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Analytical Study of Steel Fibre Reinforced Rigid Pavements under Static Load

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Abstract— Nowadays, the application of steel fibers in concrete has increased gradually as an engineering material. The knowledge is not only necessary to provide safe, efficient and economic design for the present, but it also to serve as a rational basis for extended future applications. In this study, steel fibre reinforced rigid pavements are analyzed for stresses developed due to Static loads & temperature differentials. All the models are generated and analysis is carried out using the ANSYS software. Comparison of curling stresses in SFRC with conventional concrete is carried out. Parametric study for the effect of change in slab length & slab thickness of pavements on curling stresses is also done. Curling stresses due to Linear & Nonlinear temperature distribution in top & bottom layer of SFRC pavement slabs are also calculated. Frictional stresses in SFRC due to uniform temperature differential are almost same as conventional concrete. Analysis results shows, SFRC develops more stresses as compared to conventional concrete & nonlinear temperature distribution develops more stresses than linear temperature distribution. SFRC pavements are analyzed for Single axle static load for varied thickness and subgrade. Results reveal that the loading stresses are higher, when the load is at the edge region.

Key words: SFRC, ANSYS, FEM, PCC

I. INTRODUCTION

Concrete pavements, often called rigid pavements, are made up of Portland cement concrete and may or may not have a base course between the pavement and subgrade. The rigid pavements are made of Portland cement concrete either plain, reinforced or prestress concrete.

A. *Temperature stresses*

Temperature stresses in a Rigid pavement concrete (Portland cement concrete) (PCC) pavement can be classified into two types. The two types of stress in a concrete pavement are:

1) *Curling stresses (Warping stresses):*

The slab tends to warp down ward or upward inducing warping stress, whenever the top & bottom surface of a concrete pavement simultaneously possess different temperature.

2) *Frictional stresses (thermal- expansion stresses):*

There is an overall expansion & contraction of the slab due to uniform temp rise & fall in the cement concrete slab, Since the slab is in contact with soil sub grade or the Sub-base, the slab movements are restrained due to the friction between the bottom layer of the pavement & the soil layer. The frictional resistance therefore tends to prevent the movement thereby inducing the frictional stress in the bottom fibre of the cement concrete pavement. Stress in slabs resulting due to this phenomenon varies with slab length. Temperature stresses can also occur in PCC pavements as a result of uniform temperature changes that cause the slab to contract or expand.

Westergaard's solution has been widely used in estimating thermal stresses in curled concrete pavement. In recent days mechanistic approach is becoming more popular for analyzing pavement stresses. Finite element technique is the generally accepted mechanistic approach since it can handle complex loading and geometric conditions. [1]

B. *Steel fiber reinforced concrete (SFRC):*

Concrete containing randomly oriented discontinuous discrete steel fibers is known as Steel fiber reinforced concrete. Steel Fiber Reinforced Concrete (SFRC) is concrete containing dispersed steel fibers. The most significant influence of the incorporation of steel fibers in concrete is to delay and control the tensile cracking of the composite material. Concrete is a brittle material that will not carry loads under pure bending when cracked. By incorporating steel fibers the mechanical properties of the concrete is changed resulting in significant load carrying capacity after the concrete has cracked.

The main objectives of this project work are

– To analyse the rigid pavements reinforced with steel fibres for temperature stresses under Static vehicular load using ANSYS software.
– To determine the temperature stresses for both linear temperature gradient and non-linear temperature gradient.
– It is also aimed to determine the effect of slab length & slab thickness on curling stresses.
– Also, to determine the critical temperature stresses at various locations in pavement under Static loads.

II. INTRODUCTION TO ANSYS

Finite Element Analysis (FEA) was first developed in 1943 by R. Courant, who utilized the Ritz method of numerical analysis and variation calculus to obtain approximate solutions to vibration systems. The finite element method is a numerical procedure that can be applied to obtain approximate solutions to a variety of problems in engineering. Steady, transient, linear, or nonlinear problems in stress analysis, heat transfer, fluid flow, and electromagnetism problems may be analyzed with the finite element method the idea of representing a given domain as a collection of discrete parts is not unique to the finite element method. In this project work, the model will be generated and also engineering analysis will be carried out using the ANSYS. ANSYS finite element analysis software enables engineers to Study physical responses, such as stress levels, temperature distributions, or electromagnetic fields etc [2].

III. FINITE ELEMENT MODELLING

In this study, For all models, the properties of Steel Fibre Reinforced Concrete are taken as follows: Modulus of elasticity - E1= 35485.91 N/mm², E2=36259.48 N/mm² and E3=35850.38 N/mm² for concrete with 1%, 2% & 3% steel fibres respectively, poison's ratio = 0.15 and coefficient of thermal expansion of 9 x 10-6 per °C [3].

