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ANALYSIS OF STRESS AND DEFLECTION IN RAILROAD TIES SUBJECTED TO LOAD

KALLA PARTHASARATHI REDDY, JAYAM SREE HAR, K. PAVAN KUMAR REDDY

ASSISTANT PROFESSOR [1,2] , ASSOCIATE PROFESSOR [3]

kpsreddy999@gmail.com, jayam.sreehari@gmail.com, pavan.intell@gmail.com

Department of Mechanical Engineering,

Sri Venkateswara Institute of Technology,

N.H 44, Hampapuram, Rapthadu, Anantapuramu, Andhra Pradesh 515722

ABSTRACT:

Rectangular in shape, railway ties (sometimes called cross ties) and sleepers provide support for railway rails. Wood was the original material for ties, but steel and concrete eventually replaced it, and now composites are commonplace. The precise and time-saving finite element approach is used to ascertain the different ties stresses caused by static and dynamic loads. Concurrent with the rise in prominence of numerical techniques for engineering analysis and the widespread usage of high-speed electronic digital computers, the FEM has evolved. The finite element method is an effective and flexible tool for many different types of problems due to its systematic generalizability. The stress study in this project is performed using finite element analysis software, namely ANSYS R11.0. A railway tie constructed of steel and composite materials is subjected to static and dynamic stresses using 3D analysis in this study. The geometric modelling tools in ANSYS are used to construct a comprehensive model of the tie. The stress distributions and deflections are examined as a result of static loading. We show the stress distribution maps, analyse the findings, and look at how they affected the tie.Achieving dynamic stability requires further modal, harmonic, and transient analysis.

Increasing the thickness of composite ties further reduces stress and increases their longevity, according to the data, which shows that they may be used instead of steel ties. Composites have a greater starting cost, which is a big drawback.

Keywords: Static analysis of rail loads, stresses, steel ties, harmonics, and transients.

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1. INTRODUCTION:

Train tracks are supported by rectangular objects called railway ties, cross ties or railway sleepers. For the purpose of supporting and fixing the rails, transferring weights to the ballast and subgrade, and keeping the rails at the right gauge, sleepers are often set transverse to the rails. Wood has always been the material of choice for ties. Although steel ties were later developed, concrete has become the material of choice. Concrete ties are significantly more common, although composite ties are also in use, albeit to a far lesser extent. The track ballast is often used to lay ties, since it offers stability, drainage, and flexibility in addition to holding the ties in position. Ballast typically consists of heavy crushed stone, however sand, gravel, and even ash from coal-fired steam locomotive fires have been used on lines with lower speeds and weight. Distributed at two-foot intervals over the gradient, they are laid.Atop that, the steel rails are placed.

the bonds, in a direction opposite to them. For wooden ties, the rails are clamped down by laying studs and driving spikes into the ties. Rail spikes secure the rails to the wooden ties. Steel clips, such as the Pandora clip, are often used to secure rails to concrete ties.The next step is to fill the areas around and between the ties with ballast, which will secure them in place. They provide a little give to tolerate weather and settling, and they also function as spacers and anchors for the rails. The ballast is at the top, so the ties are "floating" underneath it. When it comes to the rails' usage and safety, the failure of only one knot is usually negligible. In order to keep track of how old each piece of railroad tie was, railroads began hammering date nails into the ties after installation for maintenance reasons.Atypical

There are around 3,000 ties every mile of rail. Timber ties are often made of several hardwoods, with oak being one of the most common. While softwoods have the benefit of receiving treatment more easily, they are more sensitive to wear. Nevertheless, certain lines employ them still, sometimes out of material need. Some woods, like sale, are long-lasting enough to be used untreated, although most are severely creosoted or treated with additional preservatives. The primary issue with wood is its susceptibility to rot, especially in the areas where the rails and ties are connected.

Fig.1.1.rail with tie.

