RESEARCHERID
THOMSON REUTERS
[Ramdeen et al., 5(8), Aug 2020]

ISSN : 2455-9679
Impact Factor : 3.340

ijrtsm

IJRTSM

INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY SCIENCE & MANAGEMENT

"STATIC STRUCTURAL BUCKLING ANALYSIS ON I SECTION STEEL BEAM BY USING FEA METHOD"

Ramdeen Tyagi [1]***, Arun Pandey*** [2]***, Renu Bala Goswami*** [3]

[1] *M.Tech Research Scholar, Department of Civil Engineering, P K university, Shivpuri, Madhya Pradesh, India.*
[2] *Assistant Professor, Department of Civil Engineering, P K university, Shivpuri, Madhya Pradesh, India.*
[3]*Head of Engineering, P K university, Shivpuri, Madhya Pradesh, India.*
ramdieentyagi@gmail.com

ABSTRACT

In Beam, buckling is the sudden change in shape of a structural component under load such as the bowing of a column under compression or the wrinkling of a plate under shear. The similitude when displaying with 1D component and 3D component is that they can create a similar outcome boundaries.1D component will give a much sort out outcome however less detail which require less exertion in the understanding of results. 3D FEA outcomes are shown as tensor, which give more subtleties to each area of the structure yet additionally require more exertion to decipher the outcomes. Other than strategy for displaying and use of burden and limit conditions, 1D component and 3D component likewise contrast as far as twisting of the structure. 1D component gives an unpleasant thought of how the structure will distort when burden is applied. While 3D component gives the best knowledge to the disfigurement of structure. In light of the preferences and constraints, three variables are to be viewed as when choosing the sorts of components to use in FEA, which are the calculation of the structure, wanted outcomes, and time period just as the ability of the PC. The most significant factor is the calculation of the structure. 1D FEA require the least memory and the quickest to finish while 3D FEA require the most memory and slowest to finish. In this project ANSYS software used for FEA tools and modeling purpose CATIA software used and find out beam analysis.

Key Words: *ANSYS, CATIA, Beam. Buckling , Deformation , Shear Stress, Bending Stress*

I. INTRODUCTION

Buckling is a mathematical instability, leading to a failure mode. The formal meaning of the notion is found in engineering and sciences, regarding stability of systems. Theoretically, for a structural system, buckling is caused by a bifurcation in the solution to the equations of static equilibrium. In practice, buckling is characterized by a sudden failure of a structural member under a compressive stress, which is less than the ultimate compressive stress that the material is capable of withstanding. Failure occurs in a distinct, most of the times unpredictable, direction compared to the direction of the applied load. A structural member under compression, at any level, is always prone to failure via buckling. Although the stability of bars was first studied over 250 years ago by Euler [1], adequate solutions are still not available for many problems in structural stability. So much has been and is being studied and written in the field of structural stability, a question arise that why, after such intellectual and financial efforts, there are no definite solutions to these problems. Determination of the collapse load of stability, is one of the most sensitive problems of structural design. This is due to the following factors. (a) The loss of stability depends on numerous factors, some of which are very difficult to control. (b) Instability occurs in a region with both strong geometrical and material nonlinearities. (c) The significance of the effect of imperfections on the stability. (d) Checking, the buckling resistance of structures experimentally is very difficult, because it is impossible to test the actual structure just until it collapse. In spite of extensive efforts, in the last seven decades, the problem of buckling analysis is not ended. This can be easily observed, from the considerable number of theses and reports on the buckling analysis of steel beams and columns in the last decade [2–7]. Several selected references are reviewed here.a structure.

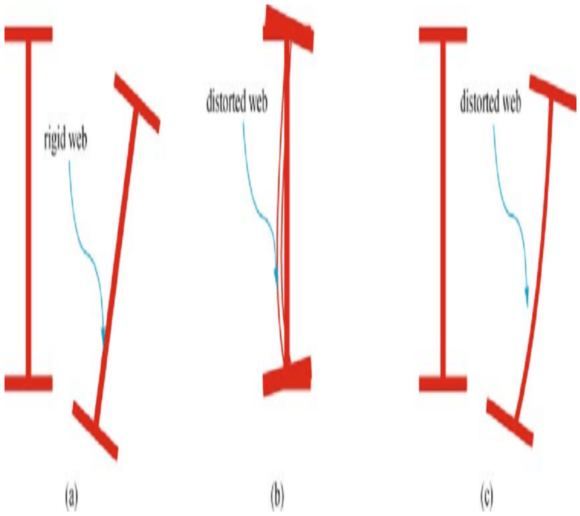

Fig. 1.1. Axial Loading on Column & Beam

II. FAILURE OF BEAM

Flexural disappointment happens when the bar comes up short in bowing. Or on the other hand you can say then when the horizontal burdens on the bar increment past its breaking point then this sort of disappointment happens. In any case, these are one of the least happening disappointment in steel structure and it is on the grounds that we have a straight-forward recipe and we have to see what segment will fulfill the measures. Yet, there is one more significant disappointment of shafts. Disappointment because of sidelong torsional clasping. The pictures above shows how the parallel torsional clasping resembles. Why this occurs? The explanation is, this sort of disappointment happens when the pressure rib of the pillar isn't controlled. At the point when we apply load on a bar we expect that the heap is applied precisely at the focal point of the bar, yet it isn't so in genuine situation. The heaps are available on the floor and there consistently in a capriciousness of the heap, this unpredictability prompts a contorting second and on the grounds that the rib of the shaft isn't fixed, the bar bends just as moves along the side. We ought not be stressed over this disappointment when there is a solid deck appended immovably to the bar with the utilization of shear studs. Be that as it may, in the event of a cantilever bar, this condition ought to consistently be checked in light of the fact that a 7 or 8 feet cantilever shaft for the most part flops in this condition in light of the fact that the pressure spine of the cantilever pillar isn't propped with the utilization of anything.

