SLEEPER DESIGN USING FIBRE REINFORCEMENT

Shantanu Nalawade[1], Siddhesh Ambure[2], Soham Gharat[3], Sagar Jadhav[4], Chetan Thakur[5]

[1,2,3,4,5]*Final year Student, Department of Civil Engineering, DRIEMS*

Abstract - *Railway sleepers have important roles in the complex railway system. Due to different loading condition, poor maintenance of sleeper or bad quality of ballast, a random load distribution along the sleeper-ballast interface may occur. A sleeper design, and also the track system design, which do not consider the random load distribution, could influence the performance of the sleeper and even damage the whole railway system. That's where the role of pre-stressed concrete sleepers becomes prominent. With the ability to resist incredibly large amount of stresses before failing makes them very useful. This project will be study and designing of pre-stressed concrete sleepers with optimum strength and economy, the major factors to be considered.*

Key Words*: *Railway, Sleepers, ballast, pre-stressed, concrete, optimum, economy

1. INTRODUCTION

A railroad tie/railway tie/crosstie railway sleeper rails is a rectangular support for the railroad ties. Generally laid perpendicular to the rails, ties transfer loads to the track ballast and subgrade, hold the rails upright and keep them spaced to the correct gauge. They provide a much needed support and balance to rails and act as cushion resisting forces imposed upon them by trains. They are usually made up of timber, cement, steel and concrete.

1.1 Concrete Sleepers

They provide a much needed support and balance to rails and act as cushion resisting forces imposed upon them by trains. They are usually made up of timber, cement, steel and concrete. Amongst them concrete sleepers are used on a larger scale since they are more durable and can withstand exceedingly high compression force without buckling. Concrete ties are cheaper and easier to obtain than timber and better able to carry higher axle-weights and sustain higher speeds. Their greater weight ensures improved retention of track geometry, especially when installed with continuous-welded rail. Concrete ties have a longer service life and require less maintenance than timber due to their greater weight, which helps them remain in the correct position longer. Pre-stressed concrete sleepers especially have been a revelation in the field of engineering and designing is our primary motive. They impart greater strength and high resistance to sleepers making it more stronger. Fibre reinforcement has been adopted to enhance its initial characteristics and economy. Use of PVC fibre instead of standard steel reinforcement is our innovation for the same.

1.2 Literature Review

In order to precisely understand and gather concise information regarding the design of sleepers it is necessary to completely grasp and understand the details regarding the same. Sleeper design has previously been adopted by plethora of groups and for better understanding we have thoroughly scrutinized these papers and have implemented the ideas and some of the data in our project.

1.2.1) Shan Li, KTH Royal Institute of Technology

Behaviour of pre-stressed sleepers when imposed under carriage load and it's behaviour whilst resisting it has been studied and adopted from paper published by Shan Li hailing from institute KTH royal institute of technology. Pre-stressing by pre and post tensioning have been described in an elaborative manner. The detailed study of its methods have been instrumental in clear understanding of the subject matter and it's implementation in our project.

1.2.2) Doctor Martin Howard, ME Civil, Phd, Queensland University -

The most prominent aspect of sleeper designing is reliant on the method which is to be adopted while designing. USLM (Ultimate Limit State Method) is adopted from the paper published by Doctor Martin Howard Murray , ME Civil, PhD, senior lecturer at Queensland university and Jian Blan, ME, researcher at Queensland university.

1.2.3) Indian Railway Standard Specification , T -39-85 -

Other information regarding design of sleepers have been adopted from various websites related to Railway Engineering. Internet has been major source of information and myriad of data available online has been extracted from the same. Practically designing the sleeper and it's appropriation will be carried out further and field based data will be provided after performing the same. Data regarding the gauge length and constant dimensions of sleepers have been thoroughly described in Indian railway standard specification for pre-stressed broad gauge and meter gauge sleepers, T- 39-85.

2. OBJECTIVE OF PROJECT

- Make use of plastic fiber reinforcement and silica instead of conventional steel reinforcement to fulfill our purpose of achieving economy.
- Reducing the machineries required for pre-tensioning.

Methods of Design -

1.5.1 ULTIMATE LIMIT STATE METHOD

- The ultimate limit state is caused by a single once-off event such as a severe wheel flat that generates an impulsive load capable of failing a single concrete sleeper. Failure under such a severe event would fit within failure definitions causing severe cracking at the rail seat or at the mid-span.

1.5.2 PRE-STRESSING BY PRE-TENSIONING

- Anchoring of tendons against the end abutments
- Placing jacks
- Applying tension to the tendons
- Casting of concrete
- Cutting of the tendons

1.5.3 INNOVATION

- Use of Silica along with cement.
- Efficiently using plastic fiber reinforcement (PVC) as an alternative to steel reinforcement.

Based on assumptions and design we have plotted this data for design of concrete sleepers-

$l(distancebetweenties) = 0.45m$

$E(Young'sModulus) = 2.067 \times 10^{11} N/m^2$

$J(Inertia) = 2158 \times 10^{-8} m^4$

$Q_{wh}(wheelload) = 12 \times 92214 + 20 \times 29062.125$

$= 1106568 + 581242.5$

$= 1681810.5N$

$P = 130 KN/m$

$P = 0.13 KN/m$

Dynamic load of wheel-

$Q_{total} = Q_{wh}(1 + t \cdot s)$

Since V=60km/hr, w=1

s' = 0.1w (excellent track condition)

s' = 0.1 X 1

s' = 0.1

t = 3 (for probabilistic Certainty)

$\therefore Q_{total} = Q_{wh}(1 + 3 \times 0.1)$

$= 2194153.65KN$

M* = 0.8F (Qtotal)

$M^* = 0.8 * 2194153.65 = 1755322.92kN.M$

Procedure of Casting-

FIBRE REINFORCEMENT (PVC) AND SILICA

1. We chose a hollow cylindrical plastic Fibre pipe as a reinforcement having a diameter of 10mm.
2. The pipe was cut according to the size of the mould.
3. The pipe was threaded throughout its length for a better bonding between the outer surface of the plastic fibre reinforcement and concrete.
4. The mould was properly oiled on all the inner surfaces.
5. For preparing the Cement Mortar we took a ratio of 1:4 (1-Cement, 4- Fine Sand)
6. We took Fine Sand passing through the sieve of size 3.8mm and retaining on 1.8mm sieve.
7. As per volume batching we took 12litres of Fine Sand and 3Litres of Cement.
8. A water cement ratio of 1:2 was taken.
9. To increase the strength of concrete silica fumes were added.
10. The concrete was properly mixed together.

11. The reinforcement was placed in the mould as per the design given in the figure below.
12. The concrete was poured into the mould and compaction was done simultaneously.
13. Proper shape and smooth surface was provided.
14. The cast was removed from the Mould after 7 days and curing was done to gain proper strength.

Sample No.	w/c ratio	Admixture	Compressive strength
1	1:2:4	Silica Fumes	350 KN
2	1:2:4	Lime	320 KN
3	1:2:4	LW+ Seal	310 KN

3. CONCLUSIONS

1. The high costing steel was replaced by cheap plastic fibre reinforcement making it highly economical.
2. Heavy machines required for pre tensioning was avoided.
3. The risk of the wires in pre tensioning was avoided.

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