Stress Analysis Using KENPAVE Software to the Rigid Pavement Constructed By Using Recycled Aggregates

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Abstract- In today's world due to the rapid industrialization, recycled aggregates play an important role in the construction activities for the preservance of natural aggregates. The study is to determine the suitability of recycled aggregates for the construction of rural roads, which will in achieving the economy for the road construction and also helps in protecting environment degradation in terms reducing the mining and pollution. For the construction of rural roads requires large quantity of fresh aggregates, replacement of fresh aggregates by recycled aggregates is considered in this study.Recycled aggregates were collected from the demolished building from chamarajpet, Bangalore. Various tests were conducted on coarse and fine aggregates. Grade of the concrete used is M30. Compression, flexural and split tensile tests has been carried out and compared the test results with the prepared control mix. Also the rigid pavement analysis has been carried out in FEM based KENPAVE software. Variation of middle, edge and corner stress is found for the different slab thickness. For the analysis single axle with single wheel and dual wheel are considered.

I. INTRODUCTION

For the construction of rural roads, IRC SP: 20-2002 suggests the use of various regional standard accessible materials, including minor and industrial waste materials. By the practice, it could be possible to economy for the construction of rural roads. A few sorts of new materials are attempted to create the adaptability of new materials in pavement construction. However, the utilization of new materials and advances are not getting to be prevalent inferable from certain procedural imperative and in addition lack of awareness, therefore suitable steps have to be taken for the effective utilization of these new materials and technologies for building better rural roads in the future considering the economy. Implementation of such methods may also result in the conservation of natural resources and energy environment.

The materials used for the construction of rigid pavement are related to material rigidity or flexural strength or slab action so the load is distributed over a wide area of subgrade soil. Rigid pavements do not flex much under loading, it has high flexural rigidity performing good for long years. The rigid pavements are made of cement concrete either plain, reinforced or prestressed concrete. Due to varied and unexpected increase in wheel load and seasonal changes of climate, wheel load stresses and temperatures stresses are created in the rigid pavements. The concrete slab distributes the traffic load into a large area with small depth which in turn minimizes the need of different layers.

KENPAVE is finite element analysis software developed by Huang, Y.H is specifically used for the design of both rigid and flexible pavements. It is quite simple, easy to understand and operate. Also, it offers extensive features that can be used to analyze the pavement subjected to different conditions based on stiffness matrix method. This software can be used to analyze both rigid as well as flexible pavements considering different loading conditions.

Various geometric properties of pavement and characteristics of materials such as modulus of elasticity, Poisson's ratio, wheel load, tire pressure, traffic design are required. Now-a-days it is being widely used, and it was found that the results obtained from KENPAVE are compared with other conventional methods.

II. RIGID PAVEMENT DESIGN USING FEA

As known, rigid pavement has been limited to two layers (mostly) which are the subgrade and concrete slab which is rigid in nature and offers a harder surface. Rigid pavements are analyzed by plate theory using FEM. If the application of wheel load is in the interior of the slab, either plate or layered theory can be used and both should show nearly the same stress or strain. If the wheel load is applied near to the slab edge, say less than 2ft from the edge, only the plate theory can be used for rigid pavements. More clearly, if we consider the finite element grid, the grid will be along the size of pavement while analyzing rigid pavements and along the depth of the pavement while analyzing flexible pavements

2.1 Wheel loads

Stresses in rigid pavement depend upon many factors. Some are loading position on pavement, tire pressure, multiple wheel spacing, gross load etc. In this study two load groups were taken for the analysis of stress in pavements. They are

1. Single Axle with single wheel.
2. Single Axle with dual wheel.

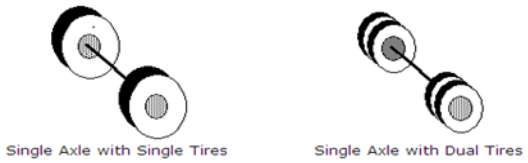

Fig 2.1: Single axle with single and dual wheels

2.2 Geometric properties of pavement

Plain cement concrete was considered in this study for analysis of stress in rigid pavements. The size of slab was 3.5 X 4m and different thickness of slab from 10 to 30cm was considered.

2.3 Material characteristics

Recycling concrete aggregates were used to model rigid pavement. From experimental results 2.8E+07 is taken as modulus of elasticity and 0.15 as poisson's ratio.