Fig.2.1 I-beam crack

2.1 Failure in compression

Failure in compression has been discussed in one of the blogs previously. It is much more important because buildings have "Columns".

Fig. 2.2 beam compression failure

2.2 Local failure

Suppose if your member is very strong and it cannot fail at global level like tension or compression or bending or anything. But then if the forces exceeds from a certain limit, then it can lead to some local failure. One of the most common local failure is local buckling of I sections. When the stresses exceed but not enough to fail the member completely then there occurs a local failure called local buckling of beams. In this failure there are high local stresses developed at imperfect locations of the member. This local members cause the beam to show some unorthodox behaviour and fails in certain region. This causes a reduction in the stiffness of the member but it can still carry load. This kind of failure is a very good failure as it gives an indication that the structure should either be repaired or it should be demolished. In the next blog we will talk something about designing. How should we design the structural elements.

Fig.2.3 I beam Local failure

III. METHODOLOGY

Stage 1: Aggregation data and information related to cooling adjusts of IC engines.

Step 2: A completely parametric model of the engine square with cutting edge is made in ANSYS and CATIA programming structure pack.

Stage 3: Model acquired in Step an attempt of is dissected utilizing ANSYS 19.2 (Workbench),to get the warmth or warmth rate, warm angle and nodal temperatures.

Stage 4: Manual counts are finished.

Stage 5: Finally, we will in general will in general check the outcomes and manual estimations for totally unique material, shapes

IV. SIMULATION & MODELING

4.1 WIDE FLANGE BEAM WITH 500 MM MODELING AND 1 D SIMULATION

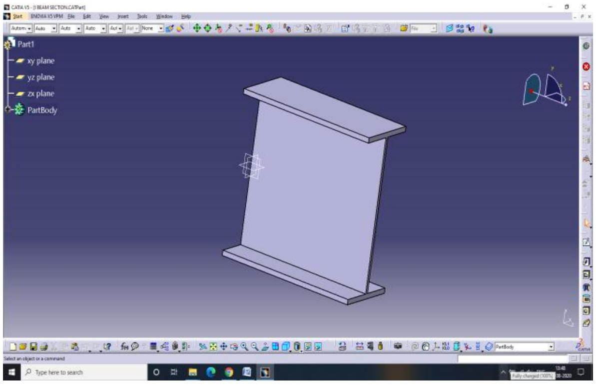

Fig. 4.1 wide flange beam with 500 mm modeling on CATIA for 3 D Simulation

ISSN : 2455-9679
Impact Factor : 3.340

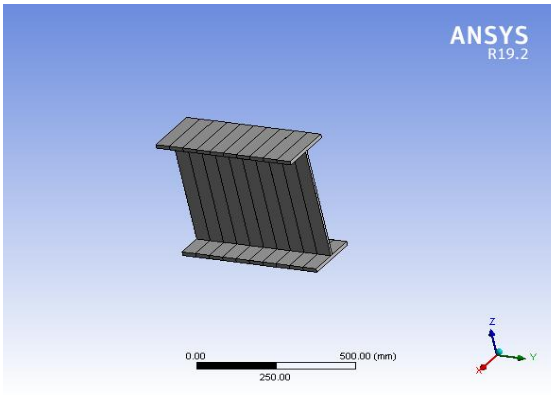

Fig. 4.2 wide flange beam with 500 mm meshing on ANSYS

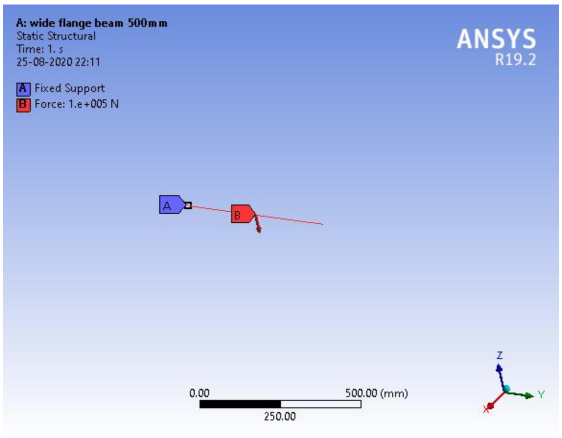

Fig. 4.3 wide flange beam with 500 mm fixed support and force support applied 100KN

