STRESS CONCENTRATION PROBLEM IN GIRDER BRIDGES

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Submitted in partial fulfillment of the requirements for the award of the degree
of
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CIVIL ENGINEERING
With specialization in
STRUCTURAL ENGINEERING
Under the guidance
of
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STUDENT'S DECLARATION

I hereby declare that the work presented in the Project report entitled ***"Stress Concentration Problem in Girder Bridges"***submitted for partial fulfillment of the requirements for the degree of Master of Technology in Civil Engineering, with specialization in Structural Engineering at **Jaypee University of Information Technology, Waknaghat,** is an authentic record of my work carried out under the supervision of **Mr. Kaushal Kumar, Assistant Professor.**This work has not been submitted elsewhere for the reward of any other degree/diploma. I am fully responsible for the contents of my project report.

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CERTIFICATE

This is to certify that the work which is being presented in the thesis titled ***"Stress Concentration Problem in Girder Bridges"*** in partial fulfillment of the requirements for the award of the degree of Master of Technology in Civil Engineering with specialization in "Structural Engineering" and submitted to the Department of Civil Engineering, **Jaypee University of Information Technology, Waknaghat**is an authentic record of work carried out by **Krishna Pratap Singh (192656)** during a period from July 2020 to December 2020 under the supervision of **Mr. Kaushal Kumar, Assistant Professor**, Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

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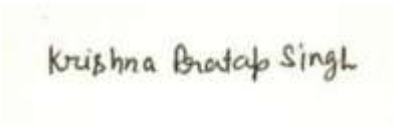

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ABSTRACT

The box, T-, I-, and U-beams regarded as made of a very wide cover sheet as a flange and integrally stiffened by an attached member referred as a web. Under the transverse loading, the cover sheet warp and displace longitudinally in such a way that the middle portion of the flange lag behind that of the portion closer to the flange-web corner due to the shear flow between the flange and web. Thus, the longitudinal displacement of the flange and web resulted in the nonuniform bending stress distribution. The warping function thus selected reflects the shear lag, i.e., warping stress distribution indirectly.Thus, it is concluded that the stress concentration phenomenon is obvious in box beam and various important structural arrangements as plated structures, cantilever and continuous box girders, and tall buildings.

A box girder model is analyzed in the present work using the infinite element analysis. The variation in the stress due to warping of the flange and thus the stress concentration at the junction of the flange and web is investigated.

Keywords: Stress concentration, fixed end, additional deformation, box girder, Finite element analysis

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CHAPTER 1

INTRODUCTION

1.1 General

The basic theoryof beam (EBT) predicted that after bending, a plane segment must remain plane, natural to the deformed axis which is also known asNavier's assumption. Thisassumption ended beam which is rigid in shear, resulting in a direct bending stress dispersal around the width of the beam. This influence of the shear strain (vertical)for deflection is important for the cases of a narrow-deepbeam having spanshort. This strain due to shear results in non-linear bending stress dispersal around flanges in girder U, T,I, and Box girder beams (Tubular building) (Figs. 1-3) with large flanges. These variationsin stresses are produced by the flange's in-plane deformation due to shear. The stress at the flange-webjunctions is higher than the stress in the flange's middle. This concentration of stress problem is expressed mathematically by

1)(Gjelsvik 1991), the width of the section, which is firstlypresented by Miller.

2) (Lee et al. 2002) stress ratio, which are defined as the ratio of extreme stress to lowest stress over the width at cross-section.

3) (Reissner 1945) stress factors are given by (σ_x/σ), i.e., the ratio stress in flange to the stress designed from EBT.

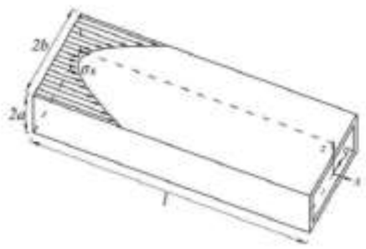


Figure 1. Variation of bending stress in a box beam

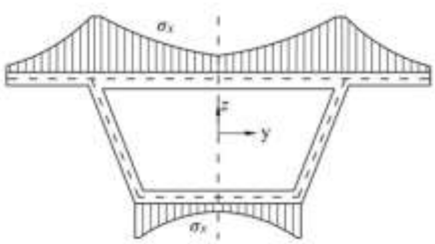


Figure 2. Variation of bending stress in a box girder bridges

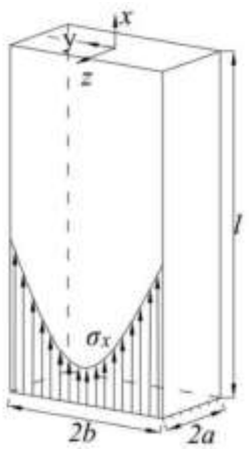


Figure 3. Variation of bending stress in a tall building

The, T-, U-, and I.box beams are all constructed of a flange, which is a very large cover sheet that is integrally solidified by a closed member which is called as a web. Because of this shear flow between the flange and the web, the cover sheet warps and displaces longitudinally under transverse loading, causing the center part of the flange to lag behind the part closest to the corner of flange-web. (Singh and Nagpal 1994;Reissner 1945; Shushkewich 1991; Singh et al. 2013).As a consequence of the displacement of axislongitudinal to the flange and web, the bending stress dispersal was non-uniform.

(Kuzmanovic and Graham1981; Chang and Zheng 1987; Chang 1984Kwan 1994, 1996; Lee et al. 2000, 2001;Foutch and Chang 1982;Zhou2008 ;Luo et al. 2002; Lin and Zhao 2011a;Mahjoub et al. 2011). The cover sheet's equivalentto warping displacement function is generally thought to be parabolic, cubic parabolic,penticor quartic parabolic. (Qin et al. 2015;Zhang and Lin 2014) This warping feature thus chosen represents the shear lag, i.e., the indirect warping stress dispersalas a result, the stress concentration phenomenon is clearly visible in box beams and other critical structural configurations such as frames, continuous box girders and cantilever and tall buildings.

1.2 Need of the Study

According to the literature analysis, the stress accumulation effect is visible in the beamsi.e box girders and various major structural parts such ascantileverbox girders, covered frames, and continuous beams. There is a scarcity of literature on stress concentration in stiffened plated structures such as girder bridges

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

Evans and Shanmugam (1984) proposed a simplified method for predicting the linear and nonlinear behaviour of multi-cellular structures, as well as determining their ultimate load. The continuous plated structure is idealised as a grillage, and shear lag effects are accounted for using empirical coefficients. To ensure that the proposed approach is accurate, in the elastic range, the outcomes are contrasted to those of a finite element analysis for a variety of cellular structures.The grillage approach is expanded to the nonlinear range by using an incremental loading technique, and the idea of an effective width is used to account for buckling of the compression flange.

Dezi and Mentrasti (1985) In a trapezoidal box beam with lateral cantilever, nonuniform natural longitudinal stress distribution has been addressed. The variational approach is used to solve a problem, with the three functions and a displacement of the beam axis that define the horizontal flanges which are warpedas the unknowns. In the example, each structural element's state of stress is investigated and made known in the results.

A differential framework of the theorem of least potential energy yielded the sixth ordergoverns in a bent beam with a thin-walled cross section and lateral cantilevers, the issue of inhomogeneousdispersal of normal longitudinal stress. The findings of the numerical application are summarised, with a critical review of the inversion of the longitudinal stress distribution's curvature (shear lag anomaly).

Baiendra and Shanmugan (1985) An experimental research was conducted to check the grillage idealisation for complex analysis of multicellular structures. Two versions of the same scale are made of Perspex stock, one of which had no opening, while the other one has 25% web-openings.For two separate sets of boundary conditions, the natural frequencies and corresponding mode shapes are determined: Both four of the sides were supported, two opposite sides were supported, and the last remaining sides were unsupported. The trial results match the theoretical results obtained using grillage idealization and finite element methods very well.

Branco and Green (1985) Using the results of a finite strip study and data from a one-quarter scale girder model test, they explored the effect of bracing systems on open box behaviour. The use of distortional bracing andtieswas discovered to be efficient in preventing distortion, with web stiffening outperforming interior cross bracing. The use of horizontal support at the flange portion was identified to aid in the prevention of twisting of the segment. Top part of chord bracingorTorsion boxes are also effective options for this form of bracing. A rigid segment action is used to perform a torsion-bending analysis.

Shushkewich (1986) The membrane forces which are acting on anevenly filledsteel or concrete box girder beam are determined using simple strength of material relationships.By considering the box girder as the beam, the longitudinal membrane forces can be calculated.

The membrane shear power is calculated by differentiating Nxsw.r.t x, i.e., integrating with respect to y and the longitudinal direction (transverse direction). Further differentiating N_{xx}w.r.t x and integrating w.r.tthe transverse force is obtained. N. A numerical illustration demonstrates how the derived equations can be applied to a real-world problem.

Chang and Zheng (1987) Using a variation method and finite element techniques, stress concentration in cantilever box girders was investigated. The dynamic distribution of bending stresses on the flanges of cellular parts under symmetrical loading is also discussed. The lenghtwise displacement on flanges is supposed to obey a parabolic quartic variance. However, with the interrelationship of span/width constraints involved, terms are derived to determine the section of negative shear lag effect.

The theoretical outcomes are then comparedwith a plexi-glass model test and are almost identical to the test results

Blandford and Glass (1987) It was discussed the dynamic andstaticbehaviour of frames made of steel supporters with narrow walls. Frame examination employs first-order geometric nonlinearities and/or post-local buckling. The effective width theory is used to account for post-local buckling behaviour, which includes both bending andaxial stresses.

For frames made up of thin-walled members, the results presented in this paper show how important it is to account for the stress reorganisation effects of geometric nonlinearity of the first order and both local buckling.For the problems studied, the stress redistribution induced (first-order geometric nonlinearity) P-delta behavior and by beam-column the damage caused by local buckling was found to be more serious.

Hjelmstad (1987) presented a beam theory that accounted for transverse shearing-induced cross-sectional warping. For elastic beams, a stress resultant theory is developed, and specimens are given to evaluate the properties of warpin. The concepts are then applied to elastoplastic warping.

There is a mathematical formulation for analysing the problem, as well as cases of elastoplastic warping.

Khristek and Bazant (1987) deterministically and stochastically investigated the creep deformations due to shear lag and redistributions of tension in concrete box girder bridges.

The shear lag is found to be equally important in creep and elastic deformations. The shear lag induces a large surge in the overall longitudinal stress, changes the stress restructuringsbecausefo a shift in the structural system significantly growths in the deflections and during the construction stage as compared to bending theory predictions.

If a successful plan of box girder from the standpoint of long-term useability is to be accomplished, the shear lag effect as well as the statistical uncertainty of creep must be considered.

Shushkewich (1988) has shown that real 3Dbehaviour of a box girder can be approached by using roughly basic equations in concurrence with a plane frame study, as predicted by a finite element analysis, finite strip, orfolded plate.

