Analysis of Rigid Pavement
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Abstract—Analysis of the rigid pavement is necessary to study and evaluate the pavement for improve the design procedure in the traditional design method. Rigid pavement is studied for to find out the weaker portion, causes of distress such as deflection, tensile stresses, temperature stresses, stresses at joints, edge and at corner of the pavement. Stress pattern are plotted for the same. Finite-element analysis is not new to the pavement analysis and research community. In past 20 years 2-dimensional finite program was use for analysis of rigid pavement. Now a days 3-dimensional finite-element analyses appeared as a influential tool which is most useful for study the pavement response. The study of effect of temperature effect, stress pattern for various condition of pavement using ANSYS software is presented. Theses study result are compared with traditional design method and required improvement in design are suggested. It is observed that temperature caused stresses in long slab. And heavy load caused critical stress at joint, edge and corner of the slab.

Key words: ANSYS, D.C. Rigid pavement

I. INTRODUCTION

Now a days concrete pavements is widely adopted type of pavement for construction of new roads in India due to their long life and small maintenance. The current designing of the rigid pavement sub-grade, sub-base followed by DLC layer on which top concrete layer is provided. Rigid pavements have flexural strength and flexural rigidity. In rigid pavement stresses are just up to the slab they are not transfer in below layers. The rigid pavement is constructed by plain cement concrete, reinforcement concrete. The plain cement concrete pavement flexure stress up to 4 N/mm2. Wheel loads and temperature variation causes the stresses in the pavement

ANSYS software is used for the modeling and analysis of the rigid pavement. In this study 3 dimensional finite element model for concrete pavement is developed. For this analysis of the pavement ANSYS software used.3 dimensional SOLID 185 element having 8 nodes with three degree of freedom element is used for modeling in the software.

The main objectives of analysis to determine the effect of temperature stresses and to study the stress pattern at the different position of the pavement. Modeling is done for various thickness of the pavement to study the effect of it on the stresses. This number of modeling for different properties of the pavement gives effective slab model which can be used for further design purpose.

<table>
<thead>
<tr>
<th>Pavement Thickness (mm)</th>
<th>Relative Stiffness (I)</th>
<th>Boundary coefficient (β)</th>
<th>Temperature Different (t)</th>
<th>Corner Stress σc N/m²</th>
<th>Edge Stress σe N/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>7000</td>
<td>350</td>
<td>0</td>
<td>3x10³</td>
<td>0.8</td>
</tr>
<tr>
<td>200</td>
<td>7000</td>
<td>350</td>
<td>0</td>
<td>3x10³</td>
<td>0.8</td>
</tr>
<tr>
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<td>0.8</td>
</tr>
</tbody>
</table>

Table 1: Properties of Pavement for stress analysis

II. MODELING OF PAVEMENT

Modeling of pavement is done using ANSYS software to study the effect of traffic and temperature stresses on the pavement. SOLID 65 element is used for pavement slab and SOLID 185 element is used for the sub-base and sub-grade layers. Single axle and Tandem axle load is applied on the pavement slab at the corner, edge, and interior portion of the slab to evaluate the weaker portion in the slab.

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</tbody>
</table>

Table 2: Properties of Pavement for stress analysis

Fig. 1: Traffic load Stresses

Fig. 2: Temperature Stresses

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### Table 3: Temperature Stresses

<table>
<thead>
<tr>
<th>Load Stress N/mm²</th>
<th>Single Axle</th>
<th>Tandem Axle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Corner Stresses</td>
<td>Edge Stresses</td>
</tr>
<tr>
<td></td>
<td>σc N/mm²</td>
<td>σe N/mm²</td>
</tr>
<tr>
<td>3.3</td>
<td>2.6</td>
<td>6.03</td>
</tr>
<tr>
<td>2.4</td>
<td>1.9</td>
<td>5.47</td>
</tr>
<tr>
<td>1.7</td>
<td>1.4</td>
<td>4.90</td>
</tr>
<tr>
<td>1.3</td>
<td>1.2</td>
<td>4.26</td>
</tr>
</tbody>
</table>

### Table 4: Total Temperature Stresses

<table>
<thead>
<tr>
<th>Load Stress N/mm²</th>
<th>Single Axle</th>
<th>Tandem Axle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Corner Stresses</td>
<td>Edge Stresses</td>
</tr>
<tr>
<td></td>
<td>σc N/mm²</td>
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<td>4.26</td>
</tr>
</tbody>
</table>

**Fig. 2: single axle**

Above comparison shows that the temperature stresses are significantly higher than the stresses due to traffic load at the corner of the pavement.