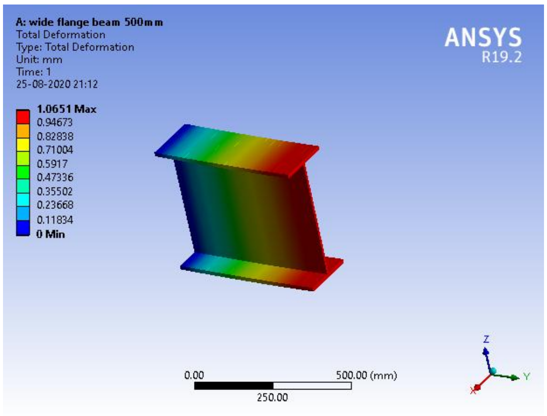

Fig. 4.4 wide flange beam with 500 mm total deformation 1 D simulation results

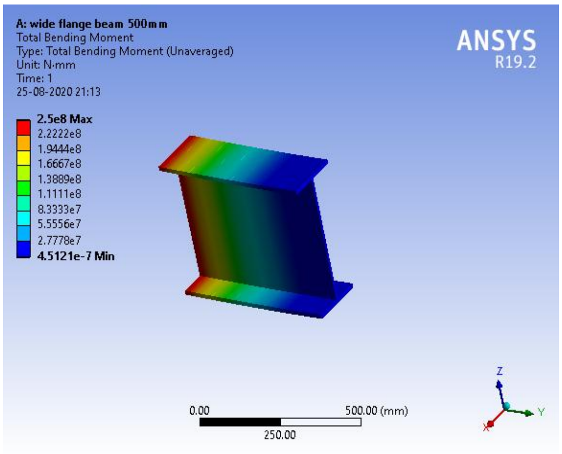

Fig. 4.5 wide flange beam with 500 mm bending moment 1 D simulation results

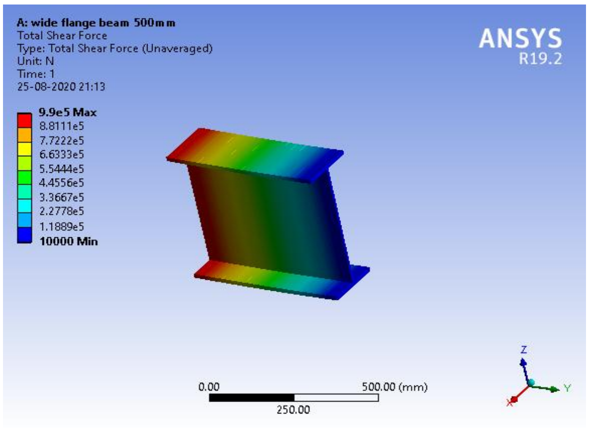

Fig. 4.6 wide flange beam with 500 mm shear force 1 D simulation results

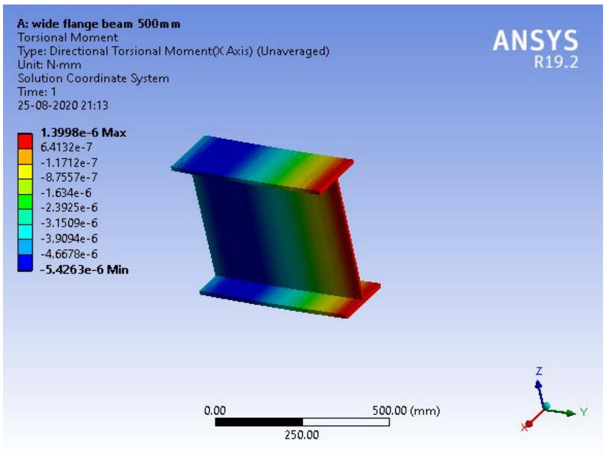

Fig. 4.7 wide flange beam with 500 mm torque 1 D simulation results

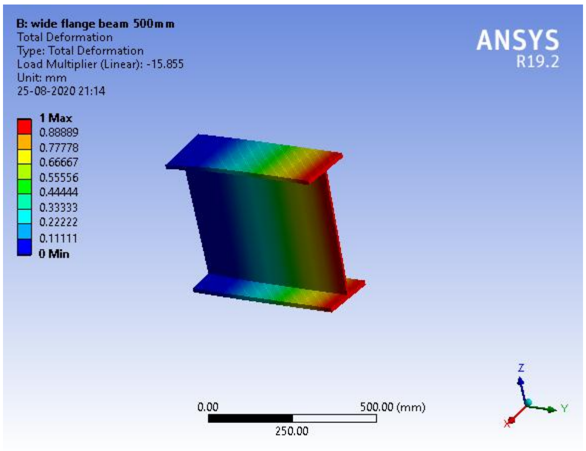

Fig. 4.8 wide flange beam with 500 mm Buckling 1 D simulation results