A. Model description for comparison of curling stresses

In this study, a 3-D finite element model for concrete pavement system has been developed. For this, the structural analysis package ANSYS has been used. A 3-D brick element SOLID 45 was used to model the concrete slab as well as the base. For all models, the concrete slab is taken as 6.1m long and 3.5m wide. Positive temperature gradient of 0.66°C/cm and a negative temperature gradient of -0.33°C/cm are applied. Three different slab thicknesses of 20.32, 25.40 and 35.56 cm were used. The following properties were used for base: poisons ratio of 0.3 and modulus of elasticity 153N/ mm², 181N/ mm² and 233N/ mm² for slab thickness of 20.32cm, 25.40cm and 35.56cm respectively. A comparison of steel fibre reinforced concrete with 1%, 2% and 3% steel fibres was done with conventional concrete.

B. Model description for parametric study

A parametric study has been conducted to study the effect of slab length and slab thickness on positive curling stresses and negative curling stresses. A 3-D brick element SOLID 45, having 8 nodes are used to model the concrete slab as well as the base. The various parameters used in the study were unit weight of SFRC= 26.72 KN/m3, Slab length – L1=4m, L2=6m and L3=8m, Slab width = 3.5m, Slab thickness- H1=18 cm, H2=24 cm and H3=30 cm, Positive curling temperature differential (temperature at the top of slab is higher than that at the bottom) T1=5.6°C, T2=8.3°C and T3=11.1°C, Negative curling temperature differential(temperature at the bottom of slab is higher than that at the top)T1=2.8°C, T2=5.6°C and T3=8.3°C and Base properties: Modulus of elasticity = 150 N/mm²,poison's ratio = 0.3 and Ground unit weight = 21KN/m3.

C. Model description for frictional stresses

The Comparison of frictional stress value of SFRC was done with the results obtained for conventional concrete. A 3-D brick element SOLID 45, having 8 nodes are used to model the concrete slab as well as the base.

The various parameters used in the study were Modulus of elasticity of Base, E = 15 x 10³ Mpa, Slab length – L = 4m, Slab width = 3.5m, Slab thickness – H = 24cm, Ground unit weight = 21 KN/m³, Friction factor = 3, Uniform temperature = 16.7°C and unit weight of Concrete = 26.72 KN/m3.

D. Model Description for Effect of Linear & Non-Linear Temperature Distribution

To study the effect of linear & non-linear temperature distribution, a 3-D brick element solid 45, having 8 nodes was used to model the concrete slab and slab is meshed for 4 layers. The base is modeled as a Winkler foundation that consists of a bed of closely spaced independent linear springs. Each spring deforms in response to the vertical load applied directly to that spring and is independent of any shear force transmitted from adjacent areas in the foundations. Spring element namely COMBIN 14 was used to represent the Winkler foundation. The effective normal stiffness of the element is taken from the IRC 58 – 2002.

The slab dimension and properties are 4.5m long and 3.5m wide and having thickness 150mm, 200mm, 250mm and 300mm. Correspondingly temperature differentials values were 17.3, 19, 20.3 & 21°C, density of concrete– 26.72 KN/m³and modulus of sub-grade reaction k = 6 x 10^7 N/m3 [4]. The details of load application are shown in table 7 & 8.

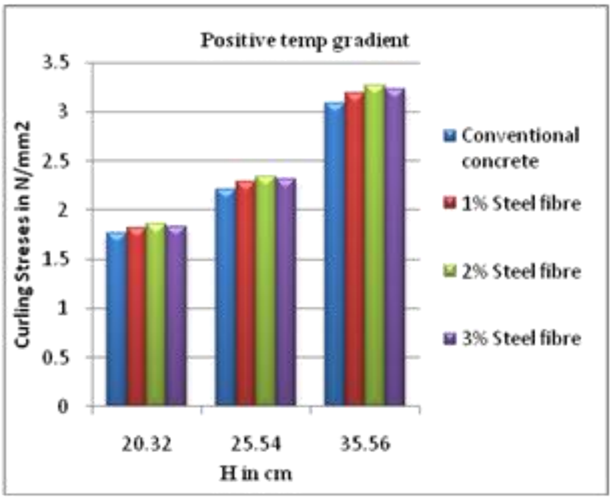
E. Model Description for Effect of single axle static load

The model contains two layer namely concrete base and subgrade. Solid 64 was used to simulate subgrade soil behavior. A single segment of slab of size 3.5m x 4.5m was used for analysis. The width of slab taken is that of single lane carriage way. The length of slab is taken as different between two successive contractions joints. The slab segment was analyzed for single axle load by varying slab thickness and coefficient of subgrade modulus (k) values. The varied slab thickness are 150mm, 200mm, 250mm, 300mm and k values as 6x10^7N/m3, 8x10^7N/m3, 10x10^7N/m3, 15x10^7N/m3 and 30x10^7N/m3. The properties of Steel Fibre Reinforced Concrete are taken as follows: Modulus of elasticity E=36259.48 N/mm² for concrete with 2% steel fibres respectively, poison's ratio = 0.15 and coefficient of thermal expansion of 9 x 10^{-6} per °C. The poison's ratio for subgrade is 0.4.

