Structural performance of heavy duty composite railway sleeper

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Introduction

• Heavy duty mono-block prestressed concrete sleeper currently suffers from rail-seat deterioration and unexpected cracking due to chemical attack.
• Early failure of sleeper increases the track maintenance cost.
• The production of cement for infrastructure (e.g., concrete sleeper) contributes to more than 5% of global carbon dioxide emission.
• Composites are now an emerging materials because they are environmentally friendly, have high strength and good resistance to chemical attack.

Motivation

• High maintenance cost
• Huge CO₂ emission
• Early failure of sleepers

Are composite materials a suitable alternative for heavy duty railway sleeper application?

Objective

• To investigate the performance of sandwich composites coated with polymer concrete and determine their suitability for heavy duty sleeper application.

Materials and method

Composite railway sleeper concept

Optimization

Analysis and results

(a) optimal design
(b) testing of sleeper

Fig. 4: Optimised composite sleeper

Fig. 5: Composite sleeper on high stiffness support foundation

Table 1: Performance of composite sleeper

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Results</th>
<th>Allowable limits</th>
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</thead>
<tbody>
<tr>
<td>Deflection of sleeper, (mm)</td>
<td>2.13</td>
<td>6.35</td>
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<tr>
<td>Sleeper-ballast contact pressure, (kPa)</td>
<td>670</td>
<td>750</td>
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<tr>
<td>Tensile bending stress, (MPa)</td>
<td>2.57</td>
<td>5.5</td>
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</tbody>
</table>

Conclusions

• Optimal composite sleeper design reduces approximately two-third volume of material usage.
• Structural performance of composite sleeper complies with the design requirements for heavy duty railway sleeper.

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