In single-celled prepared concrete metameric box girder, the system requires the reinforcement and prestressing chosen proportioned forstirrups as well as the transverse flexure to be proportioned for longitudinal torsion andshear.

Chang and Yun (1988) The shear lag effect on box girder with differing depth was studied using a finite difference solution. The study is accepted using Reissner's process, in which the lengthwise displacement on the cross section is considered to be a parabolic quartic curve rather than a quadratic. On a cantilever girder with a diameter that varies linearly, shear lag effects are computed for less than four forms of loading. Model comparisons are used to compare the results.

Bazant and Kim (1989) Probabilistic approaches can now be used to predict long-term deflections and external influences in segmental box-girder made of prestressed type of concrete. Predictions based on existing creep in concrete models have a very high level of ambiguitybut it can be significantly reduced by Bayesian updating using short-term deflection calculations during renovation or short-term creep and shrinkage strains of specimens constructed from the same concrete as the bridge.

Latin hypercube type of sampling can be used to obtain the modified (posterior) probabilities, reduces the issue to a sequence of randomly generated sample deterministic shrink-predictive structural analyses of shrinkage models.

The approach does not require the problem to be linearized in terms of parameters at random, and a large number of unpredictably generated parameterscan be considered.

The numerical utilization to a standard box girder bridgewith structural system shift from statically indeterminate to determinate and age variations between segments is seen.

Koo and Cheung (1989) A variational theory with a combination of variables for thin-walled prismatic assembly has been suggested, along with a solution process. The cross-section of this thin-walled prismatic assembly, in this theoryit is supposed to be static in plane of its own but fluid outside of it, stresses anddisplacements are not known variables in this part.

The diverse variational approach anticipated in the paper is straightforward and shall be used to analyse shear-lag in realworld designs. The cross-section geometry is the shape of the cross-sectioncan be used to evaluate the coordinate function in the solution, and the unknown functions can be solved analytically.

Fan (1989) The nonlinear contact of local buckling and overall,of panels have symmetric cross sections that are stiffened was investigated. For both theimperfect andperfect panel, the interactions between the two local buckling andoverall modes are considered.

The flexural and compressiverigidities of the cross section are reduced as a result of local buckling. The opposing nonlinear relationship between local buckling andoverall is also caused by the reduction of flexural rigidity.

It is claimed that restricting to a single local mode is sufficient because the decreaseof the flexural rigidity is same to the decreasein the compressive stiffness. The above point does not hold true in the case of a symmetric cross section with the most important primary local mode deflections on both sides of the neutral axis. For these situations, incorporating a second mode into the study would be beneficial.

Mirambe and Aguado (1990) An analytical model for predicting stress and temperature distributions in box girder was briefly presented. Concrete bridge temperature distributions are nonlinear, resulting in self-equilibrated stress distributions.

The findings of the theoretical model are related to the results of the experiments. Several parametric revisionswere also carried out to inspect the impact of cross-section shape on the stress and thermal response distributions in\ box girder bridges.

Song and Scordelis (1990)A consonant shear-lag examinationtaking in plane stress elasticity for stresses in flanges of continuous or simple beams with I, T and box-section has been defined based on certain conceptual assumptions.Since consonantstudy is used, the merging of the as well as the ultimate stresses in flange are thoroughly investigated. To boost convergence, a useful technique is presented.

The impact of shear-lag on longitudinal stress dispersion in a continuous beam having small flanges is consideredand then is defined a wide-ranging protocol to justify for it.

Distinctivemathematical examples are given, and the outcomes are related to solutions, to demonstrate the consistency and applicability of the solution.

Song and Scordelis (1990) For stresses in big flanges, an empirical match between empirical andanalytical results was madegiven by Song (1984a), using the plane stress elasticity, we also generalised analytical calculations and diagrams for determining the shear-lag effect in simple beams with I and box cross sections under different loading.

Razaqpur and Li (1991) They created a finite element that can model thin-walled box girdersexpansion,torsional, flexure, distortion, torsion, warping,shear lag effectsand distortional warping, Vlasov's thin-walled beam principle was extended for this project.

A regular beam system has six nodal degrees of freedom in addition to the six nodal degrees of freedom of a regular beam element, the module has extra degrees of freedom to take into account the distortion,torsional,shear lag, distortional warping. The differential equationswere used to quantify the element's exact form functions,nodal load vector stiffness, and matrix for each action.

A simple technique was used for decoupling the different shear lag and distortional modes. In an example, the suggested approach was compared to facet-shell finite element analysis, and those two sets of data were found to be very similar.

Song *et al*. (1991) A full modal scale enthusiastic test structure for structure reaction control under earthquake loads has been planned and fabricated with an active bracing system. The strategy of the control algorithm creation,active system and simulated control outcomes under proposal earthquakes are the first two parts of a two-part sequence. The active device is meticulously designed and analysed in standings of hardware creation, force constraints, and energy and power requirements.

It is demonstrated, within the limitations of current technology, a full model scale effectivevigorous structural rheostat system can be created.

Simulation outcomesoffers details on the output constraints that is anticipated of dynamic structural control systems under earthquake loads and under realistic limitations.

Connor and Pouangare (1991)proposed a straightforward model for analysing and designing framed-tube structures that are subjected to lateral loads. A collection of stringers and shear panels are used to model the structure. The method's beauty lies not just in its simplicity and precision, however, there's also the fact that the model contains all of the necessary parameters, allowing for the generation of design sensitivities, parametric studies, and fair first estimates for member sizes.

For preliminary design, the stress and displacement analytical terms are correct and easy to use, enabling the designer to obtain the desired effects.

The model can be specifically applied to the study of structures that include a variety of materials and properties along the structure's height. A formula for a transfer matrix has been developed.

Gjelsvik (1991) presented a method for analysing composite beams having shear-lag induced by shear deformations orlarge flanges caused by shear studs.The basic concept is to substitute an analogue beam for the actual one, with all shear deformation rigorous in a slimsheet. The properties of thelinking theslab andshear studs andthebeam can be used to calculate the equivalent stiffness of the shear plate.

As the stiffness is allotted to the shear film, original beam and its analogue behave identically.Via simple formulas, the stresses anddeformation in the real beam are closely related to the result to the analogue beam problem.

The method is more complex than the traditional effective width method, but it is also more reliable, and it may be useful in design.

LandoMentrasti (1991) The effects of cross section distortion on thin-walled trapezoidal beams (cross-section) having cantilevers endangered to a torsional load is considered.

Six shape functions control thelongitudinal and transverse displacements of the walls, which takes into account shearing strain in the mid plane of the walls, as well as distortion and torsion of the cross section; the shear centre is ignored. The governing equilibrium equations were derived using the theorem of minimum total potential energy, which has a closed form solution. (and boundary conditions).

A diverse collection of limits is investigated (flexible orrigid transverse diaphragms, mixed static and kinematicboundary conditions).

Stevens *et al.* (1991) an elastic/strain plasticity for steel, a rate-dependent model for soil, and a non-local damage/plasticity model for plain concrete.

In two different research programmes, the technique was used to examine two blast-damaged shallow buried reinforced concrete arches (pressures caused by explosives added to the soil surface).

The two specimens have different geometry and structural detailing, as well as different soil properties, burial depths, and surface blast pressures. Overall, the similarities in the forecasts and the test outcomes suggest a good agreement.

KristekandStudnicka (1991) The key characteristics of the negative shear-lag spectacle have been identified. Negative shear lag is not a rare occurrence, but it is a significant impact that can arise in a wide range of plated structure arrangements.

Negative shear lag exists lengthwise a significant slice of the duration of these systems, according to the findings. The shear lag is confirmed to be dependent not only because of thethe degree of shear forceor shear-flow extent, but also on the shear-flow rise, which is mainly determined by the form of load.

Chang (1992) The shear-lag effect in thebox girder having thin-walled section has been recognised and documented, However, the shear-lag effect produced by the amalgamation of self-weight and prestress load of a box girder receives less attention. The shear-lag effect was addressed by means of the theory of superposition, which assumes that thearrangement of a prestressed tendon resembles a fractured traditional line.

Two identical lengths of a box girder having continuous spanof continuous depth with a shear-lag effect is used as acase. The disparity between the real stress due tothe stress measured by beam theory (elementary beam theory) and bending under symmetrical loading is known as the shear-lag effect.

Mosallamand Bank (1992) Under short-term static loads, the behaviour of a pultruded fiber-reinforced plastic portal frame was investigated. A glass/vinylester pultruded FRP thin-walled section (1.83 m x 2.74 m) plane portal frame was planned and built. The failure of the beam-to-column connections as well as the girder's compression flange buckling was addressed. To predict the frame's nonlinear reaction, an empirical investigation was conducted. The numerical model takes into account the propertiesof flexuraland shear andaxial formation of the numbers, as well as the stability of the beam to column links and post buckling of the frame.The experimental data is compared to the theoretical data.

Cluleyt and Shepherd (1994) have looked at the effects of concrete creep and shrinkage, as well as prestressing ligaments relaxation, on deflections and stresses in segmental, cable-stayed,erected bridges. Theseabove paraphernalia should be taken into account while calculating the girder cross sectional stress rearrangement needed by shear lag. To analyse these effects, a special drive3D finite element code is being created. Varied displacements in pylons andgirders,anchorage slip loss and sag effects in cable stays, are all considered time-independent effects.

Tesar (1994) Shear lag effects on thetorsional andflexuralbehaviour of thin-walled box bridges were considered, as well as the implementation of a technical theory of bendingtorsionbehaviour of thin-walled box beams when shear lag machineries were taken into account.

The FETM-method as a problem-basedamalgamation of finite element techniques and transfer matrix was used to solve orthogonalized equations of torsion-bending action, as well as numerical verification of the technical approaches established.

Huckelbridgeet al. (1995) A series of field tests on prestressed box girders was discovered, bridges with multiple beams. The aim of the test was to see how well the grouted shear keys performed in-situ between neighboring girders at their longitudinal joints. The longevity of these joints may be a concern for this style of bridge; failure of the joint would usually compromise not only the load-sharing structure between opposing girders, but also the deck waterproofing framework, causing corrosion issues.

At least some of the joints on all of the bridges tested showed relative displacements, indicating a fractured shear main.

Huang *et al.* (1995) presented a method for calculating the activerejoinder of thin-walled box-girder when they are loaded by trucks. A variety of thin-walled beam components make up the box-girder bridge.

The proposed technique was compared to the folded-plate approach used by previous researchers. This is a very clear contrast of these two approaches. The empirical results show that many vibration modes are primarily responsible for the dynamic response of the vertical bending moment, while the higher modes have a significant impact on torsion and distortion.

Bousias*et al.* (1995) To provide data for Columns exposed to biaxial bent mathematical simulations, under cyclic biaxial or uniaxialflexion with axial load, twelve equivalent cantilever-type column specimens were shaped and calibrated. The load path was the only test variable.