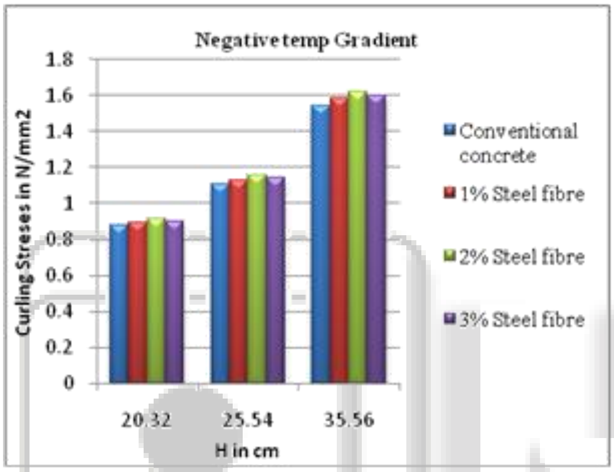
Single Axle Single Tyre (SAST) with a static load of 10.2 tonnes was applied upon the pavement at three locations i.e. mid slab, corner of slab & at edge. The axle spacing was 1800 mm for single axle.

Slab Thickness H in cm	**Analytical model [ANSYS]**	**Maximum Curling Stresses N/mm2**	
		Positive Gradient [0.66 C/cm]	**Negative Gradient [-0.33 C/cm]**
20.32	Conventional concrete	1.760	0.8803
	1% Steel fibre	1.813	0.8930
	2% Steel fibre	1.853	0.9129
	3% Steel fibre	1.832	0.9024
25.54	Conventional concrete	2.210	1.110
	1% Steel fibre	2.285	1.132
	2% Steel fibre	2.335	1.157
	3% Steel fibre	2.308	1.144
35.56	Conventional concrete	3.080	1.54
	1% Steel fibre	3.195	1.586
	2% Steel fibre	3.263	1.620
	3% Steel fibre	3.227	1.602

Table 1: Comparison of curling stresses



Graph 1: Comparison of Positive Curling Stresses of SFRC with Conventional Concrete



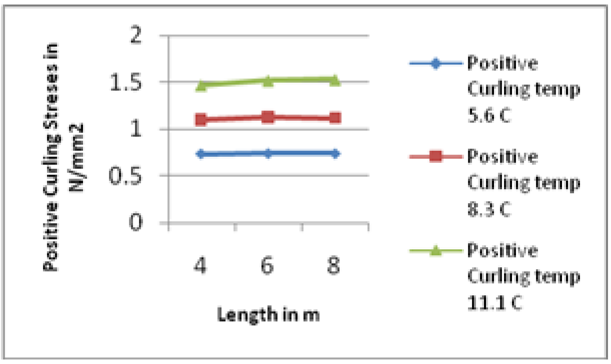
Graph 2: Comparisons of Negative Curling Stresses of SFRC with Conventional Concrete

Slab Dimensions in M	Positive curling Temperature C	Stresses in N/mm2		
		1% Steel Fibre	2% Steel Fibre	3% Steel Fibre
4 x 0.24 x 3	5.6	0.721	0.735	0.727
	8.3	1.07	1.10	1.08
	11.1	1.44	1.47	1.45
6 x 0.24 x 3	5.6	0.724	0.738	0.731
	8.3	1.09	1.13	1.10
	11.1	1.48	1.52	1.50
8 x 0.24 x 3	5.6	0.723	0.737	0.733
	8.3	1.08	1.12	1.11
	11.1	1.49	1.53	1.51

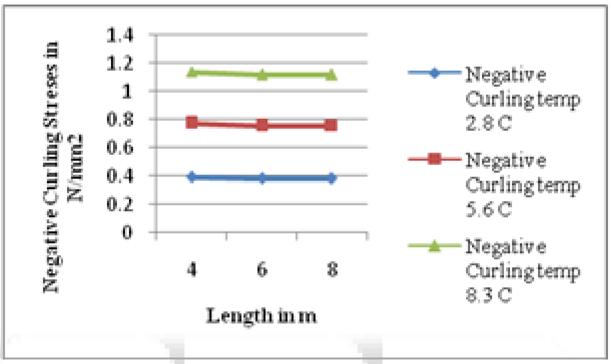
Table 2: Effect of Slab Length on Positive Curling Stresses

Slab Dimensions in M	Negative curling Temperature C	Stresses in N/mm2		
		1% Steel Fibre	2% Steel Fibre	3% Steel Fibre
4 x 0.24 x 3	2.8	0.383	0.391	0.388
	5.6	0.758	0.773	0.766
	8.3	1.12	1.14	1.13
6 x 0.24 x 3	2.8	0.373	0.382	0.378
	5.6	0.740	0.755	0.748
	8.3	1.09	1.12	1.11
8 x 0.24 x 3	2.8	0.375	0.383	0.380
	5.6	0.743	0.758	0.751
	8.3	1.10	1.12	1.11

Table 3: Effect of Slab Length on Negative Curling Stresses



Graph 3: Effect of slab length on positive curling stresses for SFRC slab with 2% fibres



