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DESIGN OF REINFORCEMENT OF OVERLAPPING SHEAR KEYS IN BRIDGES.

Anushree Gede[1], Prof. Amey Khedikar[2]
[1]*Research Scholar, Tulsiramji Gaikwad Patil college of Engineering and Technology, Nagpur, India,*
[2]*Research Scholar, Tulsiramji Gaikwad Patil college of Engineering and Technology, Nagpur, India,*
[1]*anushreegede0796@gmail.com*
[2]*amey.khedikar@gmail.com*

Abstract: In this research, the stability of the girder by using shear key are analyzed in ANSYS 19.2 software. There are three box girder used that is inter connected with each other with the help of shear key. The examination methodology includes finite element analysis of extension models with reasonable help and loading conditions. The outcomes demonstrate that the box girder have adequate solidarity to oppose breaking from vehicular burdens, yet shrinkage strains cause high tensile stresses in the shear key areas and lead to intelligent breaking. The examinations showed the most noteworthy burdens were frequently close to the backings, rather than at mid span.
The model of the bridge is formed in the ANSYS software and applied the static and dynamic loading. Here HS25 trucking loading are used by using AASTHO code. The deformation of the girder, shear stress, shear strain, normal stress and many more parameter are calculated. Compare all the joint loading with transverse normal stress and strain is calculated.

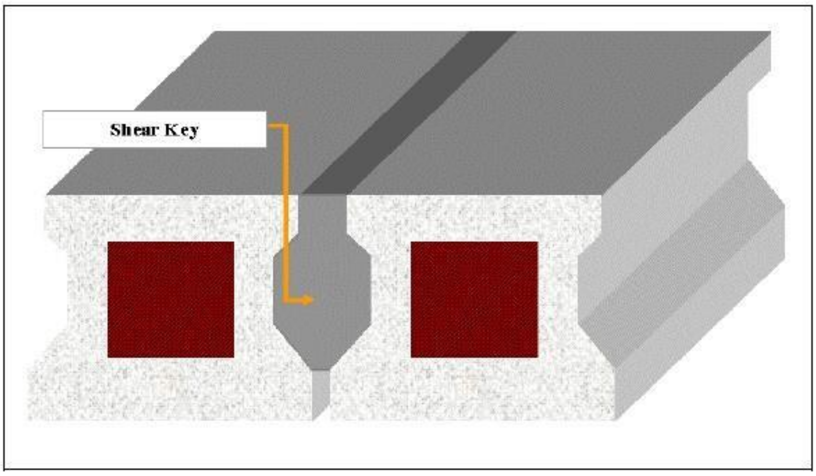
Keywords: **ANSYS, AASTHO code, Shear Key**

1. INTRODUCTION

Transportation offices across the U.S. have been utilizing substantial box brace bridge since the 1950's. This bridge style represents a critical level of new what's more, existing bridge (FHWA 2005). The segment profundity is one of the most significant contemplations for another bridge, as the upward leeway of an bridge influences many expenses related with bridge development. The concrete box brace bridge is appropriate for interstate designs that require a restricted segment profundity, short to medium ranges, and fast development. The underlying expense of the bridge is high when contrasted with other bridge types, yet, the upsides of box support spans frequently legitimize the greater expense.

The development interaction for a multi-beam bridge happens in particular stages. The first stage is the development of the crate braces off-site, at a precast cement producing office. The advantage of the precast interaction is that the maker would be able keep an elevated degree of value command over the materials utilized in the development of the box brace. The following stage is the on location development of all the bridge sub-parts, like bowed covers and move toward sections. Whenever the site is prepared for the arrangement of the box braces, they are lifted into place with a crane. Regularly, the crate braces lay on bearing cushions that will oblige the warm lengthening experienced by the crate braces. The last period of the development cycle is the production of joints, called shear keys, that interface the singular box supports together and move vehicle loads from one beam to the following so they share the loads delivered by vehicular traffic. What's more, a composite deck piece might be applied either as an essential piece of the shear key projecting.

