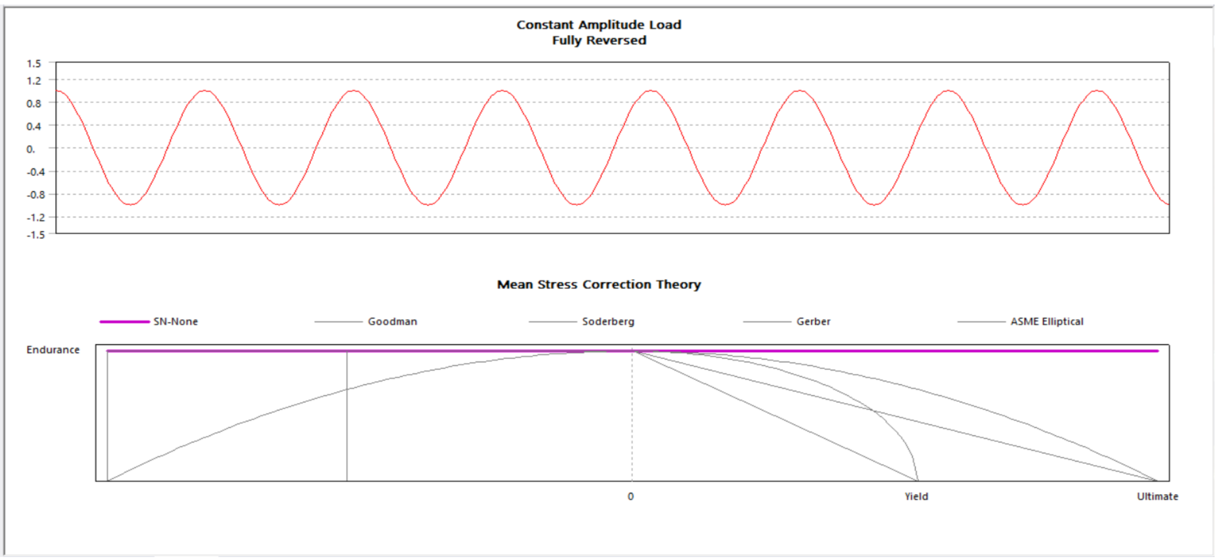

Fig. 2.15 Fatigue Tool for Fixed Beam

Finally, we successfully analyse the I beam for both cantilever and fixed conditions. The above figure shows various results during the analysis.

CONCLUSION

Fatigue Analysis of an I beam of steel material is studied. The fatigue analysis is conducted with the help of Ansys Workbench fatigue module. To find design life , various factors are considered: support type, fatigue tool, fatigue factor of safety ,total deformation and equivalent stress. The maximum deflection and the equivalent stress, and minimum factor of safety occurred at end of the beam for cantilever condition and at top of the beam for fixed condition.

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