III. STRESS RESULTS

Stress results for different thickness of slab for single axle with single wheel (Load group A) and single axle with dual wheels (Load group B) analysed using KENPAVE software are as follows

Table 3.1: Stress for load group A

Thickness of slab in cm	Corner stress in kpa	Edge stress in Kpa	Centre stress in Kpa
10	3946.95	-3616.52	-3785.39
15	2417.62	-2012.45	-2122.48
20	1654.65	-1345.87	-1413.82
25	1179.70	-984.06	-1017.19
30	879.96	-755.49	-761.82

Table 3.2: Stress for load group B

Thickness of slab in cm	Corner stress in kpa	Edge stress in Kpa	Centre stress in Kpa
10	7346.84	-5915.65	-5741.62
15	4653.60	-3065.75	-3243.42
20	3206.00	-2003.27	-2185.40
25	2344.55	-713.08	-1589.01
30	1811.40	-536.87	-1202.19

IV. VARIATION OF STRESSES WITH THICKNESS OF SLAB

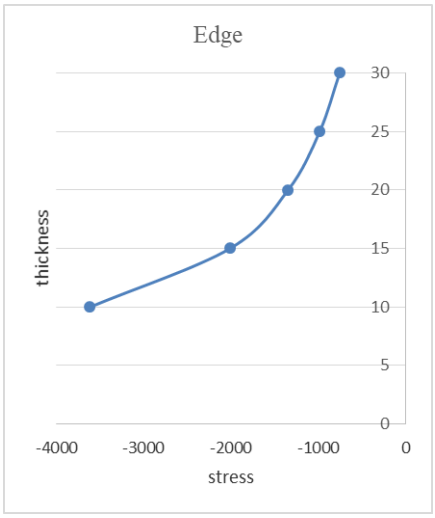

Fig 4.1: Variation of Edge stress with slab thickness for Load group A

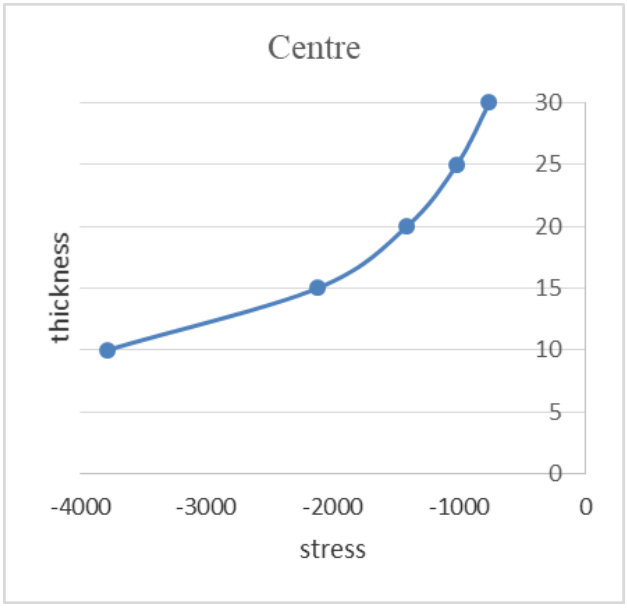

Fig 4.2: Variation of Centre stress with slab thickness for Load group A

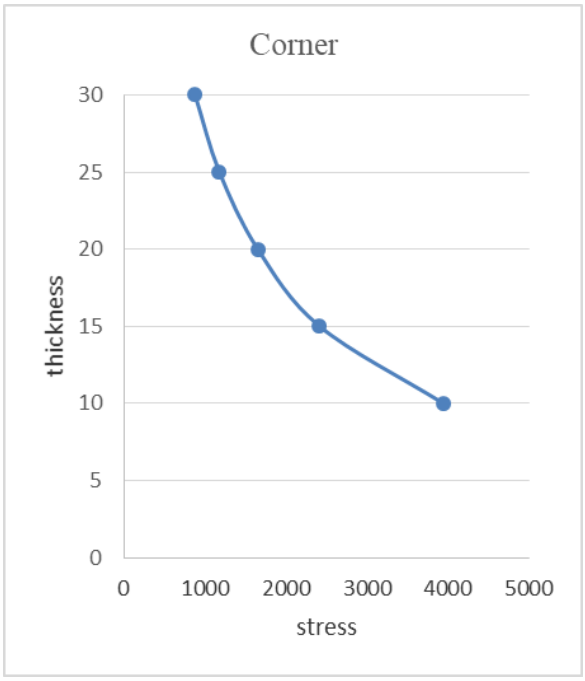