The shear key gets its name from the exchange of vertical shear powers between nearby braces. It has a math that makes the two braces avoid as a solitary unit. At the point when present, a composite deck chunk additionally adds to the exchange of powers between nearby boxes. The multi-bar bridge cross area displayed in Figure 1 is a Texas Division of Transportaion (TxDOT) standard and uses a huge shear key.



Schematic of Two Box Girders and a Shear Key

2. LITERATURE REVIEW

Dinesh H , Sowjanya G V, S R Ramesh, dr. T V Mallesh Aug 2019

A Skew span is an extension that assembled diagonally from one bank to another. An endeavor has been made to comprehend the conduct of the slant spans with various slant pointsalso, FEM procedures. This paper incorporates various methods also, related works that have been accomplished for various slant point on spans by utilizing CSi span programming. The different load rules on spans were considered according to Indian Road Congress and its revisions. The conduct of the slant spans with the diverse length, slant points are for the most part between related. The adjustment of the various elements of the extension can influence the different boundaries like twisting second, shear power and torsional impacts. This segment sums up the finish of this review on impact of slant on the conduct of brace span investigation. For the most part, the benefit of bowing diminishes with expansion in the slant point, the worth of shear power and Torsion increments with expansion in slant point. For the mix of dead burden and live burden, it was noticed that, bowing second, second because of twist, and same configuration bowing second was expanded slowly with increment of slant point from 0° to 60°. It has been seen that for all span models considered in this review, the longitudinal Uprooting is 0.13 m most extreme for 60˚ slant.

Underlying reactions for dead burden twisting second reductions at the left outside brace and increments at right outside support. The dead burden shear power will be most extreme at left outside support and dead burden twist will be greatest at right outside brace.

The examination on slant span is finished by differing their projection slant point, section level and length plan. The little change in the construction mirror the huge changes in the result. The slant in the scaffold makes the examination and plan confounded and tedious. The way of behaving of extension in each slant point is fluctuates and increment in slant point increment the difficulty in plan. Scientific and mathematical investigations of slant span with enormous slant point have exhibit that the static and dynamic reactions of these extensions are unique from those of their straight partners. **JunyiMeng et.al.**

Different exploratory and insightful test is done on the slant extension to comprehend the reaction of scaffold in various condition. The grillage and limited component technique is use to investigate the construction. **Khaled M et.al.**
Both the technique component technique the section is discretized in are unique in relation to one another and not comparative for each lattice size, in grillage examination the piece is discretized in matrix of interconnecting shaft also, in limited matrix of interconnecting plate. In the Comparison of both the strategy, grillage technique is not difficult to utilize and not consuming additional time as contrast with the FEM and limited component strategy required more exertion and time in demonstrating than grillage, and give the exact outcome.

There are different kinds of powers are following up on the spans like breeze, seismic, dead, live loads and so forth these powers produce different response as contrast with the typical scaffold since in ordinary scaffold load response and dissemination is uniform and in slant span the calculation of the scaffolds isn't straight so the circulation of powers isn't uniform, nonuniformity in force circulation it impacted the security of the span. The powers following up on the extension is following up on a specific point, it influence the solidness of the extension and the most extreme response is acting at the insensitive corner and lesser on opposite end. **ArindamDhar et.al .**

3. METHODOLOGY

Box Girder Description

The box section, shear key, and slab are modelled using three dimensional finite element model. The box girder dimension is 40m x 40m x 7m and their slab dimension is 40m x 40m. the shear key is provided in between the two girder provided the groove in between the girder. In this model there are three boxes girder are used and two shear keys are provided. The first and last end are applied by fixed support. The whole model are formed in ANSYS 19.2 software where there is firstly formed the geometry of the model and then provided the dimension of the model. The model of the composite box girder is as follows.