Graph 4: Effect of Slab Length on Negative Curling Stresses for SFRC Slab With 2%Fibres

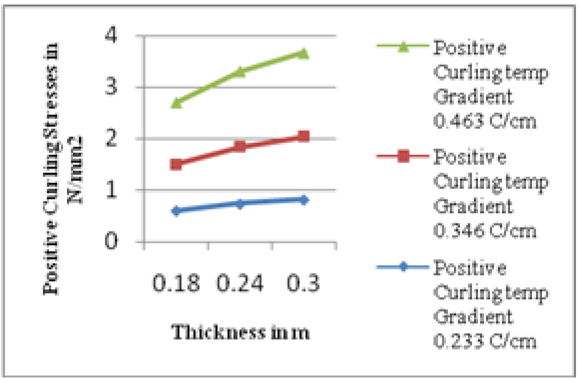
Slab Dimensions in M	Positive Gradient C / cm	Stresses in N/mm2		
		1% Steel Fibre	2% Steel Fibre	3% Steel Fibre
4 x 0.18 x 3	0.233	0.589	0.602	0.595
	0.346	0.877	0.896	0.885
	0.463	1.18	1.20	1.19
4 x 0.24 x 3	0.233	0.721	0.735	0.727
	0.346	1.07	1.10	1.08
	0.463	1.44	1.47	1.45
4 x 0.3 x 3	0.233	0.802	0.816	0.807
	0.346	1.20	1.22	1.20
	0.463	1.60	1.63	1.62

Table 4: Effect of Slab Thickness on Positive Curling Stresses

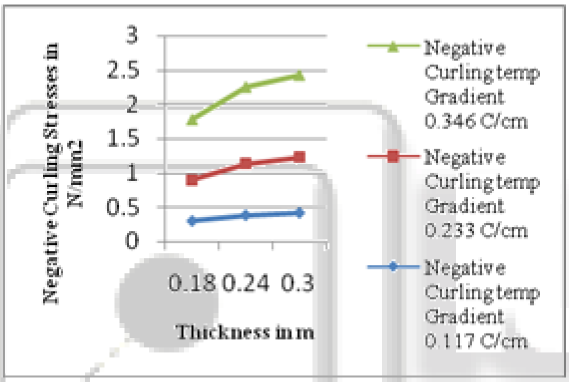
Slab Dimensions in M	Negative Gradient C / cm	Stresses in N/mm2		
		1% Steel Fibre	2% Steel Fibre	3% Steel Fibre
4 x 0.18 x 3	0.117	0.295	0.302	0.298
	0.233	0.584	0.597	0.590
	0.346	0.864	0.884	0.873

4 x 0.24 x 3	0.117	0.373	0.382	0.378
	0.233	0.740	0.755	0.748
	0.346	1.09	1.12	1.11
4 x 0.30 x 3	0.117	0.407	0.414	0.410
	0.233	0.801	0.815	0.808
	0.346	1.18	1.20	1.19

Table 5: Effect of Slab Thickness on Negative Curling Stresses



Graph 5: Effect of Slab Thickness on Positive Curling Stresses for SFRC Slab With 2%Fibre



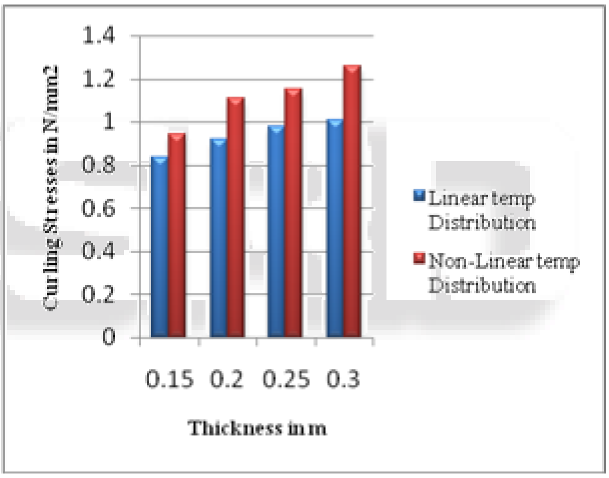
Graph 6: Effect Of Slab Thickness On Negative Curling Stresses For SFRC Slab With 2%Fibres.