4.2 WIDE FLANGE BEAM WITH 500 MM 3D SIMULATION

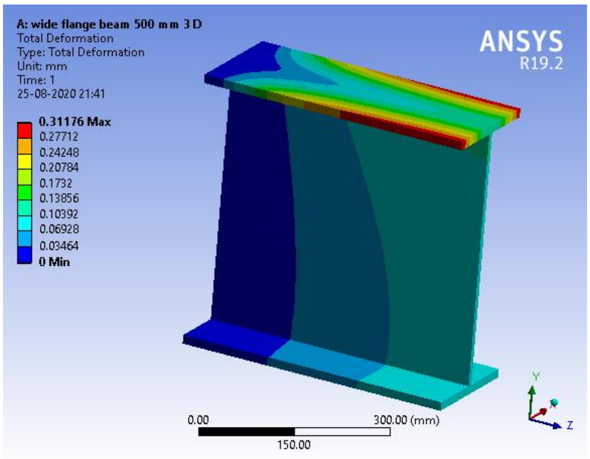

Fig. 4.9 wide flange beam with 500 mm deformation result

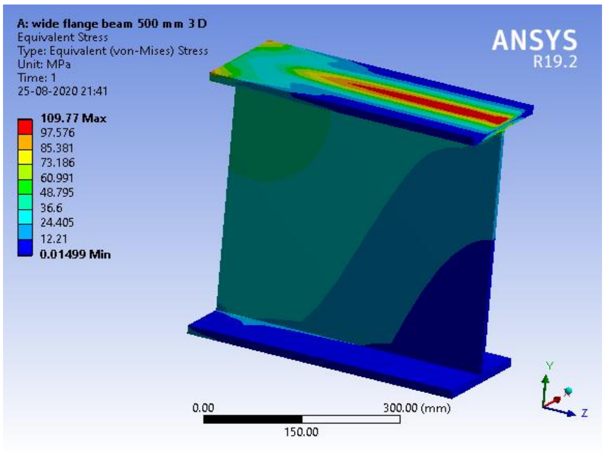

Fig. 4.10 wide flange beam with 500 mm von misses stress result

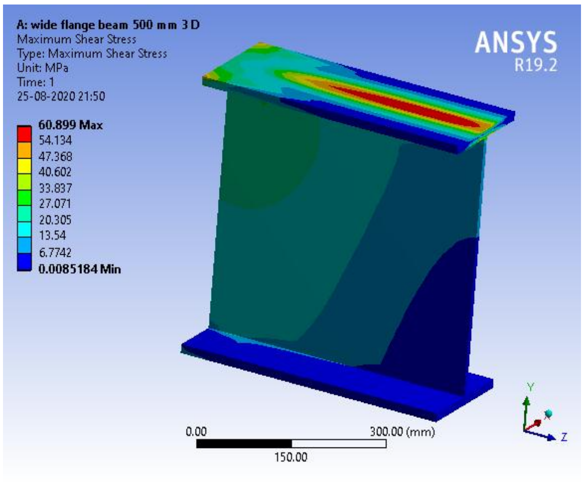

Fig. 4.11 wide flange beam with 500 mm shear stress result

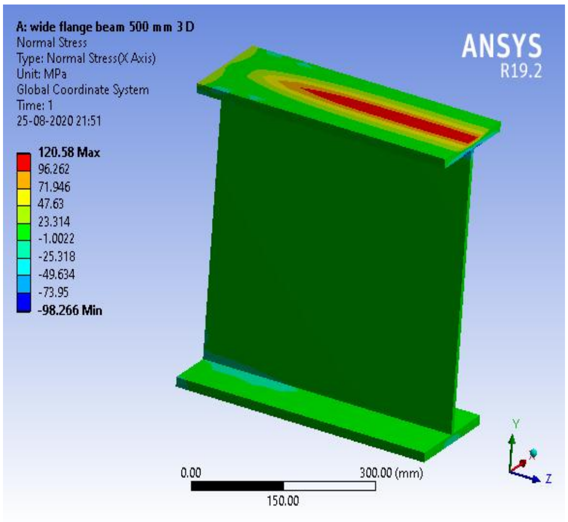

Fig. 4.12 wide flange beam with 500 mm bending stress result

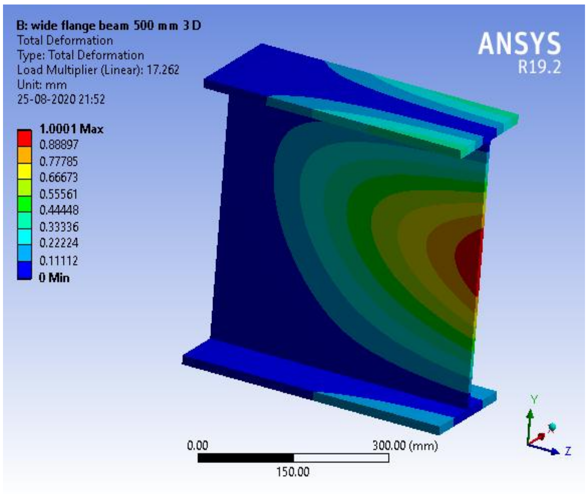

Fig. 4.13 wide flange beam with 500 mm buckling result