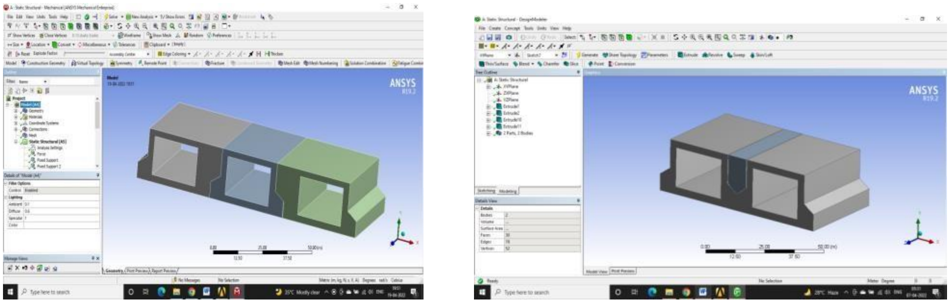
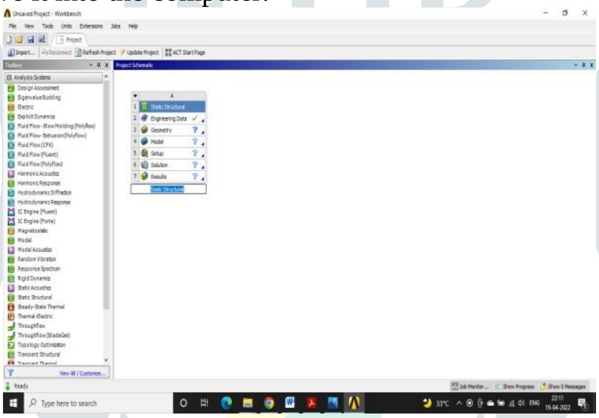


Figure 1 Model of box Girder Bridge and shear key provided in between two girders

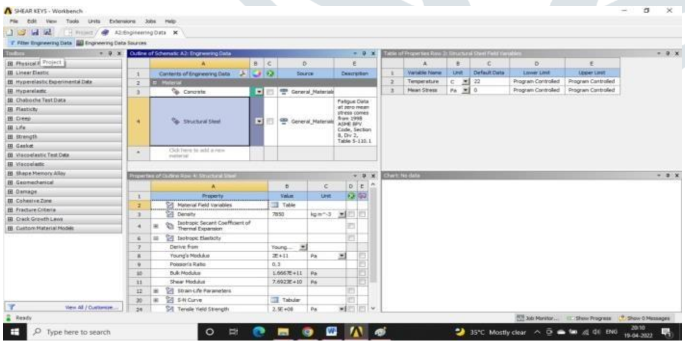
Methodology adopted for Box Girder

1. Open the ANSYS workbench and drag the analysis system to create the standalone system in the workbench. After that name the file name and save it into the computer.



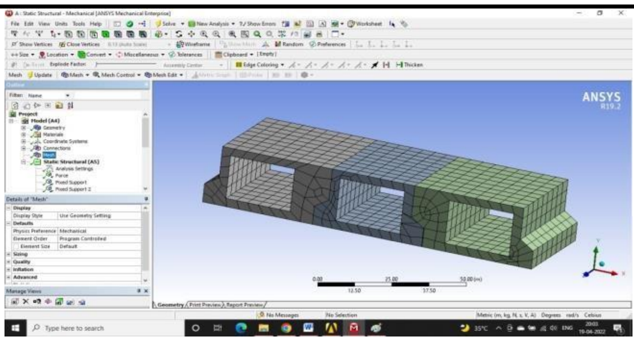
Static Structural analysis System workbench

2. Set the engineering source data by double clicking on engineering data command. In that tab the material and their properties are shown. In this the material properties are selected for the project which is used in the structure.



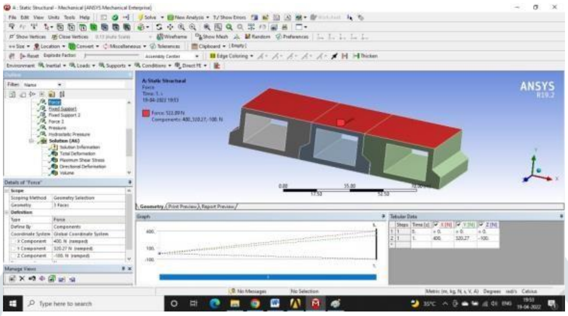
Engineering Data Source

3. Now go to the geometry tab by right click and choose DIM programming for the framework analysis. For 3d analysis another tab are used. Then after the modelling are started. The units are set out before the modelling of the structure.
4. The geometry command is like as a AUTOCAD software command but the difference is that in AUTOCAD the drawing is formed with proper dimension and in ANSYS, first of all the structure is made and then the dimension is set out.
5. Modify all the structure and set the shear key in between the two girder. Make a solid girder and then create a hole in the solid girder. As the modelling of the girder is done then close that window and open the model window for further analysis.
6. In model window the meshing on the structure is generated with follow the proper procedure and the meshing to be generated that is shown below.