The axial deformations were affected by cycling the deflections in two ways:

(1) For lowest to mediocre axial loads, incremental permanent truncation; for axial loads of very low magnitude, when loss approached, the incremental expansion turned into a shortening.

(2) a reversible axial extension that is roughly related to the vector consequential of deflections under constant transverse force, cycling the axial force produced aintensifying increase in deflections.

Zembaty (1995) The effects of dynamic and pseudostaticvibrations on random vibrations of a bridge were investigated, as well as seismic excitations and joint effects. A 4 span bridge modelled as a 3D frame is subjected to a detailed numerical analysis.

With uniform excitations, the root-mean-square answer is normalised. The normalised displacement response is constant between and 1, while the normalised force response may be greater than 1, suggesting additional 3-D effects. The paraphernalia were discovered to be caused by a pseudo-static response, which was most noticeable for low apparent wave velocity in relation to backing distances. To inspect the joint effect of dissemination velocity and angle on the reply, a sensitivity, first passage, analysis is performed.

Wang *et al*. (1996)The dynamic reaction of a multivehicle load moving over a rugged bridge deck was studied in cantilever and continuous thin-walled box girder bridges. A variety of thin-walled beamhaving elements were used to segment the box girder bridge. The research takes into account both warping torsion and distortion.

The empirical results show that different modelsvehicle speeds, and road surface profiles have very different effects on the different forms of bridge's complex responses. The vehicle speed is the most significant factor that influences the effect of cantilever bridges.

Anido and Rao (1996) presented a prismatic thin-walled orthotropic composite beam warping solution afor beam small elements, the shortcutmethod ofresolution is used to achieve displacements such as using summation of all the Fourier functionsandpolynomial. Constitutive calculations for both stiffened and slender FRP sections was proposed. The nodal line parameters are used to test the wall displacement area. To provide a methodfor explanation of the design, elastic factors that has explanation for warping effects are added. In the flanges of box beams, boththe active longitudinal and the width modulus variation have been expressed.

Nagaraj and Rao (1997) Mechanical properties of GFRPbox beams and large flange were characterised experimentally and theoretically. A total of 187 trials were directed to estimate shear effect, shear lag, warping, and manufacturing efficiency of pultruded beams' static responses. The beam stiffness is affected by interfacial slip of fabric layers andfibre asymmetry, according to the results of the experiments.

Warping and shear lag spectacles have been observed experimentally and debated. Interfacial slip amongneighboring glass fiber layers had a major impact on strain quantity, according to test results.

In comparison to bending deflections, shear deflections were found to be important.

Park *et al,* (1997) By employing aiterative implementation of St Venant's semi-inverse process, the general displacement area of thin-walled section beams was proposed, taking into account uniform and non-uniform shear warping deformation. A continuous FEM with boundary element shorteningmethod was made and applied to the study of the general flexural and torsional results on beams with asymmetrical component

A beam model has been developed. It was confirmed that established beam mode is very efficient and useful in getting thestress concentration andadditional deflection due to warping because of shear, for the warping discontinuity's reliability state,also for intermittently variable section beam difficulties.

Wang (1997) Using Hamilton's theory, outlined a model and expanded it to cover the dynamics of thin-walled members with open or closed cross sections. The key finite member element procedure, created on the displacement variational principle. The method uses the displacements at the two ends of the member element as basic variables. The warping displacements along the section of the thin-walled member are simulated using a transformed B3spline function.

The consequence of shearing strains on the mid-surface of walls on the vibration that represented the shear lag is taken into account in the study.

Tahan*et al.* (1997) tackled shear lag using a classic technique that, in its current form, tends to provide a simpler and straightforward approach, giving a closed-form result for the longitudinal stress dispersal in wide flanges of beams with box girder and the resulting effective-breadth ratios.

This approach is particularly well suited to parametric research. Some of the most important characteristics are highlighted, especially as a tool for engineers working on the preliminary design of plated structures.

Nairn(1997) introduced the assumptions needed from the comparisons of elasticity needed for asymmetric states of stressin materials having same properties in all direction in transverse direction, to get the shear-lag equations from the calculations of elasticity needed for asymmetric stress states in those type of materials. These conclusions can now be tested to see if shear-lag analysis on any issue is accurate.

Transferring tension from a matrix to a fractured fibre, some simulations were performed. When the shear-lag term is changed by a new derivatized from the estimated elasticity analysis, the shear-lag approach does a fair job (within 20%) of estimating normal axial stress in the fibre and overall strain energy in sample. These shear stresses and energy release rates are much more difficult to estimate using the shear-lag process. The shear-lag approach is also ineffective for low fiber volume portions.

Zuo and Hjelmstad (1998) In multilayered elastic beams, warping due to transverse shear was investigated. To account for the composite cross section's out of plane deformation, for each lamina, the Bernoulli-Kirchhoff theorem was assumed, which states that plane parts remain plane after deformations having different rotations.

The results of shear are taken into account by taking the rotations that are unaffected by the transverse deflection as in Timoshenko theory of beam. For layered composite beams, the effect is a straightforward linear warping principle.

The regulating equations' solutions was given using the eigenvectors and eigenvalues of a generalised matrix problem connected with the matrices that are in the basic equations.

A 2 layered cantilever problem with regularly spaced loading was explained in detailto demonstrate the effects of various elastic shear tension. As opposed to a finite-element approach, the present theory outperforms elementary theory of beamnot taking in warping, predicting shear tension.

Wanga and Lib (1999) For thin-walled member lateral buckling study, he introduced the displacement variational theory is used to create a finite member element method. The longitudinal torsionshift field along the section of those of the thin-walled member was simulated using a transformed B3 function. The effect of shear strains on the mid surface of walls on clipping is taken into account in the study, which illustrates the shear lag phenomenon. As compared to outcomes from classical concept and other approaches, the mathematical results show that the proposed method is versatile, and effective andaccurate. The reliability of the result is predicted by the quick convergences shown in numerical examples.

Nussbaumer*et al.* (1999) Long crack propagation in complex welded box beams made of high-strength low-alloy steel was investigated under constant-amplitude cyclic loading. The tests used a box beam to model the cellular structure of a double-hull ship, but the findings can also be applied to other box structures like bridges. The aim of these tests was to determine the residual fatigue life after a major fatigue crack had developed.

The results of the experiment showed that cellular structures have a high crack tolerance. A box beam's residual life (after a welded detail has failed) was important.

Luo and Li (2000) The result of shear lag on thin-walled curved girders, including longitudinal warping, was investigated. Instead of the curve which is quadratic in nature used by Reissner's process, the longitudinal deformingdislocation functions of these flange slabs are similar to by a parabolic curvecubic in nature. The equivalences of equilibrium for a thin-walled box girder consideringtorsion, bending, andshear lag (St. Venant and warping) are developed using the thin-walled curved bar theory and the potential variational principle. The equations' closed-form solutions are derived, and Vlasov's equation is developed further.

The shear lag effects for box girder are calculated using the formulas obtained.

Luo *et al.* (2001)The authors developed an updated finite segment systemto investigate negative shear lag paraphernalia in box girders of changing depth. Belowdissimilar loading surroundings, three types of structure were considered: continuous box girders, cantilever and simply supported

The study reveals certain peculiar characteristics of the positive and negative shear lag phenomena in box girders of various depths. The key characteristics of negative shearlag in those box girders of changeable depth are defined in this paper. The negative shear lag effect can be found not only in continuous and cantilever box girders, but also in simply supported box girders.

Prokic (2001) On the base of the anticipated warping function, a model for recitation the shear lag spectacle in thin-walled beams havinguninformedclosed oropen cross section was definite. The finite element method was used as the general approach to solving the problem. A new linear stiffness matrix has been created using the virtual displacements theory.

Vecchio (2001) A smeared delayed-rotating-crack model and disrupted Stress Field Model,was presented as a substitute to totally rotating or entirely fixed crack models for reflecting the behaviour of fractured reinforced cement concrete.

Using a technique described in this article, the Disturbed Stress Field Model formulations were incorporated into a nonlinear finite-element algorithm. The crack slip displacements were preserved as counterpoise strains in the process, which used a load secant-stiffness technique.

The analytical aspects of the design were found to be numerically stableand simple. The hybrid crack slip formulation precisely predicts the separation of stress and strain paths, providing a more precise depiction of action. Shear intensity and failure mode forecasts can be highly influenced in some situations.

Dezi*et al.* (2001) A model that took into account the concrete's long-term behaviour was used to get the shear-lag problem in composite beams with adjustable shear connections. The virtual work theorem for 3D bodies imposes a variational balance condition, which yields the problem's local formulation, which entails four equilibrium equations and their associated boundary conditions.

The numerical results demonstrated the model's ability to evaluate the mutual effect of creep, shear-lag, and interaction deformability

Luo *et al.*(2002) proposed a finite-segment technique for analysing shear-lag effects in box girders, assuming that A third-power function parabolic in nature is used to describe the spanwise displacements of the flange plates.

The foremost differential equations for two generalised displacements were created using the principle of minimum potential energy.

Bauer and Benaddi (2002) Shear lag is a phenomenon in which a tension member is linked through just a portion of its cross-section, resulting in a lack of resistance. It's a complicated problem that researchers have been studying for a long time. The size and type of the cross-section, the type of attachment, the span of welds, length of the member, and joint oddness are all factors that affect shear lag. In this article, the connection betweenchords in trusses and double-angle web members or open web steel joists is discussed. Experimentally defined resistances and failure modes are identified.
The ultimate and yield loads are compared to those measured using the Canadian Standard's design guidelines, which are discussed in the report. Finally, some preliminary conclusions about the impact of shear lag in double angle truss connections are drawn.

Luo *et al.* (2002) Using the principle of minimum potential energy, under axial and lateral loads, differential equations for cable-stayed bridge shear lag were developed.The dislocationoutlines of the finite elements were used to measure the shear lag effect in bridges (cable-stayed) using the same solutions of the differential equation for shear lag.

A model evaluation of a box girder was carried out, followed by a numerical study of the model using the finite plain strip method for assessment. The accuracy of the current approach is confirmed by these findings.

The benefit of this method over the finite strip and finite element methods is that, it can minimise computational effort by simplifying a 3D structure into a 1D structure like a beam.

Lee *et al.* (2002) From a physical standpoint, the causes of the strange phenomenon known as negative shear lag were explained.

Chang (2004) Calculated formulas andprovidingderivation for the shear lag constant in a clearly assisted prestressed box beam girder under load. For prestressed tendons with parabolic arrangements, formulas for measuring the shear lag effect are now being created.

The scale of prestress-induced ascendent loading force, as well as the relationship between box girder height and prestressed tendons sag, have all been extensively investigated. According to the results, if the prestressed tendon has a profileparabolic in nature, the shear lag effect induced by prestress force and dead load is similar to structural load working alone. The shear lag effect triggered by mobile load is also investigated centred on the load's eccentricity in relation to the box girder's half-width ratio. Charts are used to foresee the shear lag constant for mobile load. In conclusion, the deflection of box girders is studied on both evenly dispersed and localised loads after flange shear deformation is taken into account.