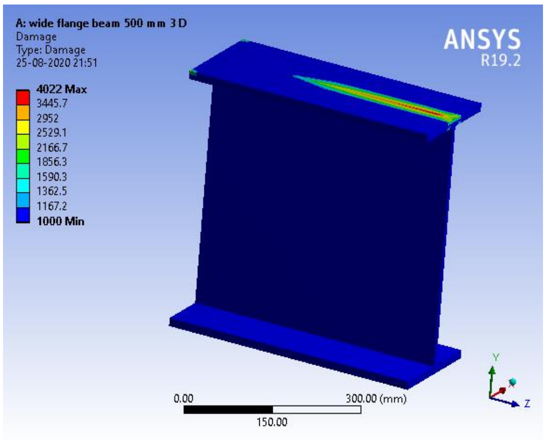

Fig. 4.14 wide flange beam with 500 mm damage result

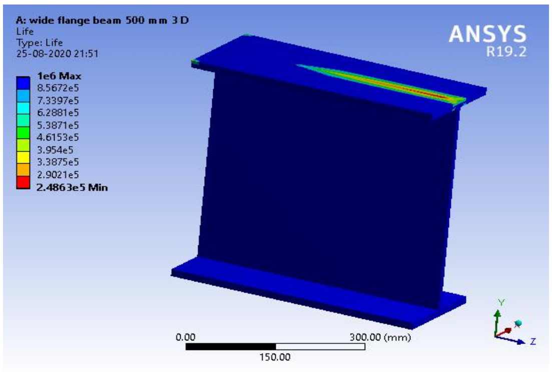

Fig. 4.15 wide flange beam with 500 mm life result

4.3 WIDE FLANGE BEAM WITH 3500 MM 1D SIMULATION

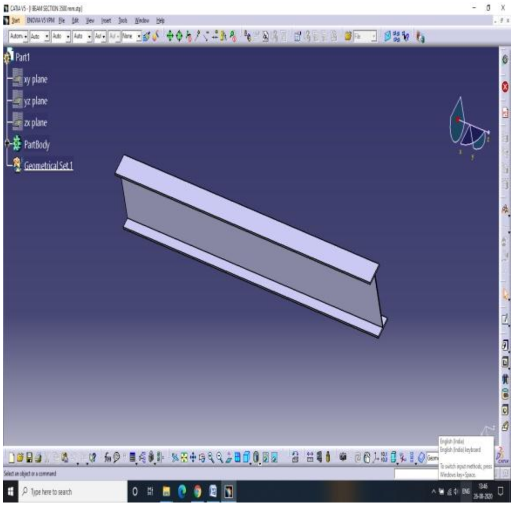

Fig. 4.16 wide flange beam with 3500 mm modeling on CATIA for 3 D Simulation

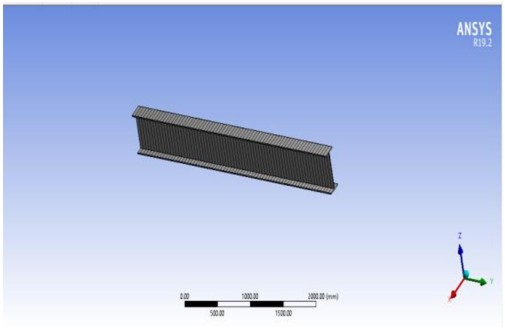

Fig. 4.17 wide flange beam with 500 mm meshing on ANSYS

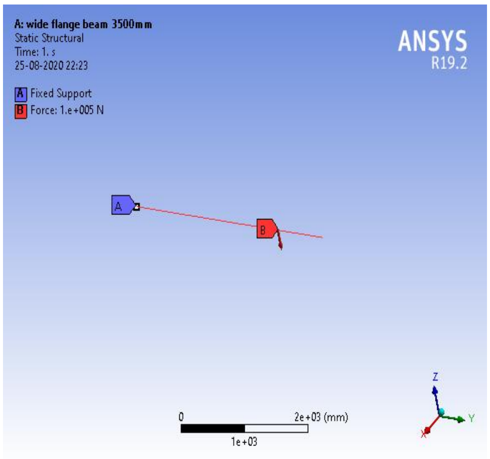

Fig. 4.18 wide flange beam with 3500 mm fixed support and force support applied 100KN