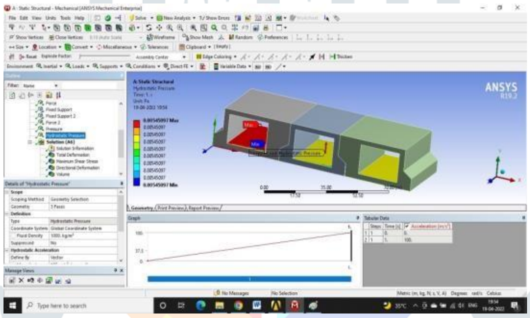


Meshing on the structure

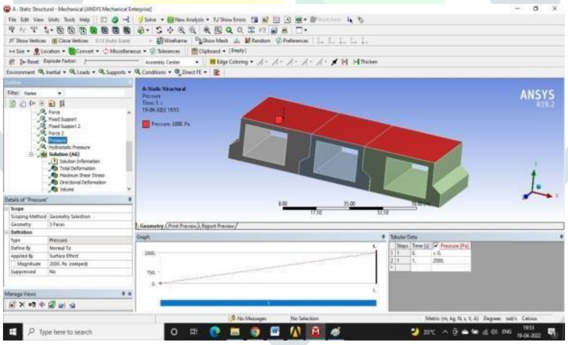
7. Apply the support, force and pressure to the structure which is shown below.



Force applied to the structure



Hydrostatic pressure applied on the girder



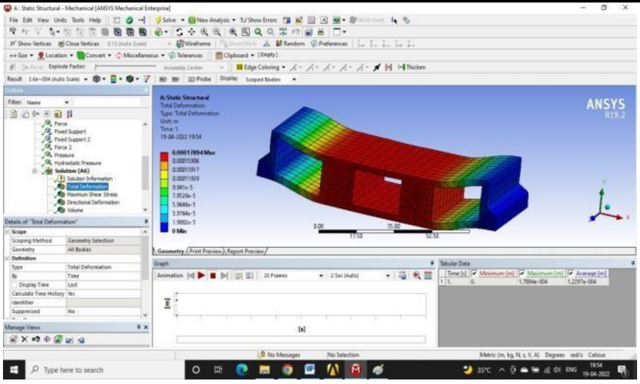
Pressure applied on the structure

8. The HS25 Loading on the bridge is considering so that the pressure applied on the bridge is about 2000Pa on the slab region.

4. RESULT AND DISCUSSION

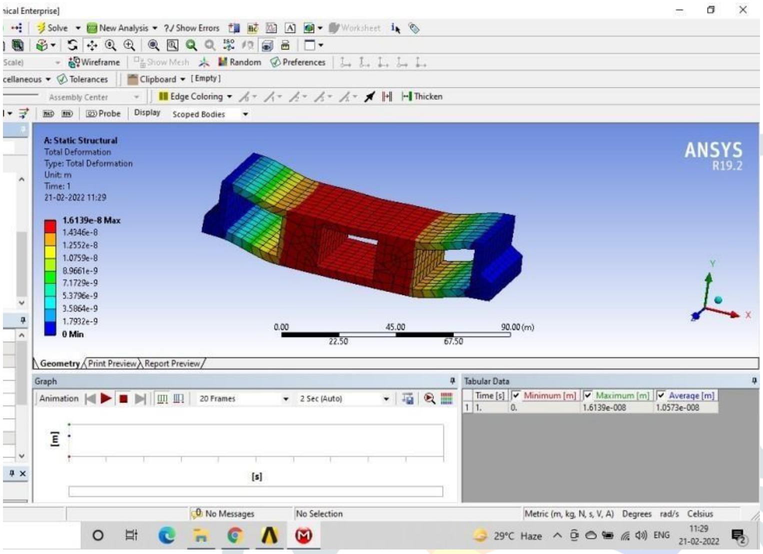
Total Deformation

Total deformation is the option that is used for checking out the deformation in X, Y and Z co-ordinates. In this analysis the result is calculated for the bridge girder is shown below.