Slab Dimensions in M	**Linear Temperature Distribution C**	**Maximum Curling Stresses N/mm2**		
		1% Steel Fibre	**2% Steel Fibre**	**3% Steel Fibre**
4.5 x 0.15 x 3	17.3	0.823	0.832	0.823
	11.534			
	5.768			
	0			
4.5 x 0.20 x 3	19	0.896	0.916	0.905
	12.667			
	6.333			
	0			
4.5 x 0.25 x 3	20.3	0.958	0.979	0.968
	13.533			
	6.767			
	0			
4.5 x 0.30 x 3	21	0.992	1.01	1.00
	14			
	7			
	0			

Table 7: Effect of Linear Temperature Distribution on Stresses

Slab Dimensions in M	**Non Linear Temperature Distribution C**	**Maximum Curling Stresses N/mm2**		
		1% Steel Fibre	**2% Steel Fibre**	**3% Steel Fibre**
4.5 x 0.15 x 3	17.3	0.92	0.94	0.93
	12			
	7			
	0			
4.5 x 0.20 x 3	19	1.10	1.11	1.10
	14			
	5			
	0			
4.5 x 0.25 x 3	20.3	1.16	1.15	1.16
	14.3			
	6.3			
	0			
4.5 x 0.30 x 3	21	1.23	1.26	1.24
	15			
	10			
	0			

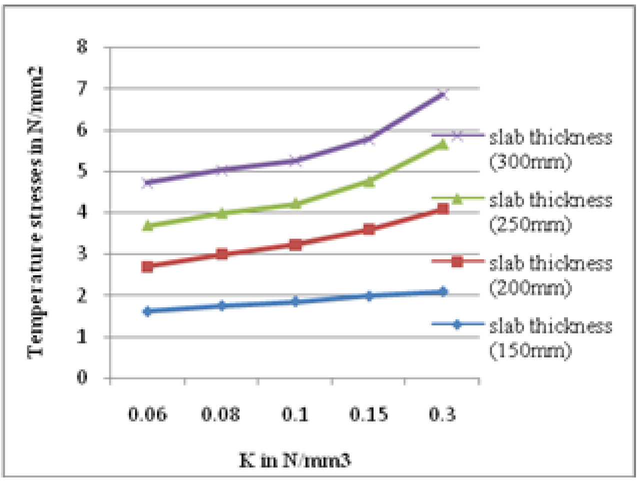
Table 8: Effect of Non-Linear Temperature Distribution on Stresses



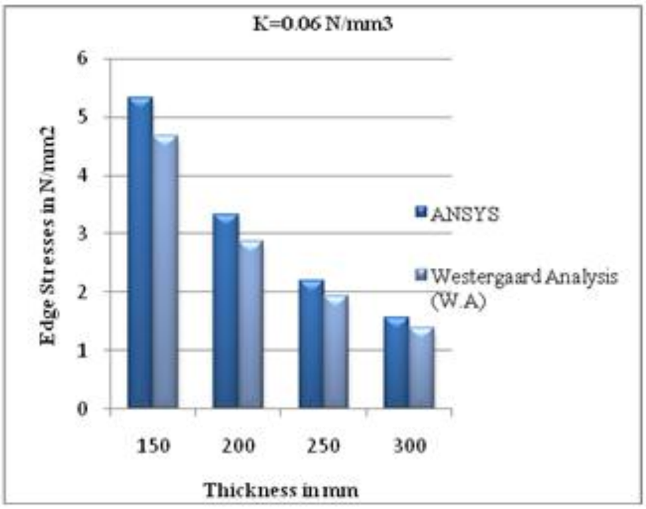
Graph 7: Comparisons of Stresses of Linear Temperature Distribution and Non-Linear Temperature Distribution

Slab Thickness (mm)	Temperature Stresses (N/mm^2)				
	ANSYS (K=0.06 N/mm^3)	ANSYS (K=0.08 N/mm^3)	ANSYS (K=0.10 N/mm^3)	ANSYS (K=0.15 N/mm^3)	ANSYS (K=0.30 N/mm^3)
150	1.61	1.75	1.85	1.98	2.09
200	1.08	1.24	1.37	1.61	1.99
250	0.99	0.99	1.00	1.16	1.58
300	1.03	1.03	1.03	1.03	1.20

Table 11: Temperature stresses for varied slab thickness and k value for SFRC slab



Graph 11: Temperature stresses for varied slab thickness and K value.



Graph 9: Comparison of results of Ansys with westergaard for edge stresses

Slab thickness (mm)	Edge Stresses (N/mm^2)									
	ANSYS (K=0.06 N/mm^3)	W .A (N/mm^3)	ANSYS (K=0.08 N/mm^3)	W .A (N/mm^3)	ANSYS (K=0.10 N/mm^3)	W .A (N/mm^3)	ANSYS (K=0.15 N/mm^3)	W .A (N/mm^3)	ANSYS (K=0.30 N/mm^3)	W .A (N/mm^3)
150	5.34	4.68	5.13	4.52	4.94	4.39	4.61	4.16	4.10	3.77
200	3.32	2.88	3.33	2.79	3.22	2.72	3.03	2.59	2.71	2.37
250	2.20	1.94	2.27	1.94	2.23	1.84	2.13	1.76	1.95	1.62
300	1.56	1.40	1.63	1.35	1.61	1.32	1.57	1.27	1.47	1.17

Table 9: Comparison of edge wheel load stresses with westergaard analysis for SFRC slab