Wang*et al.* (2004) presented a study of for box girders (curved)having corner stiffeners, an optimal finite segment approach is used for using a modified curved beam feature to model the surface of a curved box girder and using standard beam section forthe modelling the lowermost layer,corner stiffenersand webs creates a displacementfor the study of a box girder.

As a significance, when designing the displacement turf, the local flexural and shear lag effect behaviour of the surface, as well as the stiffness of those of the corner stiffeners, are taken into account.

The variational theorem was used to create the finite segment formula. In contrast to the finite element method,projected approach has the advantage of being able to reduce a 3D structure to a 1D structure for structural investigation, resulting in substantial computational savings. The effect of the corner stiffeners' stiffness is conveniently taken into account in the study. It is shown that when analysing curved box girders, the influence of corner stiffeners should not be overlooked.

Chiewanichakorn*et al.* (2004) For a composite bridge girder, a new active flange width specification and linked finite element modelling system were defined. For simple-span bridges, nonlinear finite element analysis was used to inspect and create anextra flexible effective flange width specification.

A new process for calculating the actual flange width for the steel and concrete composite section is proposed, which can be combined with the finite-element study data.

The suggested successful flange width explanation is shown numerically using a 3D finite element model of the steel and concrete composite bridge.

Two separate experimental trials were used to validate the modelling scheme using the modelling scheme. These two separate experiments agree well with the findings of finite element analysis.

Sun and Bursi (2005) Mixed beam elements with displacement and two fields were for the linear study of steel and concrete composite beams having shear lag, a new method has been suggestedand deformable shear link also being proposed. The kinematics of the shear lag are built on a parabolic shear warping system that has a uniform structure around the slab.

Lertsima*et al.*(2005) investigated the deflection at the mid-span for the consequence of shear lag for deflection using 3D finite element tests for box beam girders. The precision was ensured by using multi-mesh extrapolation. It is also shown that the design code calculations greatly underestimate the deflection, the analysis shows the impact of the parameters that define a box beam girder's geometry on deflection. It has alsobeen shown that the methods used in the design codes significantly underrating the deflection. Empirical formulas are planned to calculate the deflection intensification factors that reason for the disparity among the deflections due to the beam theory andfinite element analysis based on the numerical results.

Kim *et al.* (2005)proposed a stress function-based analysis for the (3D) near the free edge of composite bonded patches, there is a condition of tensionas a simple and effective approximation procedure.

To apply strain presumption a linear principle of superposition of cut bits in a composite areait was made from a bonded patch.To demonstrate the load shift process from the composite patch, a modest shear lag model was used.

The foremosttwo coupled ordinary differential equations are generated from the equations after a suitable development of the functions, and are solved using a general eigen-value result method.

If when the number of base functions grows, so does the complexity of the system., inter-laminar stresses converge. The free edge of the patch has the strongest inter-laminar pressures, which sharply decrease at the patch's interior. Inter-laminar stresses are localised at the edge between the layers due to mismatches in material properties and geometric singularity.

Since it exactlyguesses the three-dimensional stresses in a bonded composite to a metal substratum, the proposed approach can be used as aanalytical and simple efficient technique for modelling such components.

Feng and Hong (2005) The shear lag effect of the Lanzhou Xiaoxihu Yellow River cable-stayed bridge was studied. Many bridgescable-stayed were built with a high width-to-span ratio, causing substantial shear lag and non-uniform stress distribution lengthwiseof flanges of the bridge beam.

The theoretical results were obtained using the FEAand 3D finite model of the bridge. A scaled model was created to perform static tests in the laboratory to validate the theoretical effects. The findings of the experiment matched those of the FEA simulation. It has been demonstrated that FEA is an efficient method for predicting the shear lag effect of this type of bridge.

Shushkewich (2006) presented STRUTBOX, a computer programme for transverse investigation of box girder bridges (strutted box girder), with a focus on bridges considered and built using the strutted box widening process. The software helps you to proportion other reinforcing and the deck prestressing for diagonal flexure and the slab reinforcing and web stirrups for longitudinal shear and torsion. The software also indicates the degree to which shear lag effects are present. The software uses the folded plate approach and is as simple to use as a plane frame computer programme.

It was also demonstrated how the effects of a creased plate analysis can be approached by combining a plane frame analysis with some basic membrane force equations.

Dezi*et al.* (2006) The shear-lag effect has been observed due to key prestressing techniques in theblocks of twin-girder composite steel and concrete reinforced surfaces such asexternal slipping tendons, bonded cables in the steel and concrete slabandsupport settlements.

The research was carried out using a beam model that took into justification the slab's lack of planarity, the shear relation's stability, and the concrete's time-dependent existence. The concrete slab was assumed to have a viscoelastic, while the steel beams and shear relation were assumed to have a linear elastic behaviour.

An analysis is conducted on bridge surfaces with each style of prestressing method by changing the girder spacing andspan length. For each prestressing phase, the dispersal of longitudinal normal stresses is visible, and the appropriate slab widths are measured and thencompared with those indicated by ENV 1994-2 for various beam spacing andspan lengths.

Chen *et al.* (2007) For calculating the effective width (beff) in steel and concrete composite bridges, a simpler and more flexible design criterion was proposed. A parametric research was performed using a statistical method called design experiment principles to pick bridges for finite-element analysis. The parametric analysis considered both multiple-span and single-spanand that continuous bridges in order to descend a planned simplified design equation for computing effective widths in both negative andpositive moment regions.

Ryvkin and Abodi (2007) Using continuum equations of elasticity, the tension field in a crack embedded in a regularly layered composite directed,it was collected in the usual track to the layering and exposed to tensile load. The 2D problem of fibre reinforced materials with a transverse crack was modelled using this geometry. The higher-order theory and the representative cell method are used to conduct the research. Green's functions for displacement hedges along the crack line are constructed using the representative cell process.

The infinite domain problem is reduced to a finite domain (representative cell) on which Born–von Karman sortlimitcircumstances are functional using the discrete Fourier transform. The altered elastic field is defined by development of the displacement vector to the second order in terms of local coordinates, in accordance with the equilibrium calculations and these boundary conditions, in the context of higher-order theory. A comparison with the analytical solution for a crack entrenched in a standardized plane confirmed the precision of the proposed method. Comparisons were made with projections derived from the shear lag principle.

Jiang and Peters (2008) Complete the delay of an established ideal shear-lag model appropriate2D planar structures, a shear-lag model for single diection multilayered structures whose elements differ along the section was created. The authors explored solution algorithms for a diversity of boundary conditions. The researchers presented mathematical projections for a unidirectional laminated composite anda single-fiber composite. As compared to finite element analysis, the expectedaverage normal stresses and interfacial shear stresses show that this shear-lag model can be castoff to quickly evaluation the average normal stress distribution in different constituents.The interfacial shear stresses, however, are less precise.

Rahgozar*et al.*(2009)presented a new and easy mathematical model for determining the best position for a belt truss reinforcement device on high rise buildings such that lateral loading displacements cause the least amount of strain and stress in the building's structural members.

The impact of the belt truss and shear core on the framed tube was modelled as a centred moment at the belt truss's location. The movement caused by lateral loads causes this moment to function in the opposite direction.

The axial deformation functions for the frames' web and flange are assumed asquadratic and cubic, respectively. The established model consists of their stress relationships and minimising the total potential energy of the system in relation,the frames' flange and web axial deformation functions are thought to be cubic and quadratic, respectively. In relation to lateral deflection, plane segment rotation, and uncertain shear lag coefficients, the proven model consists of their stress relationships and minimising the overall potential energy of the system.

The proposed model demonstrates a detailed understanding of structural behaviour; it is informal to use but reasonably precise, and it is well adapted for quick estimations during the preliminary design stage, saving time.

Khanmirza*et al.* (2010) proposed two new techniques for simultaneously calculating the mass–damping–stiffness of buildings. The approach suggested a process for estimatingmodal damping ratios, natural frequencies and modal shapes based on the forced vibration responses of shear buildings.

Zhou (2010) To account for the collaboration of shear-lag and bendingdeformation in a box girder, a finite-element solution was developed. In the meantime, a shear-lagstiffness matrix was developed.

The planneddesigns were used to inspect the properties of shear lag because of deflection of box girder, shear-lag and forcescoefficients in simply supported,cantilever and continuous box girder beams havingUDL and focused loads using the proposed formulations.

The findings of this technique are consistent with those of the finite element process, finite-stringer approach, variational theory-based analytical method, and model experiments.

Xu *et al.* (2011)proposed a new systematic solution for predicting 2Dplain woven fabric (PWF) composite's shear modulus that takes into account the interaction of orthogonal interlocking strands with fixed shear deformation methods such as absolute bending, and so on. In a micromechanical unit cell, two orthogonal anecdotes were idealized as beams which were curved with a direction represented using sinusoidal form functions. A strain energy method based on micromechanics was used to calculate the forces and deformations borne by the anecdote families, as well as the macroscopic shear modulus of PWFs.

To validate the new model, 3 sets of experimental data for 3 different types of 2D PWF composites were used. The results of the results of the new model are therefore related to those obtained using two previous models presented in the literature.

Kamgar and Saadatpour (2011) It was attempted to figure out what the first normal frequency of high-rise building is usingoutrigger structures with several jumped discontinuities, belt truss,shear core andframed tube in the section of shear coreand framed tube.

The length of the high-rise building was uniformly partitioned betweenany two discontinuity points in a row. To mimic the impact of outrigger systemand the belt truss, a rigorous rotational spring was functional atoutrigger system spot andthe belt truss.

Guo *et al.* (2011)presented a probabilistic method for evaluating current prestress concrete (PSC) girder bridges time-dependent reliability. Bigger traffic volume and a hostile climate cause structural degradation such as cracking and corrosion on these bridges. Founded on collected traffic data that is adequately represented by previous one-peak probability distributions, a multiple-peak model is proposed. The maximum loads over the enduring life of bridges can be calculated using the proposed vehicle load model, which can be used to assess the impact of increased traffic loads on bridge reliability.

The effects of corrosion and increased loads are studied in this report, which provides a method for the dependability evaluation of existing girder bridges (box girder).

Lin and Zhao (2011) Using an energy-based disparitystudy, the study evaluated the AASHTO requirements for successful flange width.

The results of shear-lag in box girders were studied in depth analyzed using a variance examination technique to assess the flange width requirements that are effective in the existing AASHTO provisions.

Deschapelles (2011)presented a new finite element which gives permission to the above complexities to be avoided theargument of a non-nodal degree of freedom whichresourcefully controls the shear flow laterallywith edges of a beam-column section was the most novel aspect of the paper. When dealing with nonlinear differential equations or the gist of a mysterious mechanical feat, termedas bi- moment in the assessment of stresses induced by torsion, practising engineers were often at a loss. Modern formulations, on the other hand, can make use of the machines that are available that can easily manage the matrix elations that are used in finite element analysis.