Total deformation of the bridge girder due to 2000Pa Pressure

Time	Minimum (m)	Maximum (m)	Average (m)
1	0	1.7894 E-004	1.2297E-004



Total deformation of the bridge girder due to 25 Pa Pressure

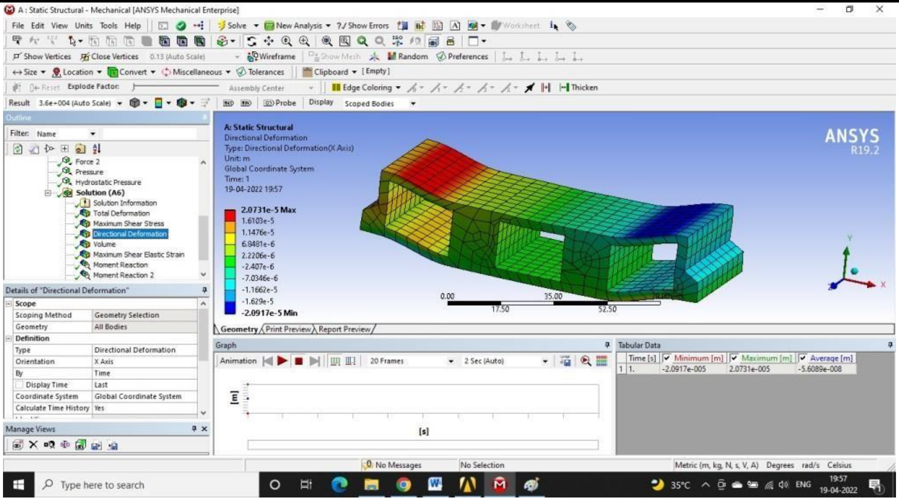
Time	Minimum (m)	Maximum (m)	Average (m)
1	0	1.6139E-008	1.0573E-008

In this the total deformation for 2000Pa loading on the bridge girder has a minimum deformation of 0 m and the maximum deformation is 1.7894 E-004. And the average deformation is 1.2297E-004 m is very negligible but in case of 25Pa, it is 1.6139E-008 m maximum deformation and the average deformation is 1.0573E-008 m. from this it is concluded that as the loading increases the deformation of the bridge girder increases.

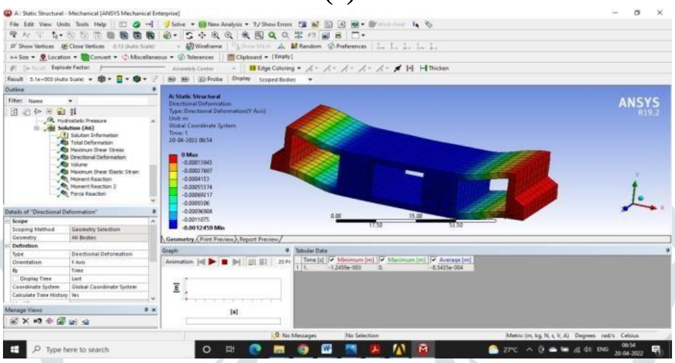
The failure effect in the shear key occurs due to gradually up gradation of truck loading. The reinforcement provided in the slab region to be bending due to the loading. Reinforcement is provided for the purpose of absorbing the tensile force generated by the loading condition which results the deformation in the structure occur.