Slab thickness (mm)	Edge Stresses (N/mm^2)									
	ANSYS (K=0.06 N/mm^3)	W .A (N/mm^3)	ANSYS (K=0.08 N/mm^3)	W .A (N/mm^3)	ANSYS (K=0.10 N/mm^3)	W .A (N/mm^3)	ANSYS (K=0.15 N/mm^3)	W .A (N/mm^3)	ANSYS (K=0.30 N/mm^3)	W .A (N/mm^3)
150	3.82	3.30	3.64	3.14	3.51	3.01	3.28	2.79	2.93	2.40
200	2.59	2.11	2.49	2.01	2.41	1.95	2.26	1.82	2.02	1.59
250	1.81	1.45	1.76	1.39	1.72	1.35	1.64	1.26	1.48	1.12
300	1.29	1.05	1.27	1.01	1.25	0.98	1.21	0.93	1.11	0.83

Table 10: Comparison of edge wheel load stresses with Westergaard's analysis for conventional concrete.

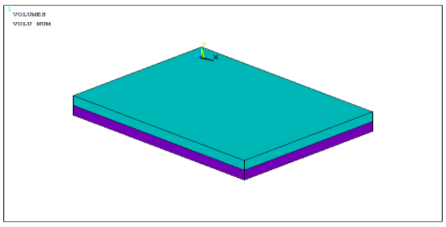


Fig 1: Pavement Model of Dimension 4 X 0.3 X m

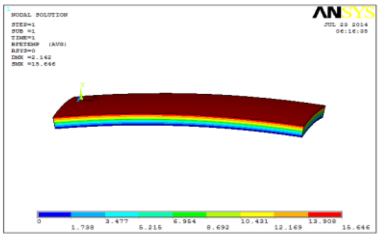


Fig 3: Positive Curling stress Contour

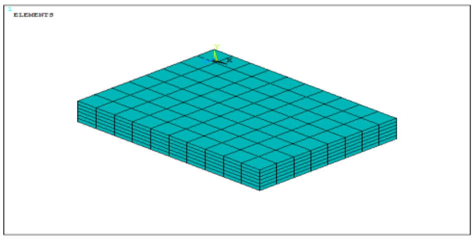


Fig 2: Meshed Pavement Model

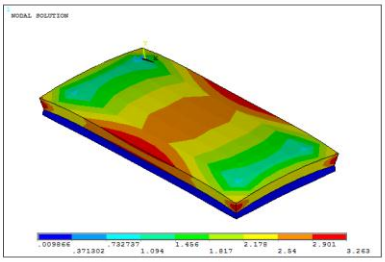


Fig 4: Positive curling temperature distribution and Deflected shape

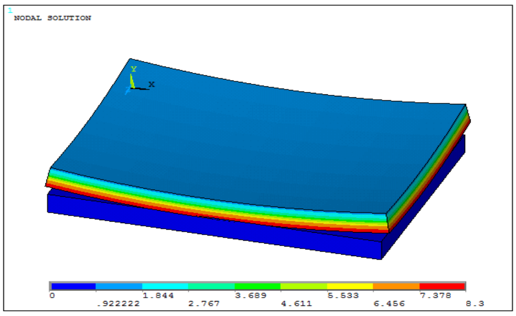


Fig 5: Negative curling stress Contour of slab length 4m

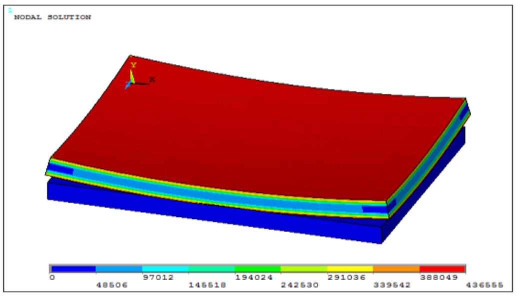


Fig 6: Negative curling temperature distribution and Deflected shape of slab length 4m

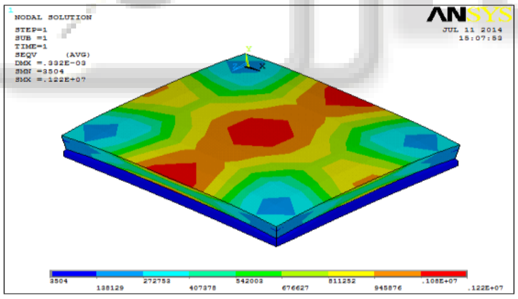


Fig 7: Contour of positive curling stresses of slab thickness 300mm

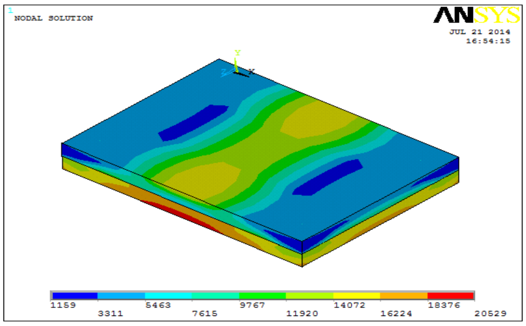


Fig 8: Contour of frictional stress due to uniform temperature

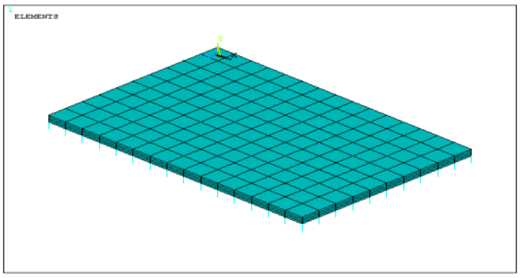


Fig 9: Pavement model of slab thickness 250mm for linear and non-linear temperature distribution