2. RELATED STUDY:

These ties are believed to be more durable than the traditional wooden tie, resistant to insects and decay, and offering more lateral stability. Other than that, they are said to be just as good at absorbing sound and dampening impact loads as the original wooden tie.Concrete ties need an entirely concrete track bed or none at all, and they require separate equipment, but their practicality lies in the fact that they may be replaced piecemeal with wooden ties. Plastic ties have many advantages over their hardwood counterparts, including being recyclable and avoiding the use of creosote, a harmful chemical. The use of reinforcing materials in composite ties is the subject of ongoing research with the goal of improving lateral stability while simultaneously increasing strength, decreasing weight, and decreasing cost.

Vol 10 Issue 02, May 2020
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Fig.2.1.Atrackbed

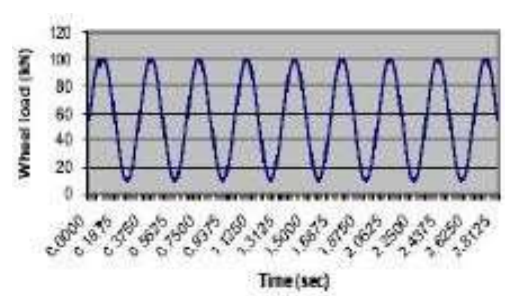
3. FEM ANSYS:

A number of engineering issues may be approximated using the finite element method, a numerical analytical tool. Many engineering colleges and businesses are starting to embrace it as an analytical tool because to its versatility and variety. Approximate solutions, as opposed to accurate closed-form solutions, are becoming more common in modern engineering. Many engineering issues cannot be solved analytically using mathematics. Mathematical expressions provide analytical solutions.

It provides the values of the required unknown quantity at any point in the body, hence it is applicable to an endless number of points in the body. Engineers often turn to numerical approaches, which provide approximate but satisfactory answers, when dealing with issues involving complicated material characteristics and boundary conditions.
For numerical solutions to many different types of engineering problems, the finite element technique is now an invaluable tool. This field has evolved in tandem with the prominence of numerical techniques in engineering analysis and the widespread usage of high-speed digital computers.Beginning with various equations or an extranet issue, this approach eventually expanded upon the structural principle to address certain elastic continuum problems.

Fig.3.1.meshedelementsoftheHH10tie.

In the computations the magnitude of the dynamic load is defined in a tabular form at discrete points of time in a cycle of loading. The points on the curve indicate at which timepointstheloadisdefined.Theelapsed time between two time points inwhich is defined



is one time increment.

Vol 10 Issue 02, May 2020
ISSN NO: 0364-4308

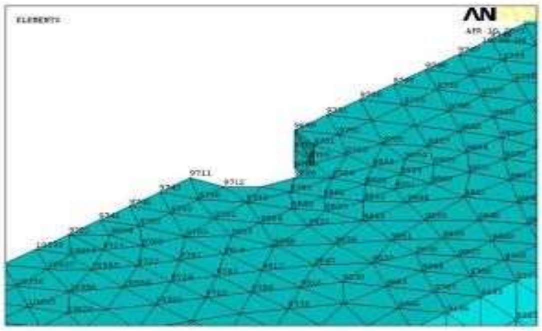


Fig.3.2.Transientloaddefinition for3Hz.

STATIC ANALYSIS OF 12mm COMPOSITE TIE:

Type of railroad tie	Steel 10mm thickness	Steel 12mm thickness	Composite 12mm thickness
Maximum stress (MPa)	82.069	70.451	68.609
Maximum Deflection(mm)	5.223	4.014	2.414

Key point	x-coordinate	y-coordinate
1	150	122
2	229	122
3	272	64
4	287	21
5	300	18
6	300	12
7	289	0
8	257	68
9	225	110
10	150	110

RESULTSAND DISCUSSIONS:

Three distinct types of railway ties are made from various materials.
Ties made of: • Steel with a thickness of 10 mm; • Composite with a thickness of 12 mm

The meshing and loading conditions are same for all of these models. We analyse all three of them using the same method. All of the ties' stresses and deflections are calculated when subjected to static loading. Results for stresses, maximum stresses, and deflections caused in different ties are shown in the table below.