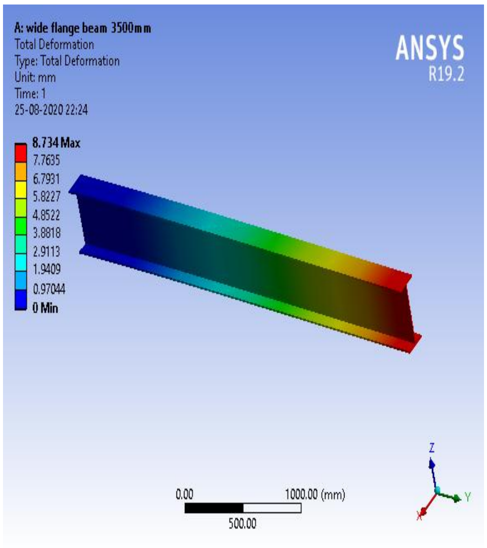

Fig. 4.19 wide flange beam with 3500 mm total deformation 1 D simulation results

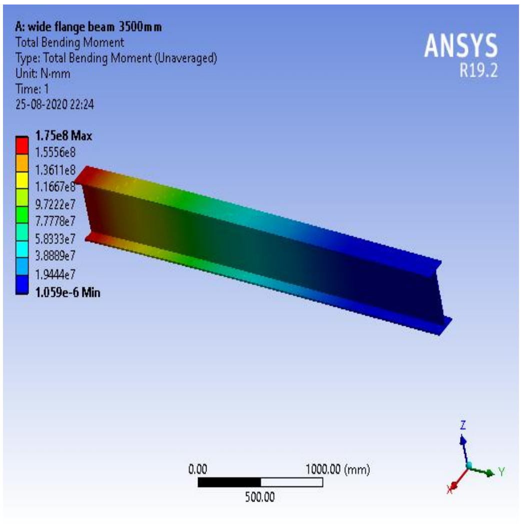

Fig. 4.20 wide flange beam with 500 mm bending moment 1 D simulation

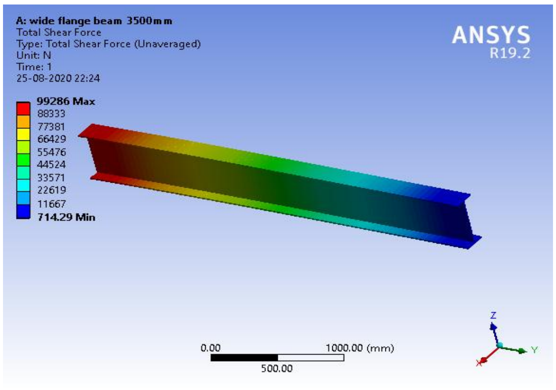

Fig. 4.21 wide flange beam with 500 mm shear force 1 D simulation results

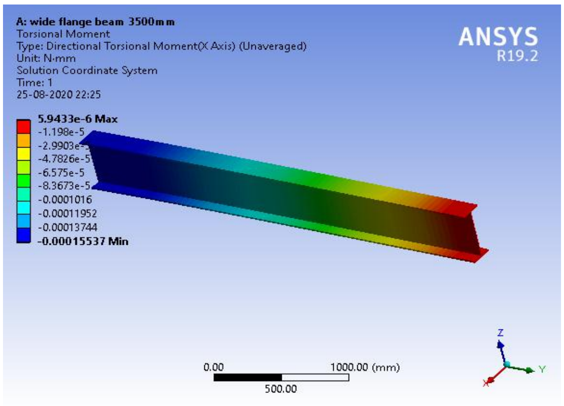

Fig. 4.22 wide flange beam with 3500 mm torque 1 D simulation results

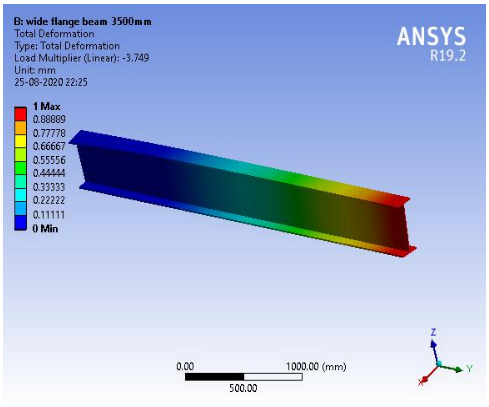

Fig. 4.23 wide flange beam with 3500 mm Buckling 1 D simulation results

4.4 WIDE FLANGE BEAM WITH 3500 MM 3D SIMULATION

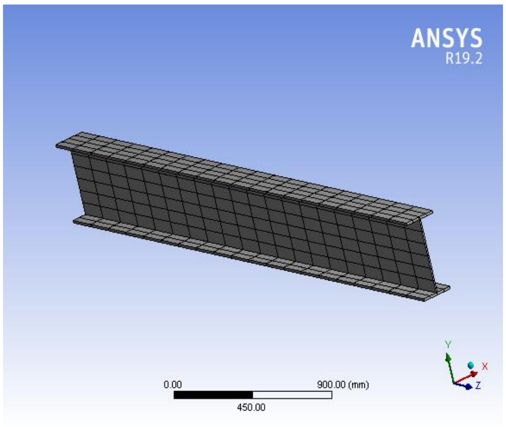

Fig. 4.24 wide flange beam with 3500 mm meshing on ANSYS

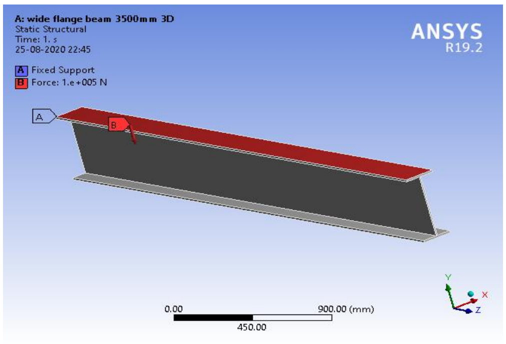

Fig. 4.25 wide flange beam with 3500 mm applied all boundary condition applied

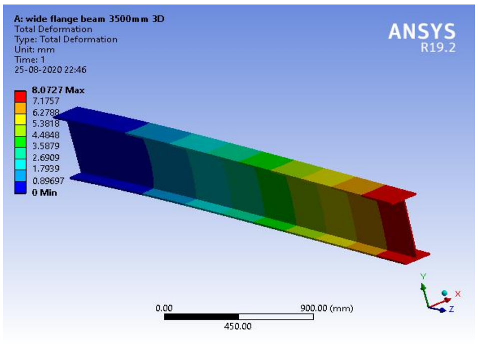

Fig. 4.26 wide flange beam with 3500 mm deformation result

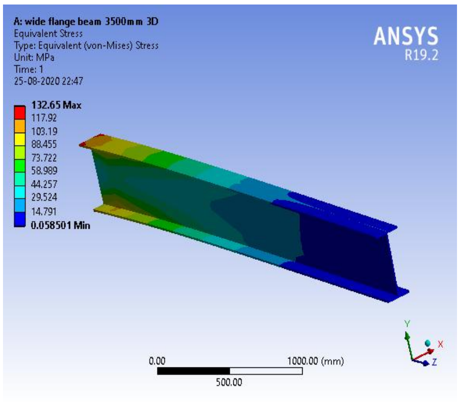

Fig. 4.27 wide flange beam with 3500 mm von misses stress result

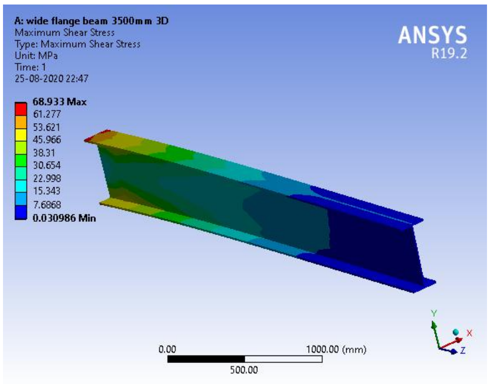

Fig. 4.28 wide flange beam with 3 500 mm shear stress result

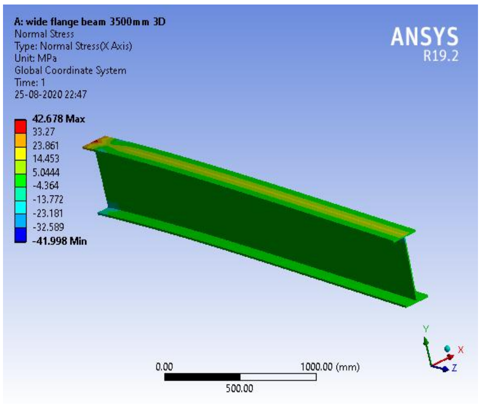

Fig. 4.29 wide flange beam with 500 mm bending stress result

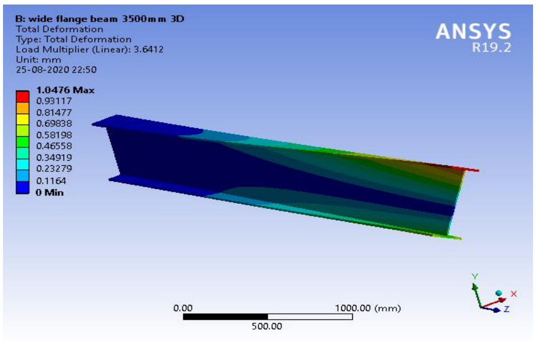

Fig. 4.30 wide flange beam with 3500 mm buckling result

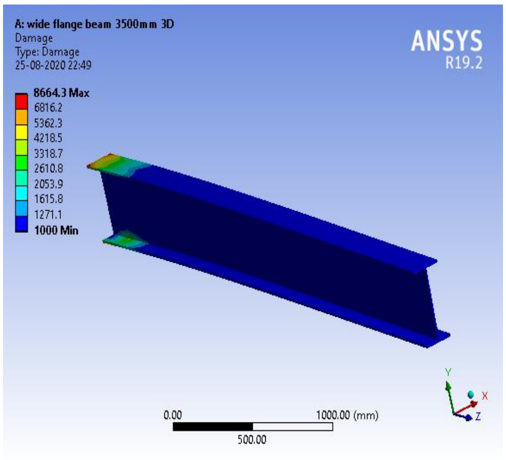

Fig. 4.31 wide flange beam with 3500 mm damage result

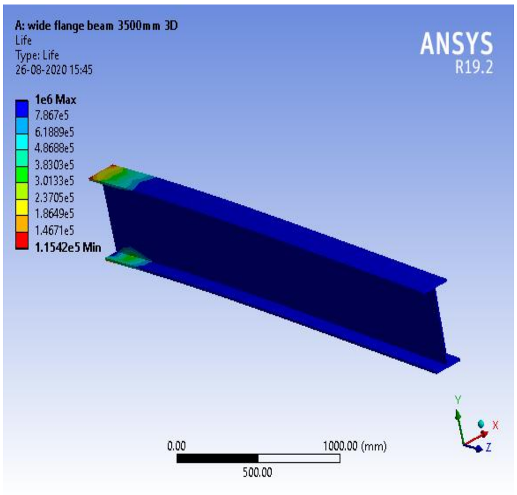

Fig. 4.32 wide flange beam with 3500 mm life result

V. RESULT & DISCUSSION

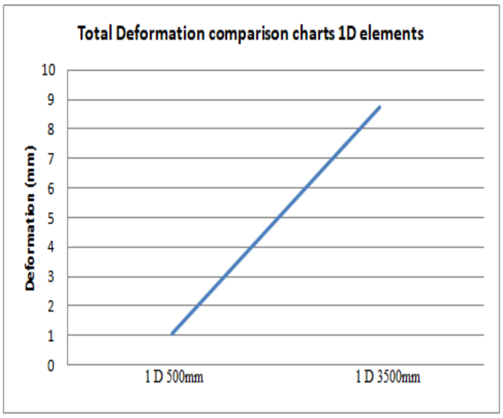

Fig. 5.1 Total Deformation comparison charts 1D elements

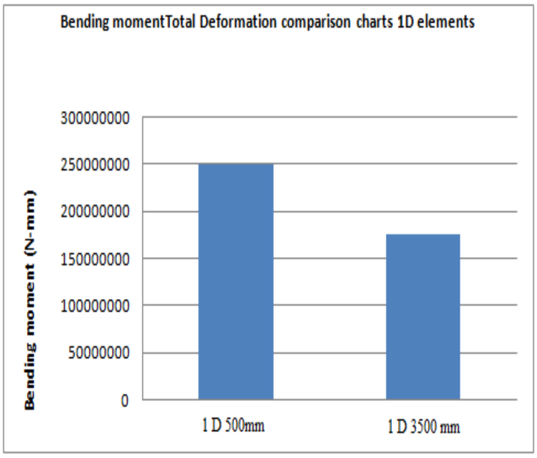

Fig. 5.2 Bending moment Total Deformation comparison charts 1D elements

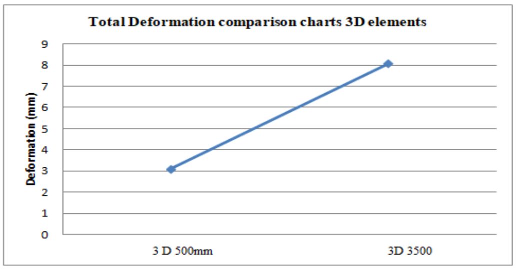

Fig. 5.3 Total Deformation comparison charts 3D elements

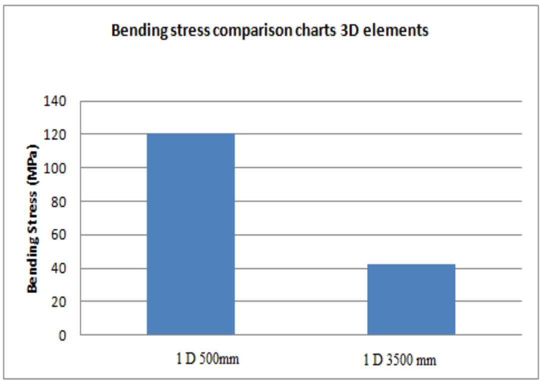

Fig.5.4 Bending moment Total Deformation comparison charts 1D elements

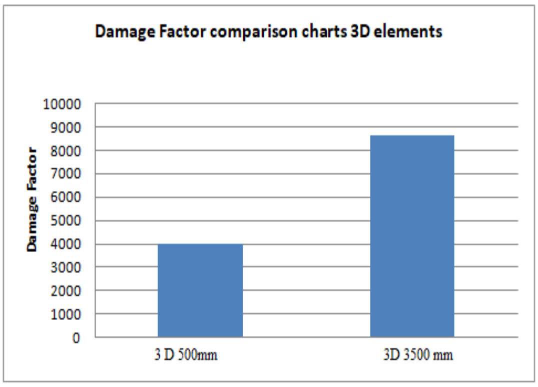

Fig . 5.5 Damage Factor comparison charts 3D elements

5.1 DISCUSSION