Zhang (2012) An enhanced displacement trait for shear lag and warping has been built in a girder(box girder)having cantilever slabs.

The concept of force matching to generalised displacement because of shear lag and the associated geometrical properties, the shear lag analysis of complex box girders was simplified using a finite analysis technique.

A FORTRAN-based finite-element computer programme was created to evaluate a continuous prestressed concrete box girder andcantilever box girder model theoretical and experimental results were good, validating the suggested method and formulations and showing the properties of the generalised moment for shear lag for the first time.

According to the literature analysis, the stress accumulation effect is visible in the beamsi.e box girders and various major structural parts such ascantileverbox girders,covered frames, and continuous beams. There is a scarcity of literature on stress concentration in stiffened plated structures such as girder bridges.

2.2 OBJECTIVE

The current study's goal has been established based on a literature review and the identification of a specific research gap:

- *To investigate the stress concentration problem in the girder bridges.*
- *The Finite Element Analysis will be utilized to analyzethe girder bridge by using a suitable software package as ANSYS available in the department*.

CHAPTER 3

METHODOLOGY

3.1 Numerical Modeling

An idealize section of a cantilever girder bridge model is tested in the ANSYS software. The idealize model have length l =75 mm, with 4w =60 mm, clear web height =20 mm, thickness of the cover plate t_f = 10 mm and web thickness t_w= 20 mm (Fig. 4). The Young's modulus and Poison's ratio of the material is 2×10^5 N/mm^2 and 0.3 respectively.

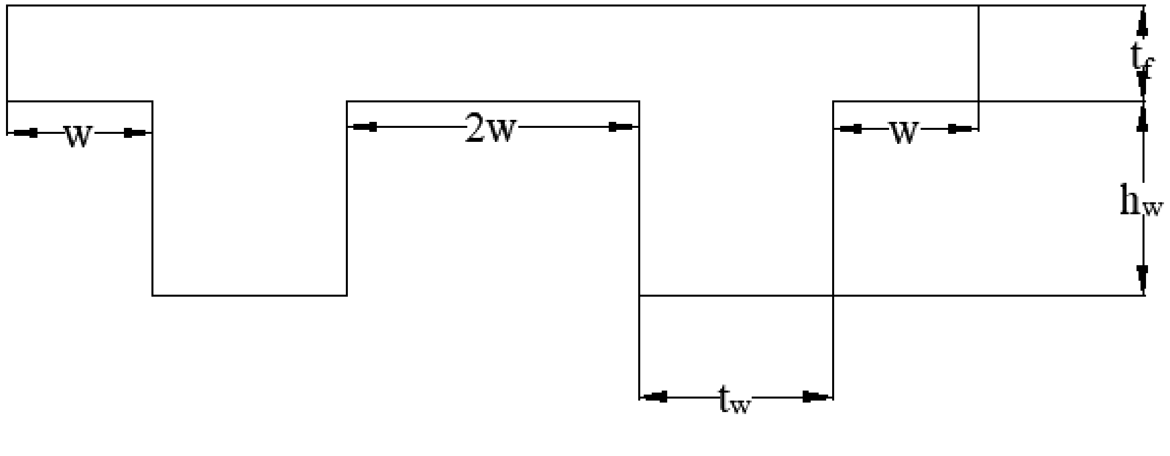
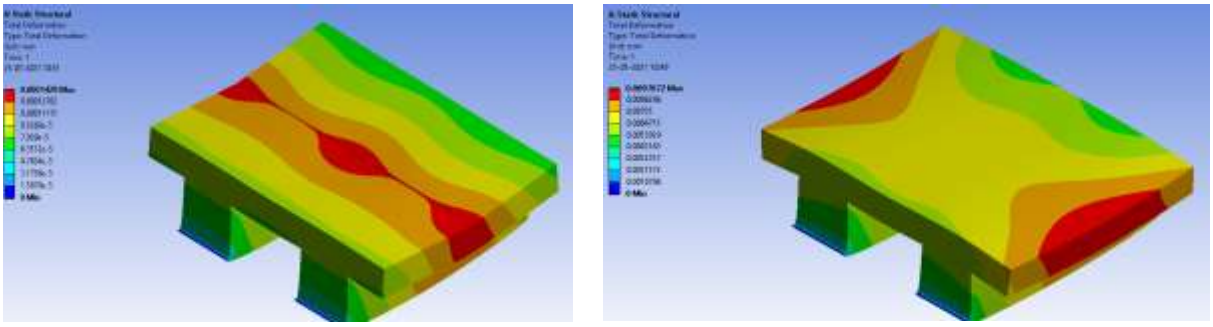


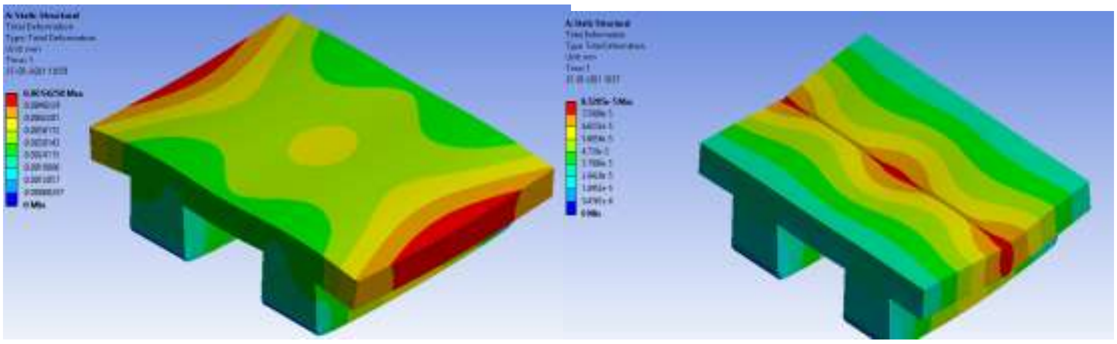
Figure 4. Idealize girder model cross section

A suitable element is selected among the various elements available in the ANSYS library. The Tetrahedrons element is used to analyze the present model. The mess conversance study is performed and 5 mm mess size is found suitable to analyze the structure. Apart from the boundary conditions at the support an additional boundary condition is applied along the length of the model. The transverse deformation, i.e., across the width is restrained through the length of the model.



(a) Deflected shape for point load (b) Deflected shape UDL

Figure 5.(a) The deflection contours in the finite element analysis of the simply supported girder models



(a) Deflected shape for UDL (b) Deflected shape for point load

Figure 5.(b) The deflection contours in the finite element analysis of the fixed support girder models

CHAPTER 4

RESULT AND ANALYSIS

TABLE NO. 1 The stresses calculated for point load in simply support girder is presented in the table below:-

LENGTH	SIMPLY SUPPORTED RESULTS(FEM)	BEAM THEORY RESULTS FOR SIMPLY SUPPORTED BEAM
0	5.4	7.65
2.0833	5.6	7.65
4.1667	5.9	7.65
6.25	6.4	7.65
8.3333	7.1	7.65
10.417	8.0	7.65
12.5	8.9	7.65
14.583	10.0	7.65
16.667	10.0	7.65
18.75	10.0	7.65

20.833	10.0	7.65
22.917	10.0	7.65
25	10.0	7.65
27.083	10.0	7.65
29.167	10.0	7.65
31.25	10.0	7.65
33.333	10.0	7.65
35.417	10.0	7.65
37.5	7.3	7.65
39.583	6.5	7.65
41.667	6.0	7.65
43.75	5.7	7.65
45.833	5.5	7.65
47.917	5.5	7.65
50	5.4	7.65
52.083	5.5	7.65
54.167	5.5	7.65
56.25	5.7	7.65
58.333	6.0	7.65
60.417	6.5	7.65
62.5	7.3	7.65
64.583	10.0	7.65
66.667	10.0	7.65
68.75	10.0	7.65
70.833	10.0	7.65
72.917	10.0	7.65
75	10.0	7.65
77.083	10.0	7.65
79.167	10.0	7.65
81.25	10.0	7.65
83.333	10.0	7.65
85.417	10.0	7.65
87.5	8.9	7.65
89.583	8.0	7.65
91.667	7.1	7.65
93.75	6.4	7.65

95.833	5.9	7.65
97.917	5.6	7.65
100	5.4	7.65

TABLE NO. 2 The stresses calculated for point load in fixed support girder is presented in the table below:-

LENGTH	FIXED BEAM	BEAM THEORY RESULTS FOR FIXED BEAM
0	3.0	5.1
2.0833	3.1	5.1
4.1667	3.5	5.1
6.25	4.0	5.1
8.3333	4.8	5.1
10.417	5.7	5.1
12.5	6.8	5.1
14.583	7.0	5.1
16.667	7.0	5.1
18.75	7.0	5.1
20.833	7.0	5.1
22.917	7.0	5.1
25	7.0	5.1
27.083	7.0	5.1
29.167	7.0	5.1

31.25	7.0	5.1
33.333	7.0	5.1
35.417	7.0	5.1
37.5	4.6	5.1
39.583	3.7	5.1
41.667	3.2	5.1
43.75	3.0	5.1
45.833	3.1	5.1
47.917	3.1	5.1
50	3.1	5.1
52.083	3.1	5.1
54.167	3.0	5.1
56.25	3.0	5.1
58.333	3.1	5.1
60.417	3.6	5.1
62.5	4.5	5.1
64.583	7.0	5.1
66.667	7.0	5.1
68.75	7.0	5.1
70.833	7.0	5.1
72.917	7.0	5.1
75	7.0	5.1
77.083	7.0	5.1
79.167	7.0	5.1
81.25	7.0	5.1
83.333	7.0	5.1
85.417	7.0	5.1
87.5	6.6	5.1
89.583	5.6	5.1
91.667	4.6	5.1
93.75	3.8	5.1
95.833	3.3	5.1
97.917	3.0	5.1
100	2.8	5.1

TABLE NO. 3 The factored stresses calculated for uniformly distributed load simply support girder is presented in the table below:-

LENGTH	SIMPLY SUPPORTED SHEAR FACRTOR RESULTS(FEM)	EBT THEORY FACTOR
0	0.7	1
2.0833	0.7	1
4.1667	0.8	1
6.25	0.8	1
8.3333	0.9	1
10.417	1.0	1
12.5	1.2	1
14.583	1.3	1
16.667	1.3	1
18.75	1.3	1
20.833	1.3	1
22.917	1.3	1
25	1.3	1
27.083	1.3	1
29.167	1.3	1