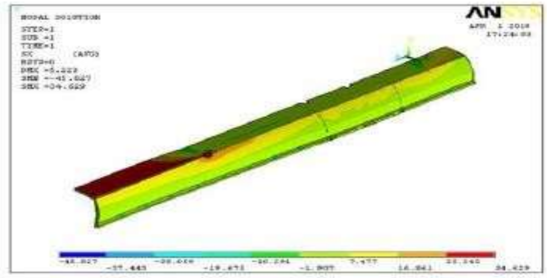


Fig.3.4.VariationofStressinx-directionofHH10 Tie, MPa

Fig.3.3.showsthemeshedmodelof12mm composite.

Below Fig shows the pattern of the transverse stress on the HH10 tie loaded by an axle load of 200KN.Maximumvalueofthetransverse stress: 82.069MPa for tension; 58.419 MPafor compression.

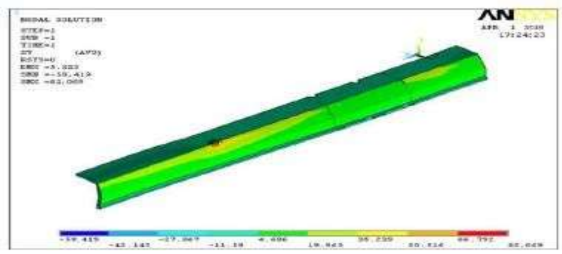


Fig.3.5.VariationofStressiny-directionofHH10 Tie, MPa.

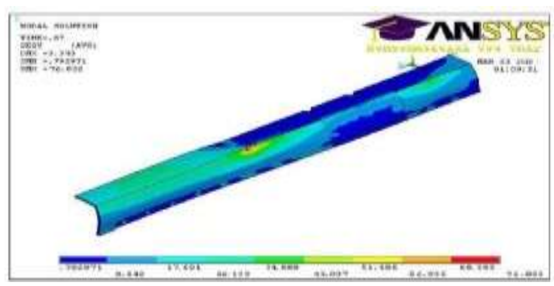


Fig.3.5.Vonmisesstressvariationattime0.67sec in steel 10mm tie (3 Hz), MPa

Above fig shows the variation of Vonmises stress on the HH10 steel tie when loaded with fig 4.2 at an accumulated time of 0.67 sec, maximum value of the stress is 76.832MPa.

Vol 10 Issue 02, May 2020
ISSN NO: 0364-4308

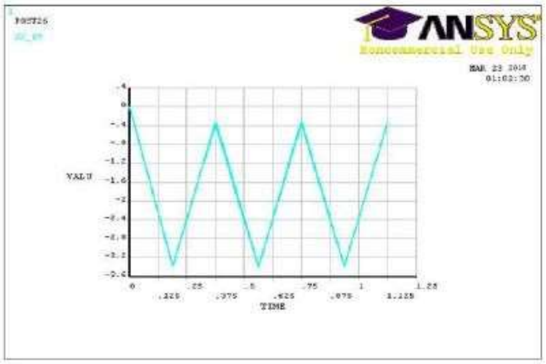


Fig.3.6showsthevariationofstressinx-direction atafrequencyof3Hzwhentheaxleloadvariesas shown in fig 3.4.

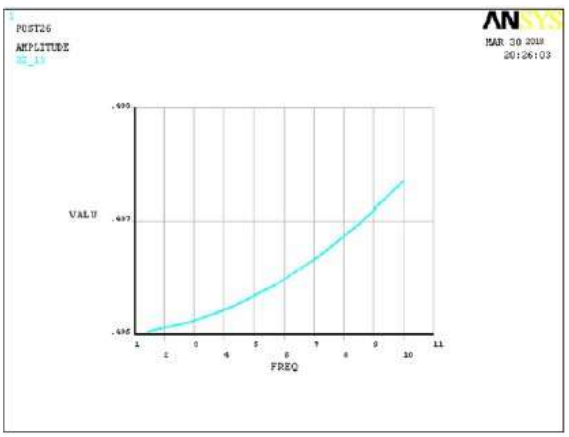


Fig.3.7.showsthevariationofstressinz-direction atafrequencyof10Hzwhentheaxleloadvariesas shown in fig 3.4.