For static analysis in FEA, all types of element will yield the stress and displacement results, which are the two most important parameters in evaluating the structure integrity. However, 1D element provides an easier method of interpretation of FEA results as the results are neatly organized and grouped into individual stresses and displacements as shown in Table 5.1 and Table 5.2 . 3D elements, although they provide greater detail, they require some effort in the interpretation of results. The results obtained can be confusing, especially for new users, but if carefully interpreted can be reliable and accurate. Graphically, 3D element produces the clearest deformation which may be experienced by the beam due to the applied load because the model is simulated closest to the actual I-beam. The importance of the detail results is the existence and location of stress concentration which may cause fatal failure of the structure. This detail stress distribution is only available in 3D FE model. In terms of accuracy, 1D element gives the exact stresses and displacements values as those calculated by theory because the assumptions used in 1D element are those of the same as theory. If a detail analysis on the stress distribution to determine the areas of stress concentration is required, then 3D element are of better choices. 1D element can still be used for rough estimation and prediction of failure of the structure. Lastly, the choice of element for FEA also depends on the time and memory capacity of the computer available. If a simple and quick analysis on the structural integrity is required, 1D element is of better choice. If a large computer memory is available, a detail analysis is always the best choice for FEA in which modelling with 3D elements is required.

VI. CONCLUSION

The similitude when displaying with 1D component and 3D component is that they can create a similar outcome boundaries. For example, straight static examination in FEA gives aftereffect of stress and dislodging however the qualities may vary from each other. The distinction in any case, doesn't imply that the outcomes are incorrect. 1D component will give a much sort out outcome however less detail which require less exertion in the understanding of results., which are the calculation of the structure, wanted outcomes, and time period just as the ability of the PC. The most significant factor is the calculation of the structure. In the event that the straightforward, balance and uniform, for example, bar, plate, pole, and so on. 1D component is attractive. 