31.25	1.3	1
33.333	1.3	1
35.417	1.3	1
37.5	0.9	1
39.583	0.9	1
41.667	0.8	1
43.75	0.7	1
45.833	0.7	1
47.917	0.7	1
50	0.7	1
52.083	0.7	1
54.167	0.7	1
56.25	0.7	1
58.333	0.8	1
60.417	0.9	1
62.5	0.9	1
64.583	1.3	1
66.667	1.3	1
68.75	1.3	1
70.833	1.3	1
72.917	1.3	1
75	1.3	1
77.083	1.3	1
79.167	1.3	1
81.25	1.3	1
83.333	1.3	1
85.417	1.3	1
87.5	1.2	1
89.583	1.0	1
91.667	0.9	1
93.75	0.8	1
95.833	0.8	1
97.917	0.7	1
100	0.7	1

TABLE NO. 4 The factored stresses calculated for uniformly distributed load in fixed girder is presented in the table below:-

LENGTH	BEAM THEORY SHEAR FACTOR RESULTS FOR FIXED BEAM(FEM)	EBT THEORY FACTOR
0	0.6	1
2.0833	0.6	1
4.1667	0.7	1
6.25	0.8	1
8.3333	0.9	1
10.417	1.1	1
12.5	1.3	1
14.583	1.4	1
16.667	1.4	1
18.75	1.4	1
20.833	1.4	1
22.917	1.4	1
25	1.4	1
27.083	1.4	1
29.167	1.4	1
31.25	1.4	1

33.333	1.4	1
35.417	1.4	1
37.5	0.9	1
39.583	0.7	1
41.667	0.6	1
43.75	0.6	1
45.833	0.6	1
47.917	0.6	1
50	0.6	1
52.083	0.6	1
54.167	0.6	1
56.25	0.6	1
58.333	0.6	1
60.417	0.7	1
62.5	0.9	1
64.583	1.4	1
66.667	1.4	1
68.75	1.4	1
70.833	1.4	1
72.917	1.4	1
75	1.4	1
77.083	1.4	1
79.167	1.4	1
81.25	1.4	1
83.333	1.4	1
85.417	1.4	1
87.5	1.3	1
89.583	1.1	1
91.667	0.9	1
93.75	0.8	1
95.833	0.6	1
97.917	0.6	1
100	0.5	1

TABLE NO. 5 The factored stresses calculated for point load in simply support girder is presented in the table below:-

LENGTH	SIMPLY SUPPORTED SHEAR FACRTOR RESULTS(FEM)	EBT THEORY FACTOR
0	0.6	1
2.0833	0.6	1
4.1667	0.7	1
6.25	0.7	1
8.3333	0.8	1
10.417	1.0	1
12.5	1.1	1
14.583	1.3	1
16.667	1.4	1
18.75	1.5	1
20.833	1.5	1
22.917	1.6	1
25	1.6	1
27.083	1.5	1
29.167	1.5	1
31.25	1.5	1

33.333	1.4	1
35.417	1.3	1
37.5	1.1	1
39.583	1.0	1
41.667	0.8	1
43.75	0.7	1
45.833	0.7	1
47.917	0.6	1
50	0.6	1
52.083	0.6	1
54.167	0.7	1
56.25	0.7	1
58.333	0.9	1
60.417	1.0	1
62.5	1.1	1
64.583	1.3	1
66.667	1.4	1
68.75	1.5	1
70.833	1.5	1
72.917	1.6	1
75	1.6	1
77.083	1.6	1
79.167	1.5	1
81.25	1.5	1
83.333	1.4	1
85.417	1.3	1
87.5	1.1	1
89.583	1.0	1
91.667	0.8	1
93.75	0.7	1
95.833	0.7	1
97.917	0.6	1
100	0.6	1

TABLE NO. 6 The factored stresses calculated for point load in fixed support girder is presented in the table below:-

LENGTH	BEAM THEORY SHEAR FACTOR RESULTS FOR FIXED BEAM(FEM)	EBT THEORY FACTOR
0	0.6	1
2.0833	0.6	1
4.1667	0.6	1
6.25	0.7	1
8.3333	0.8	1
10.417	1.0	1
12.5	1.3	1
14.583	1.6	1
16.667	1.7	1
18.75	1.9	1
20.833	2.0	1
22.917	2.0	1
25	2.0	1
27.083	2.0	1
29.167	1.9	1
31.25	1.8	1

33.333	1.7	1
35.417	1.6	1
37.5	1.3	1
39.583	1.0	1
41.667	0.8	1
43.75	0.7	1
45.833	0.7	1
47.917	0.6	1
50	0.6	1
52.083	0.6	1
54.167	0.6	1
56.25	0.7	1
58.333	0.8	1
60.417	1.1	1
62.5	1.3	1
64.583	1.6	1
66.667	1.7	1
68.75	1.9	1
70.833	2.0	1
72.917	2.0	1
75	2.0	1
77.083	2.0	1
79.167	1.9	1
81.25	1.9	1
83.333	1.7	1
85.417	1.5	1
87.5	1.3	1
89.583	1.1	1
91.667	0.9	1
93.75	0.7	1
95.833	0.7	1
97.917	0.6	1
100	0.6	1

The stress distribution for uniformly distributed load and point load in simply support girder is depicted in Fig. -6.

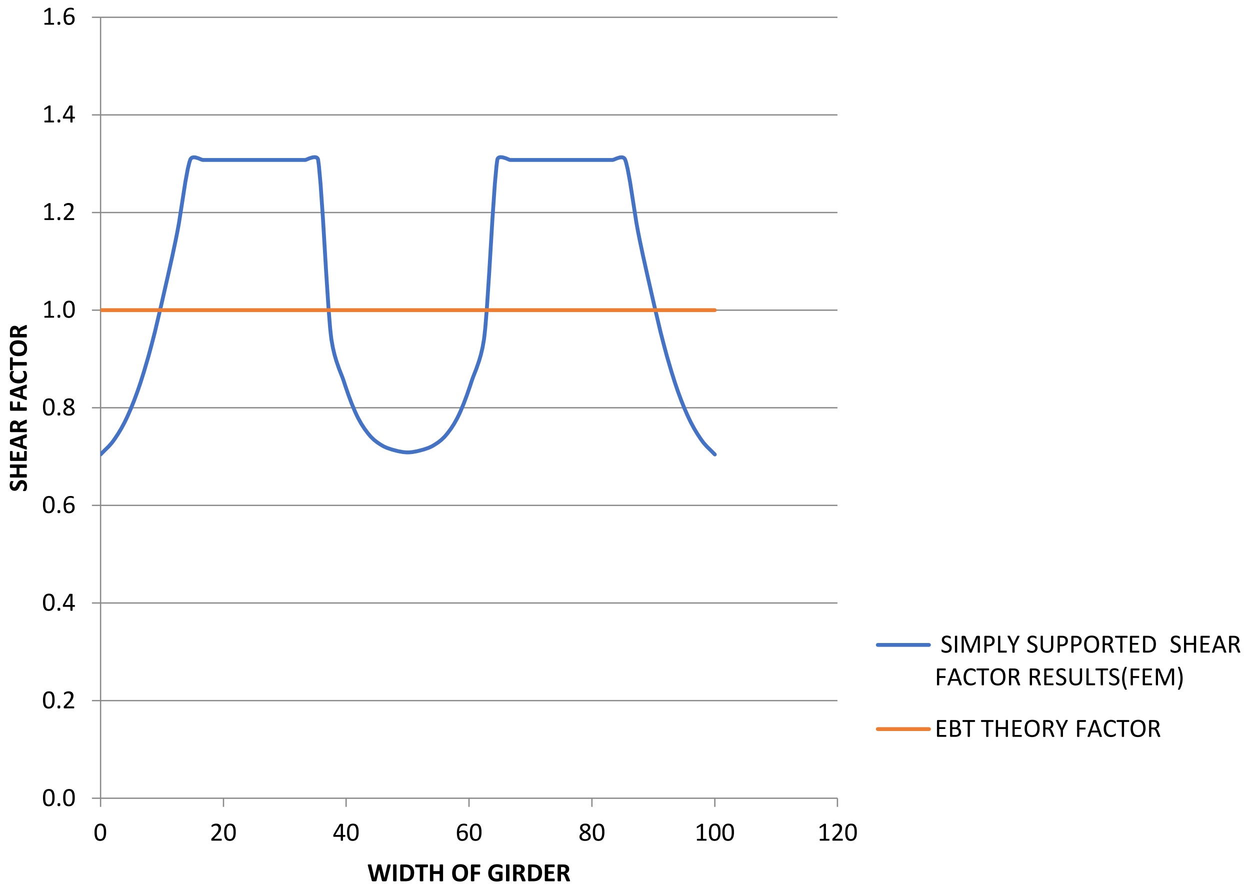


Figure 6(a). Stress distribution for simply support for UDL

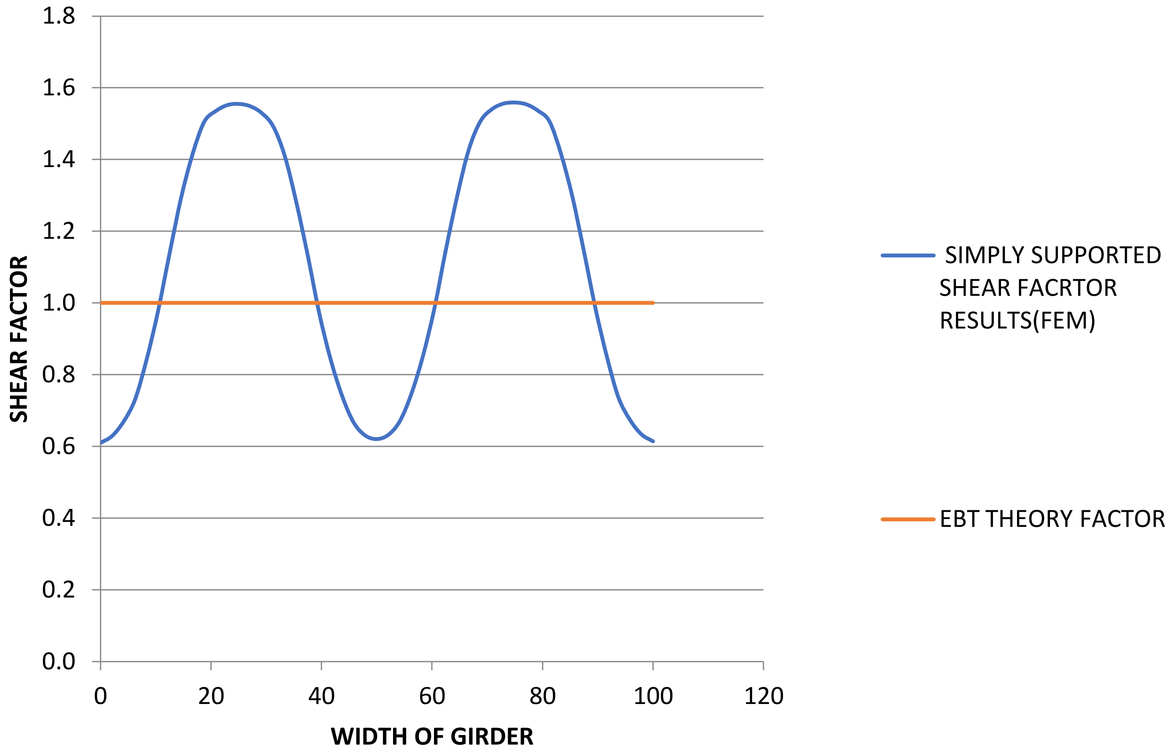


Figure 6(b). Stress distribution for simply support for point load

The stress distribution for uniformly distributed load and point load in fixed support girder is depicted in Fig. -6(c).