Directional Deformation

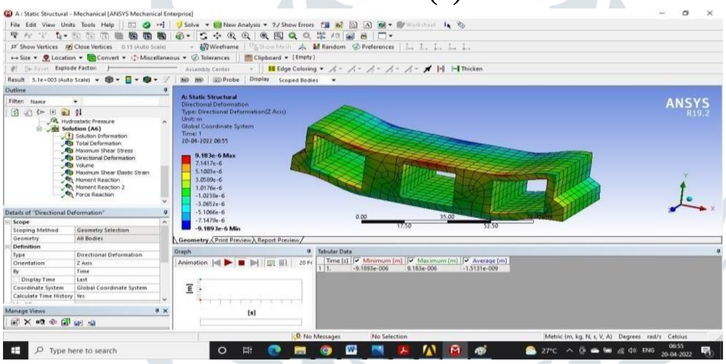
The directional deformation is the deformation that is produced due to the x co-ordinates, Y co-ordinates and Z co-ordinates. In this analysis the directional deformation is caused due to the loading condition and their values are shown below.



(a)



(b)



(c)

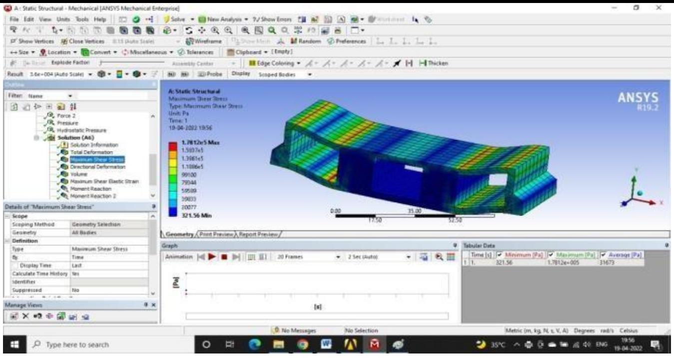
Directional Deformations in (a) X-axis (b) Y-axis (c) Z-axis

Directional Deformation				
Time	**Axis**	**Minimum (m)**	**Maximum (m)**	**Average (m)**
1	**X**	**-2.0917E-005**	**2.0731E-005**	**-5.6089E-008**
1	**Y**	**-1.2459E-003**	**0**	**-8.5435E-004**
1	**Z**	**-9.1893E-006**	**9.183E-006**	**-1.5131E-009**

In this analysis it is concluded that the directional deformation is made maximum in Y direction as compare to X and Z Axis. The average value for the deformation in x direction is -5.6089E-008 m, in Y direction is -8.5435E-004 and in Z direction is 1.5131E-009. It is clear that the deformation occur in Y direction is more so that it is needed to sort out the deformation problem.

Maximum Shear Stress

The maximum shear stress theory states that the breakdown of material depends only on the maximum shear stress attained in an element. It assumes that yielding starts in planes of maximum shear stress. The maximum shear stress occur in the bridge girder is shown in the figure.



Maximum shear stress in the bridge girder

Maximum Shear Stress				
Time	**Axis**	**Minimum (Pa)**	**Maximum (Pa)**	**Average (Pa)**
1	**X**	**321.56**	**1.7812E+005**	**31673**

In this result the minimum shear stress is produced in the bridge girder is 321.56Pa and the maximum shear stress is produced in the bridge girder is 1.7812E005 which is maximum. According to the theory, the yielding starts in the bridge girder due to the loading applied.

5. CONCLUSION AND FUTURE SCOPE

1. The average total deformation due to 2000Pa pressure on the bridge is 1.2297E-004 which is very greater as compare to the deformation of the bridge having pressure 25Pa. from this it is concluded that as the pressure increases the deformation increases.
2. In Y axis the directional deformation has a greater value as compare to the X and Z direction. In Z direction the more precaution to be needed while designing the bridge with shear key.
3. The average shear stress is produced in the bridge girder is 31673Pa. due to which the yielding is getting started in the bridge girder.
4. In this result, the above value shows that the strain produced in the bridge girder is negligible i.e. 4.1175E-007 m/m. it is very much negligible value according to the structure.
5. The force reaction is calculated in X, Y and Z direction are calculated and the total reaction is found to be 7.0212E+006 N. The fixed support is provided in the first corner and the last corner of the bridge girder due to which the force reaction in X, Y and Z direction are calculated. In this the maximum force reaction is calculated in X direction.

Future Scope

1. The design of the full length shear key is provided in bridge girder and analyses in the software.
2. The span of the bridges will be increased so that at least 20 trucking loading is applied to the model.
3. Comparative analysis of the normal bridge and the shear key applied bridge will be calculated.

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