Fig 4.3: Variation of Corner stress with slab thickness for Load group A

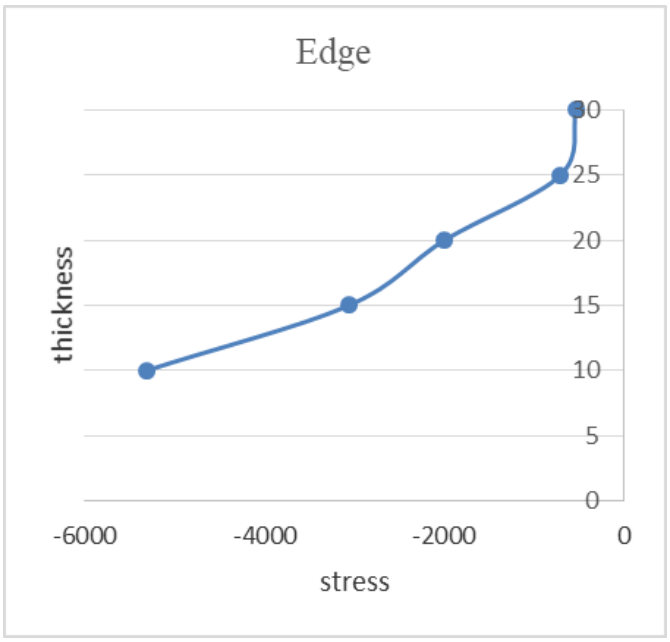

Fig 4.4: Variation of Edge stress with slab thickness for Load group B

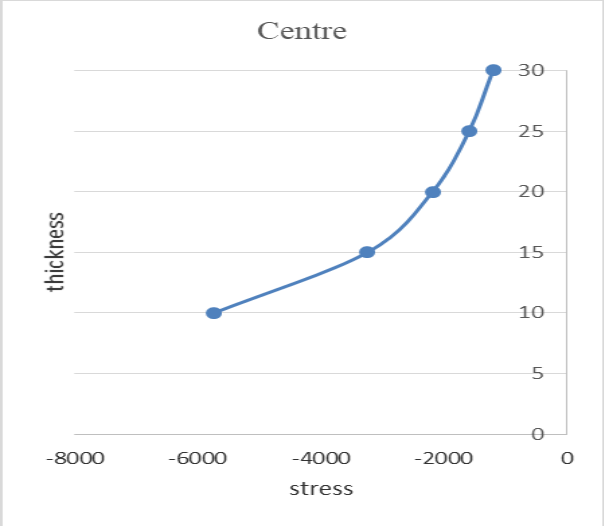

Fig 4.5: Variation of Centre stress with slab thickness for Load group B

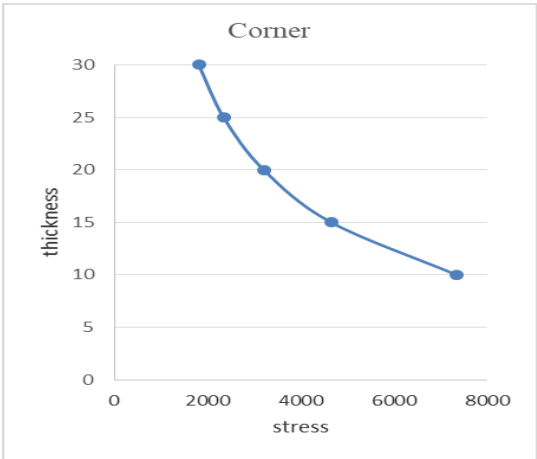

Fig 4.6: Variation of Corner stress with slab thickness for Load group B

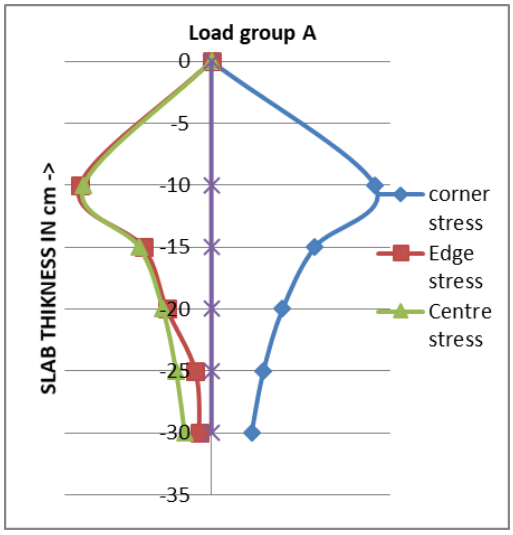

Fig 4.7: Variation of stresses with slab thickness for Load group A

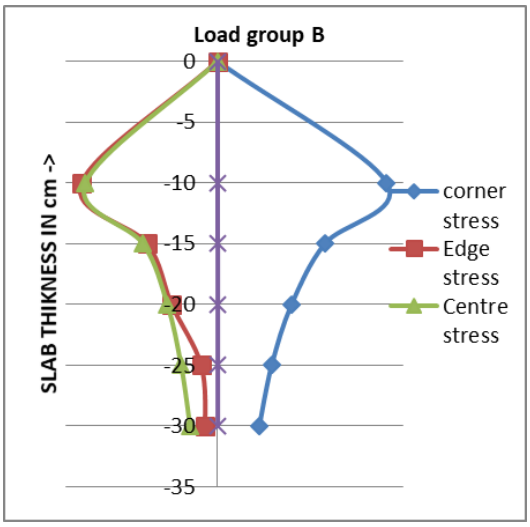

Fig 4.8: Variation of stresses with slab thickness for Load group B

V. CONCLUSION

1) The rigid pavement slab is analyzed on KENPAVE slab by inputting the experimental values obtained. Analysis was made for two different load classes.
2) The wheel load stresses are decreasing with increase in slab thickness.
3) For all cases of loading, maximum stress occurs at corner region than edge and centre regions.

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