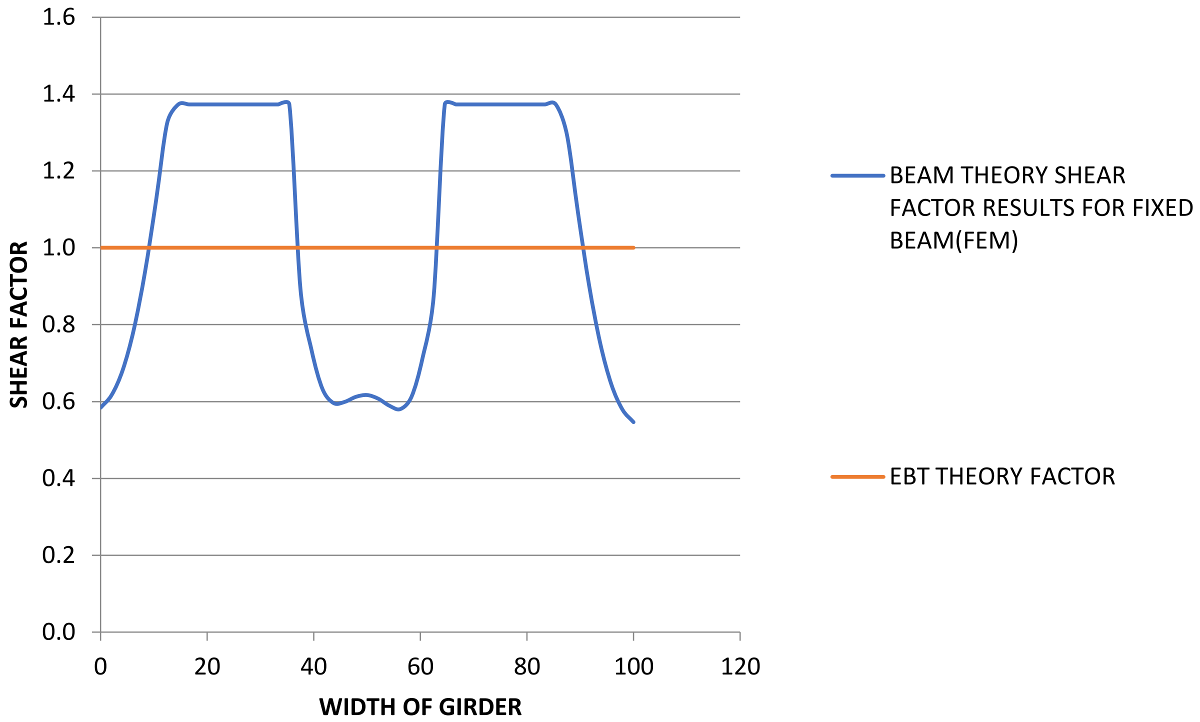


Figure 6(c). Stress distribution for fixed support girder for UDL

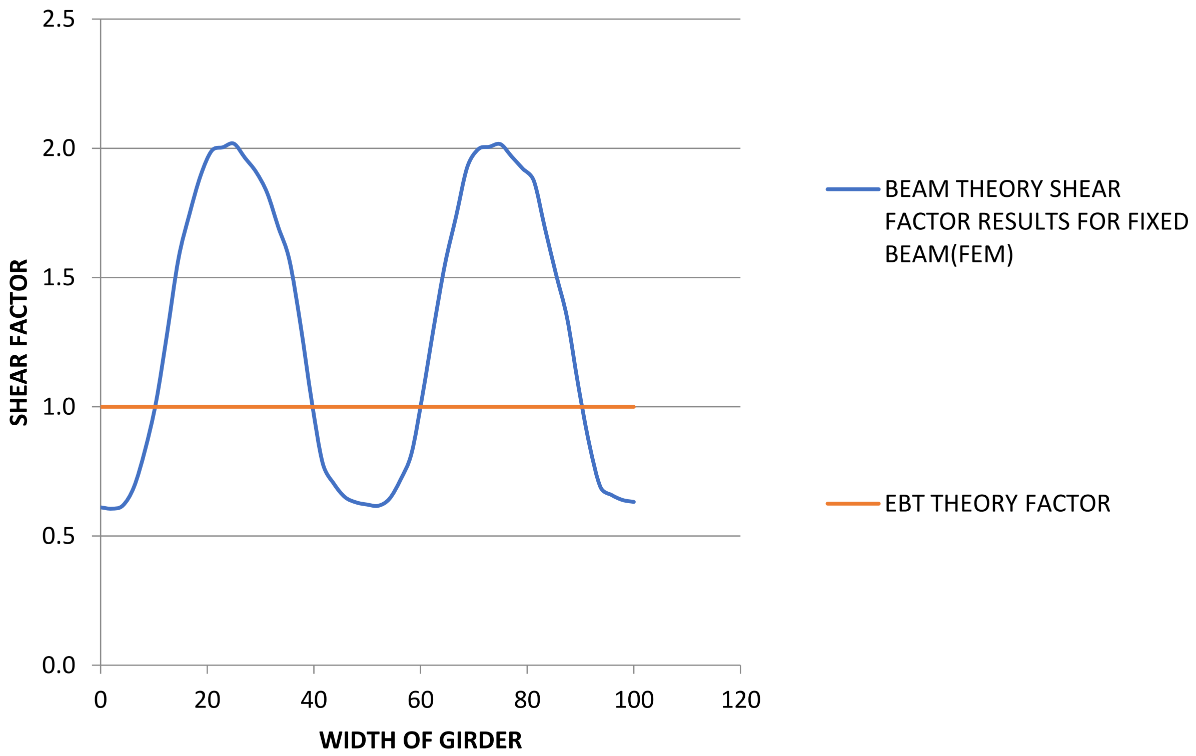


Figure 6(d). Stress distribution for fixed support girder for point load

TABLE NO. 7 The deflection of girder for point load along length in the finite element analysis of the simply supported girder model:-

LENGTH	DEFLEACTION(MM)
0	0.000080
1.5625	0.000081
3.125	0.000082
4.6875	0.000084
6.25	0.000086
7.8125	0.000088
9.375	0.000090
10.938	0.000093
12.5	0.000095
14.063	0.000098
15.625	0.000100

17.188	0.000102
18.75	0.000104
20.313	0.000107
21.875	0.000109
23.438	0.000111
25	0.000113
26.563	0.000114
28.125	0.000116
29.688	0.000117
31.25	0.000118
32.813	0.000119
34.375	0.000120
35.938	0.000120
37.5	0.000120
39.063	0.000120
40.625	0.000120
42.188	0.000119
43.75	0.000118
45.313	0.000117
46.875	0.000115
48.438	0.000114
50	0.000112
51.563	0.000110
53.125	0.000108
54.688	0.000106
56.25	0.000104
57.813	0.000102
59.375	0.000100

60.938	0.000098
62.5	0.000096
64.063	0.000093
65.625	0.000091
67.188	0.000089
68.75	0.000087
70.313	0.000085
71.875	0.000083
73.438	0.000081
75	0.000080

The deflection profile of girder for point load along length in the finite element analysis of the simply supported girder model: -

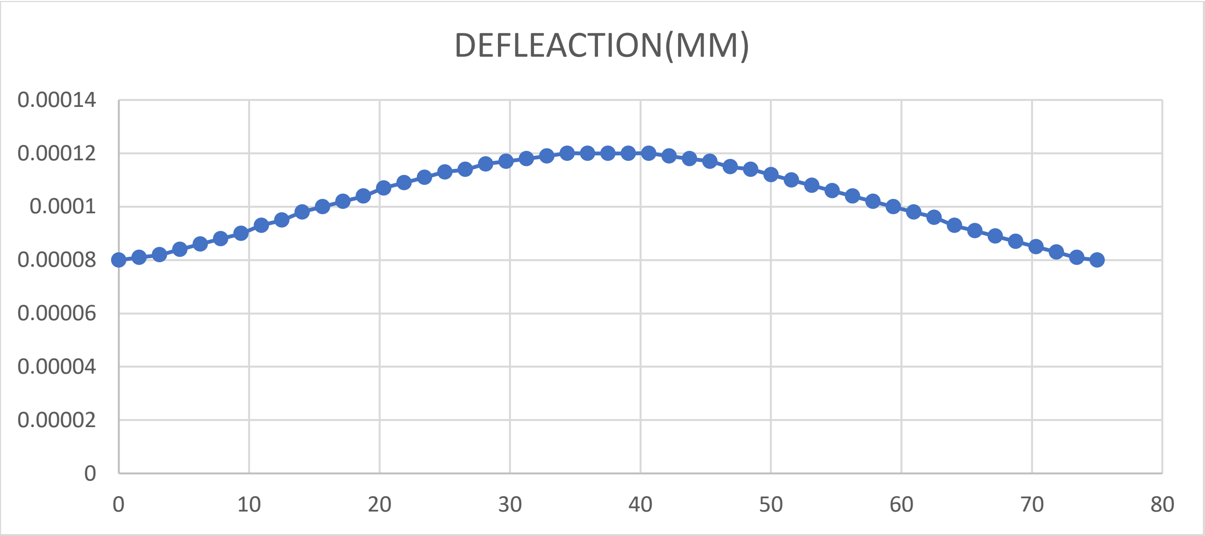


Fig 7(a). Deflection profile for point load of simply supported girder

TABLE NO. 8 The deflection of girder for UDL along length in the finite element analysis of the simply supported girder model: -

LENGTH	DEFLEACTION(MM)
0	0.005582
1.5625	0.005648
3.125	0.005731
4.6875	0.005828
6.25	0.005937
7.8125	0.006055
9.375	0.006179
10.938	0.006305
12.5	0.006431
14.063	0.006555
15.625	0.006674
17.188	0.006788
18.75	0.006896

20.313	0.006997
21.875	0.007091
23.438	0.007176
25	0.007253
26.563	0.007321
28.125	0.007381
29.688	0.007432
31.25	0.007474
32.813	0.007507
34.375	0.007531
35.938	0.007546
37.5	0.007552
39.063	0.007548
40.625	0.007536
42.188	0.007515
43.75	0.007485
45.313	0.007446
46.875	0.007399
48.438	0.007344
50	0.00728
51.563	0.007209
53.125	0.007131
54.688	0.007045
56.25	0.006953
57.813	0.006854
59.375	0.00675
60.938	0.00664
62.5	0.006525
64.063	0.006407
65.625	0.006285
67.188	0.006162
68.75	0.00604