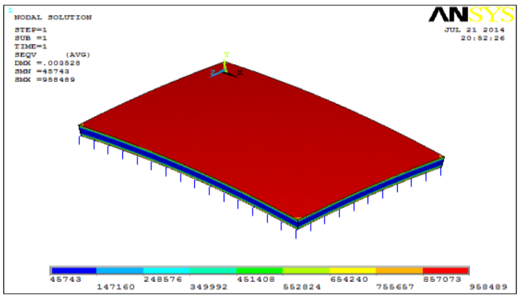


Fig 10: Contour of positive curling stresses of pavement model thickness 250mm for linear temperature distribution

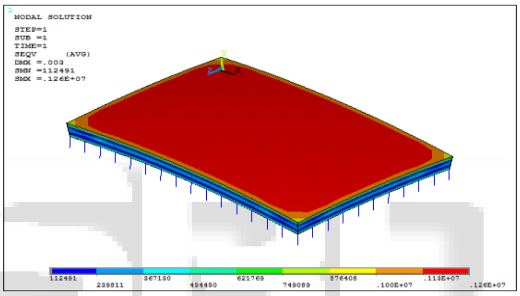


Fig 11: Contour of positive curling stresses of pavement model thickness 300mm for non-linear temperature distribution.

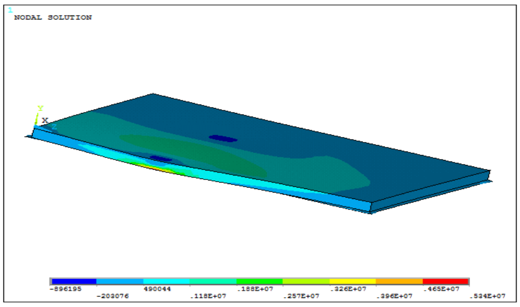


Fig 12: Contour of edge loading stresses for 150 mm thick SFRC slab and K=0.06N/mm3

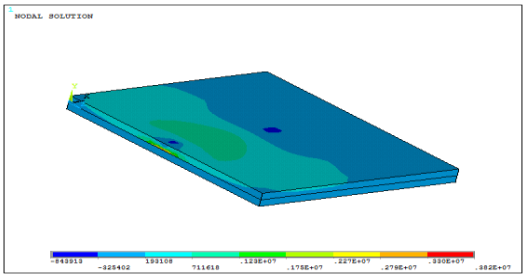


Fig 13: Contour of edge loading stresses for 150mm thick conventional concrete and K=0.06N/mm3

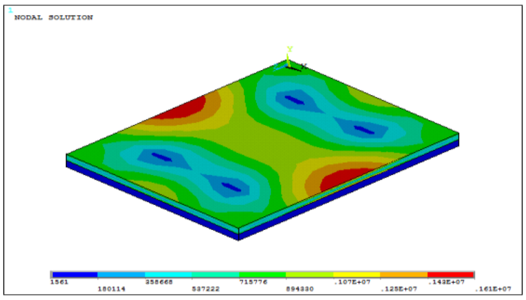


Fig 14: Contour of temperature stresses for 150mm thick SFRC slab and K=0.06N/mm3

IV. RESULTS AND DISCUSSION

A. Comparison of Curling Stress with Conventional Concrete

Steel fibre reinforced concrete slab with 1%, 2% & 3% steel fibres is analyzed here for three slab thicknesses i.e. 20.32cm, 25.54cm & 35.56cm. The SFRC Slab is analyzed for both positive temperature gradient (temperature at, the top of slab is higher than that at the bottom) and negative temperature (temperature at the bottom of slab is higher than that at the top). Temperature gradient of 0.66°C/cm depth of slab was used for positive temperature gradient and a value of 0.33°C/cm depth of slab was selected for negative temperature gradient.

The linear temperature variation is applied across the depth of slab. The temperature distribution is shown in fig 4. The slab deflection is more at the corner than at the interior of slab. The deflected shape for this case of positive temperature gradient temperature is shown in fig 4. The deflected shape for negative temperature gradient is shown in fig 6 and correspondingly temperature distribution is shown in fig 6.

Fig 3 and 5 shows the contour of positive curling and negative curling stress. Table 1 shows the comparison of curling stresses obtained by the finite element model developed in the ANSYS with the stresses of conventional concrete. The ANSYS results shows that stresses obtained for SFRC are slightly higher, when compared to conventional concrete. SFRC with 2% steel fibres yields more stress than SFRC with 1% & 3% steel fibres and Positive curling temperature gradient yields around 50% more stress as compared to negative curling temperature gradient. The comparison is shown in Graphs 1&2.