### Fig. 4: Edge stresses

**III. ANALYSIS OF PAVEMENT WITH DIFFERENT SUB-BASE**

It is important to study the pavement slab stresses for the different sub-base to determine the effect of different sub-base on the slab. The sub-grade quality created by a moduli of sub-base reaction. The modulus of sub-base reaction should be carefully selected considering loss of sub-base support due to erosion and the permanent deformation, the maximum value of modulus of sub-base reaction is suggested as 0.2 N/mm³. For the analysis purpose modulus of sub-base is selected from 0.08 N/mm³ to 0.16 N/mm³ with step of 0.020 N/mm³ to determine the stresses for the minimum subgrade reaction. Ansys software is used for determination of the stresses at the edge, corner and middle portion of the pavement.

**Table 5: Stresses for different sub-base**

<table>
<thead>
<tr>
<th>Sub-base Reaction N/mm³</th>
<th>Interior Stresses N/mm²</th>
<th>Edge Stresses N/mm²</th>
<th>Corner Stresses N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.08</td>
<td>0.677</td>
<td>1.20</td>
<td>0.712</td>
</tr>
<tr>
<td>0.1</td>
<td>0.651</td>
<td>1.15</td>
<td>0.691</td>
</tr>
<tr>
<td>0.12</td>
<td>0.622</td>
<td>1.11</td>
<td>0.672</td>
</tr>
<tr>
<td>0.14</td>
<td>0.595</td>
<td>1.10</td>
<td>0.657</td>
</tr>
<tr>
<td>0.16</td>
<td>0.557</td>
<td>1.09</td>
<td>0.643</td>
</tr>
</tbody>
</table>

**Fig. 5: Sub-base stresses**

**IV. ANALYSIS OF PAVEMENT WITH DIFFERENT SUB-GRADE**

In previous analysis for different sub-grade value, it is found that, there is not significant change in stress value. The study shows that change in sub-base reaction does create large effect on the pavement stresses. Now the pavement analysis
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is done for the different sub-grade of different layer to study their effect on the pavement stresses. Stresses are determined by using software only as there is no more change in stresses value by analytical method.

<table>
<thead>
<tr>
<th>Modulus of Sub-grade Reaction N/mm³</th>
<th>Interior N/mm²</th>
<th>Edge N/mm²</th>
<th>Corner N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.021</td>
<td>1.48</td>
<td>2.64</td>
<td>1.56</td>
</tr>
<tr>
<td>0.035</td>
<td>1.08</td>
<td>1.95</td>
<td>1.17</td>
</tr>
<tr>
<td>0.046</td>
<td>1.05</td>
<td>1.87</td>
<td>1.10</td>
</tr>
<tr>
<td>0.053</td>
<td>1.01</td>
<td>1.81</td>
<td>1.08</td>
</tr>
<tr>
<td>0.055</td>
<td>0.95</td>
<td>1.77</td>
<td>0.90</td>
</tr>
</tbody>
</table>

Table .6 Stresses for different subgrade

![Sub-grade Stresses](image)

V. CONCLUSION

1) Analysis of the pavement shows that the there temperature gives higher value than the traffic load.

2) Comparison of the stresses shows that the temperature stresses are approximately 30.5% greater than the traffic load.

3) From the analysis of the pavement for different modulus of sub-base reaction there is no significant change in the stresses. There is gradual decrease in stresses for more value of sub-grade reaction.

4) Increase in the modulus of sub-grade reaction significant decrease in the stresses value for sub-grade reaction 0.035 N/mm³ and after that value there is gradual change in the stresses.

5) For the increasing modulus of sub-grade reaction the stresses can be reduce up to 50%. It means the selection of the of the sub-grade reaction more than 0.035 N/mm³ is significant.

REFERENCES