70.313	0.00592
71.875	0.005806
73.438	0.005702
75	0.00561

The deflection of girder for UDL along length in the finite element analysis of the simply supported girder model: -

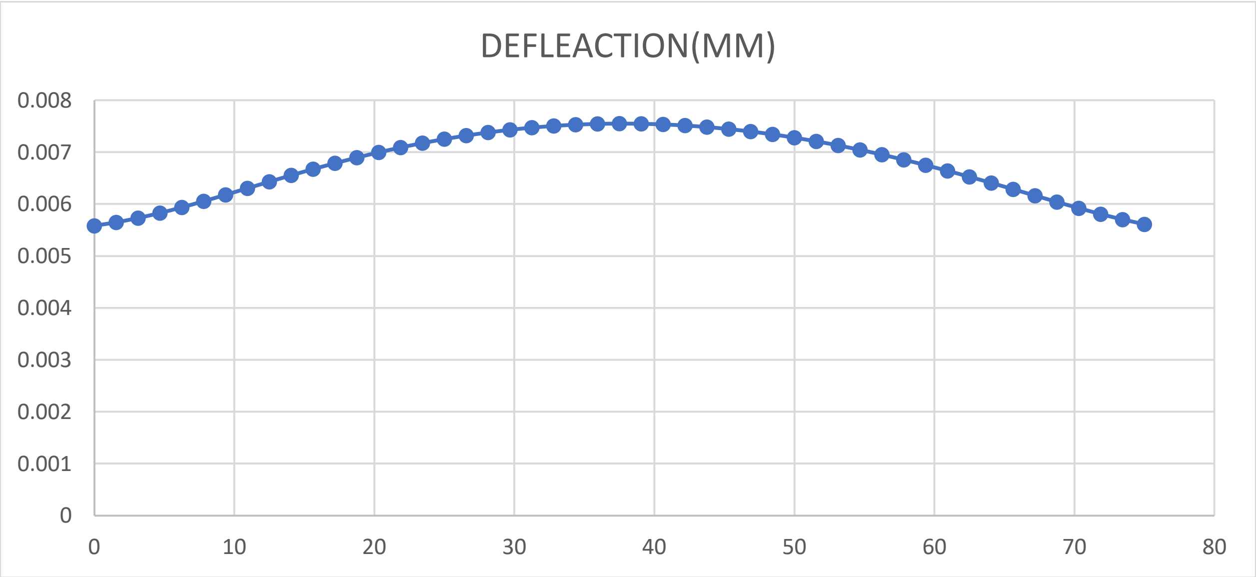


Fig 7(b). Deflection profile for UDL of simply supported girder

TABLE NO. 9 The deflection of girder for point load along length in the finite element analysis of the fixed supported girder model:-

LENGTH	DEFLEACTION(MM)
0	0.000028
1.5625	0.000029
3.125	0.000030
4.6875	0.000032
6.25	0.000033
7.8125	0.000035
9.375	0.000036
10.938	0.000038
12.5	0.000039
14.063	0.000041
15.625	0.000043

17.188	0.000045
18.75	0.000046
20.313	0.000048
21.875	0.000050
23.438	0.000051
25	0.000053
26.563	0.000054
28.125	0.000056
29.688	0.000057
31.25	0.000058
32.813	0.000059
34.375	0.000060
35.938	0.000060
37.5	0.000060
39.063	0.000060
40.625	0.000060
42.188	0.000059
43.75	0.000058
45.313	0.000057
46.875	0.000056
48.438	0.000054
50	0.000053
51.563	0.000051
53.125	0.000050
54.688	0.000048
56.25	0.000046
57.813	0.000045
59.375	0.000043

60.938	0.000041
62.5	0.000039
64.063	0.000038
65.625	0.000036
67.188	0.000035
68.75	0.000033
70.313	0.000032
71.875	0.000030
73.438	0.000029
75	0.000028

The deflection of girder for point load along length in the finite element analysis of the fixed supported girder model: -

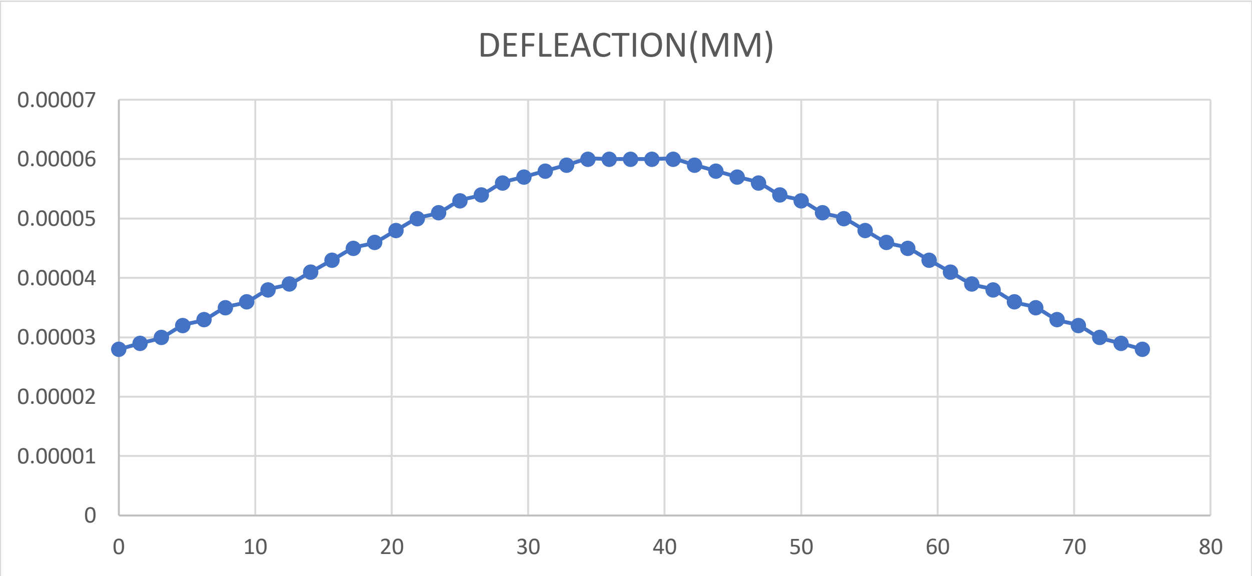


Fig 7(c). Deflection profile for point load of fixed supported girder

TABLE NO. 10 The deflection of girder for UDL along length in the finite element analysis of the fixed supported girder model:-

LENGTH	DEFLEACTION(MM)
0	0.002408
1.5625	0.00244
3.125	0.002483
4.6875	0.002535
6.25	0.002595
7.8125	0.00266
9.375	0.002728
10.938	0.002799
12.5	0.002871
14.063	0.002942

15.625	0.003011
17.188	0.003078
18.75	0.003142
20.313	0.003202
21.875	0.003258
23.438	0.00331
25	0.003357
26.563	0.0034
28.125	0.003436
29.688	0.003468
31.25	0.003494
32.813	0.003514
34.375	0.003529
35.938	0.003538
37.5	0.003541
39.063	0.003538
40.625	0.003529
42.188	0.003514
43.75	0.003494
45.313	0.003468
46.875	0.003436
48.438	0.0034
50	0.003357
51.563	0.00331
53.125	0.003258
54.688	0.003202
56.25	0.003142
57.813	0.003078
59.375	0.003011
60.938	0.002942
62.5	0.002871
64.063	0.002799
65.625	0.002728

67.188	0.00266
68.75	0.002595
70.313	0.002535
71.875	0.002483
73.438	0.00244
75	0.002408

The deflection of girder for UDL along length in the finite element analysis of the fixed supported girder model: -

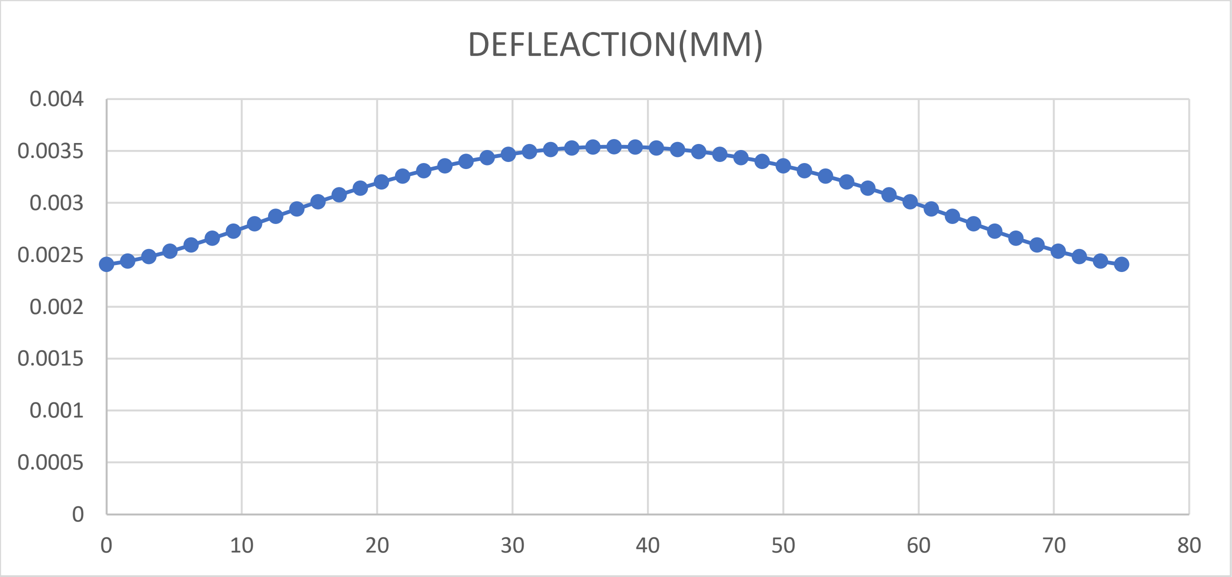


Fig 7(c). Deflection profile for UDL of fixed supported girder

CHAPTER 5

DISCUSSION

5.1 GENERAL

The stress and the deformation in the girder model are plotted for the unit load. The variation in stress across the width is not linear as reported in the simple beam theory (SBT). The stress concentration is responsible for the non-linear variation in the stress at the support in the cantilever model.

Stress localization problems are generated in the stiffened plate type structure such as box girder bridges and girders.

In the present study a model representing as the girder bridges is analyzed. The stresses at the junction of web and flange were obtained higher to those obtained by simple bending theory. The variation in the maximum deflection was observed to be deviated less than 5% from what was obtained by simple bending theory.The present study helps in the accurate design the joint of flange and web and thus the stiffeners in the composite girder bridges.

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