B. Parametric study

1) Effect of slab length on curling stresses

Effect of slab length on curling stresses is determined here. The Pavement Slab model is shown in Fig.1 & Meshed model is shown in Fig.2. The effect of slab length on positive curling stresses is shown in Table 2. From the table, it is observed that the increase in slab length doesn't influence the positive curling (temperature at the top of a slab is higher than that at the bottom) stresses in SFRC, it yields approximately same values. The result is shown in Graph 3. But with the increases in temperature, the stresses in slab increases. The maximum stress of 1.53 N/mm2 is obtained for Steel Fibre Reinforced concrete slab with 2% steel fibres under a positive curling temperature of 11.1^{o}C.

The effect of slab length on negative curling stresses is shown in Table 3. From the table, it is observed that as the temperature increases the stresses increases but under a particular negative curling (temperature at the bottom of a slab is higher than that at the top) as the slab length increase, the stress will remain approximately constant. The result is shown in Graph 4.The maximum stress of 1.14 N/mm2 is obtained for Steel Fibre Reinforced concrete slab with 2% steel fibres under a negative curling temperature of 8.3oC.

2) Effect of slab thickness on curling stresses

The effect of slab thickness on positive gradient is shown in table 4. From the table it can be observed that, curling stresses increase as the temperature gradient increase. On the other hand under a particular temperature gradient as the slab thickness increases the stress also increases. The comparison is shown in Graph 5.The maximum positive curling stress is obtained for a slab thickness of 300mm under a positive temperature gradient of 0.463oC/cm was 1.63 N/mm2. The effect of slab thickness when used negative gradient, is shown in table 5. From the table it can be observed that as the temperature gradient increase the stress also increase on the other hand, under a particular temperature gradient as the slab thickness increases the stress also increases. The comparison is shown in Graph 6. The maximum negative curling stress is obtained for a slab thickness of 300mm under a negative temperature gradient of 0.346oC/cm was 1.20N/mm2.

C. Frictional Stresses Due to Uniform Change in Temperature

The Frictional stress contour due to uniform change in temperature is shown in fig 8.Frictional stress of steel fibre reinforced concrete was calculated for a typical case of slab of length 4m using ANSYS. The result was compared with the value of frictional stresses in conventional concrete. The comparison is shown in table 6. From the result it was observed that the value obtained for SFRC are 5 to 10 % higher than conventional concrete. From the analysis it was observed that the frictional stress value was dependent on the uniform temperature differential value used and its value increases with the increase in uniform temperature change.

D. Curling stresses Due to Linear & Non-Linear Temperature Distribution

The contour of stresses for linear temperature distribution, deflected shape and linear temperature distribution is as shown in the fig 9 & 10. The contour of stresses for non-linear temperature distribution, deflected shape and non-linear temperature distribution is as shown in the fig 11.

The comparison of stresses for linear temperature distribution and non-linear temperature distribution can be seen in table 7 & 8 & Graph 7. It can be observed that for both linear and non- linear temperature distribution, as the thickness of slab and temperature increases, stress also increases. It was observed from the results that non-linear temperature gradient resulted in higher curling stresses than that given by linear temperature gradient. The percentage difference in the stress values for two cases varied between 21.17% and 25.15%.

E. Loading stresses due to single axle static load

The steel fibre rigid pavements was analysed for single axle static load of 102KN for the varied thickness of slab and K value. The result is tabulated in table 9. The contour of stresses for loading stresses due to single axle static load along the edge is shown in Fig.12. It is observed that the loading stresses are higher, when the loads are at edge region. Loading stress of 5.34 N/mm2 is observed at this location for 150mm thick slab and K=0.06N/mm3. Moreover, the stress at this position for conventional concrete is 3.82N/mm2 .The corner stress and centre stresses results are tabulated in table 10 and table 12.The contour of temperature stresses is shown in fig 14. The maximum temperature stresses for 150mm thick SFRC slab and K=0.06N/mm3 is 1.61 N/mm2.

V. CONCLUSION

- There is 2 to 5% increase in stresses yielded from Positive curling temperature gradient & negative curling temperature gradient in steel fiber reinforced concrete, when compared to conventional concrete.
- Steel fiber reinforced concrete with 2% steel fibres yields slightly more stress as compared to 1% & 3% steel fibre reinforced concrete for both Positive curling temperature gradient & negative curling temperature gradient.
- The variation of length of slab does not influence the curling stresses distribution in both the case of positive and negative temperature gradient for SFRC slab.
- Frictional stresses are almost similar for conventional concrete as well as steel fibre reinforced concrete.
- Non-linear temperature distribution causes higher curling stresses than the linear temperature distribution for SFRC slab.
- The increment in stresses for SFRC lies in the range of 20-41% when compared with those of conventional concrete.
- The maximum increment in the stress value obtained is 40.9% for K=0.08N/mm3 and H=150mm.

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