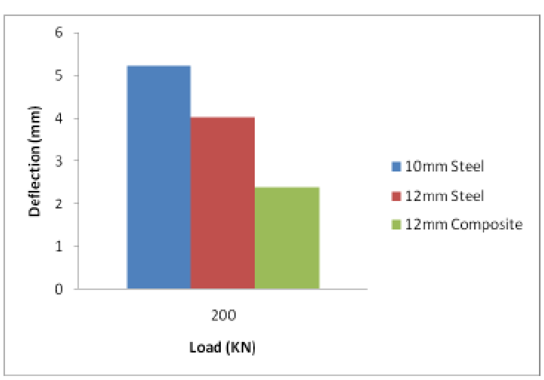


Fig.3.8. shows the variation of maximum deflectionsofsteelandcompositetieunderstaticloa ding.

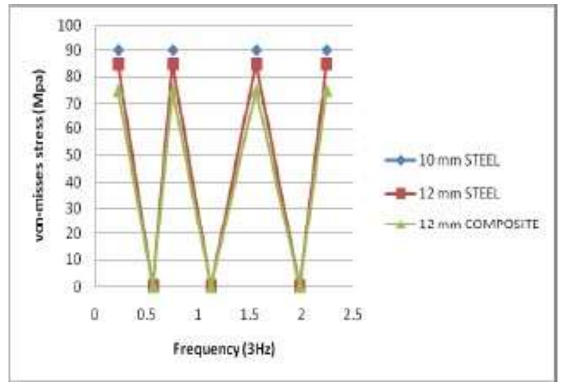


Fig.3.9.showsthevariationofvon-missesstressin steel and composite tie at a frequency of 3Hz.

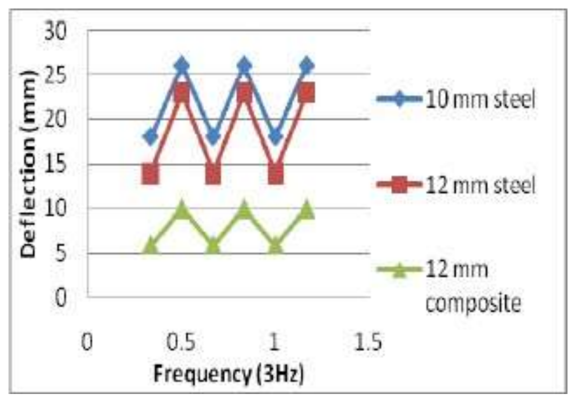


Fig.3.10. showsthevariationofdeflectionsin steel and composite tie at a frequency of 3Hz.

4. CONCLUSION:

Results showed that the highest stresses caused by a 10 mm steel tie were 82.069 Mpa, a 12 mm composite tie was 70.4 Mpa, and a 12 mm composite tie was 68.6 Mpa.

the induced deflections are 5.223 mm, 4.014 mm, and 2.414 mm, respectively. At the same loading circumstances, the static analysis showed that steel ties with a thickness of 10 and 12 millimetres produced more maximum

Vol 10 Issue 02, May 2020
ISSN NO: 0364-4308

stress than composite ties with a thickness of 12 millimetres. Composite ties are less deflection-prone than steel ones, and their maximum stress is 681.6 MPa. since of its rigidity and strength, the composite tie is more stable than steel ties. Composite ties are also better from a design standpoint since they last longer, experience less wear and tear, and do not corrode. The results of the modal study show that, in comparison to steel ties, composite ties have higher natural frequencies. The results of the dynamic study show that the longitudinal direction experiences higher stresses than the transverse and lateral orientations. At the same loading circumstances, steel ties experience greater stresses and deflection in the longitudinal direction than composite ties.Under the same stress, the composite tie is the better option, as shown above.

as per the standards for strength. This means that composite ties will replace traditional tie materials.

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