3D component ought to be utilized just when the structure has complex calculation which can't be improved. Next factor to be considered is the outcomes required. 3D component is utilized for detail results, for example, assurance of stress dispersion, while 1D component is utilized for harsh gauge. To wrap things up is the execution time and memory required for the solver to run the investigation. 1D FEA require the least memory and the quickest to finish while 3D FEA require the most memory and slowest to finish.
\

REFERENCES

1. Euler, L. Sur la force des colonnes. Mem. Acad. R. Sci. Belle Lett. 13, 309–318 (1759)
2. Pi, Y.L., Trahair, N.S.: Lateral distortional buckling of hollow flange beams. J. Struct. Eng. ASCE 123, 695–702 (1997)
3. Kesti, J.: Local and distortional buckling of perforated steel wall studs. Ph.D. thesis, Department of Civil and Environmental Engineering, Helsinki University of Technology, Finland (2000)
4. Wanniarachchi, S.: Flexural behavior and design of cold-formed steel beams with rectangular hollow flanges.

Ph.D. thesis,School of Urban Developments, Queensland University of Technology, Australia (2005)

5. Anapayan, T.: Flexural behavior and design of hollow flange steel beams. Ph.D. thesis, School of Urban Developments. Queensland University of Technology, Australia (2010)

6. Kankanamge, N.D.,Mahendran,M.: Behavior and design of cold formed steel beams subjected to lateral torsional buckling. Thin Walled Struct. 51(1), 25–38 (2012)

7. Du, Y.: Lateral torsional buckling of wooden beam deck systems. M.Sc. thesis, Department of Civil Engineering, University of Ottawa, Canada (2016)

8. Ranjbaran, A., Rousta, H., Ranjbaran, M., Ranjbaran, M.: Dynamic stability of cracked columns; the stiffness reduction method. Sci. Iran. 20(1), 57–64 (2013)

9. Ranjbaran, A., Shokrzadeh, A.R., Khosravi, S.: A new finite element analysis of free axial vibration of cracked bars. Int. J. Numer. Methods Biomed. Eng. 27(10), 1611–1621 (2011)

10. Ranjbaran, A.: Square of the Dirac's delta distribution: a new definition for engineering mechanics. NED Univ. J. Res. 11(1), 21–28 (2014)

11. Tadeh Zirakian*and David Boyajian" Research on Distortional Buckling of Steel I-Section Beams" Journal of Steel Structures & Construction, J Steel Struct Constr, an open access journal ISSN: 2472-0437 Volume 4 , Issue 2 , 2018