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Construction of Precast and Prestressed Pavements In Highways

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Abstract: ***Pavements in multilane highways carry heavy loads and have to withstand large stresses. Pre fabricated and pre stressed pavements are advantageous due to (a)Speedy construction (b) Good quality (c) No curing and no hindrance to traffic (d) Curing and temperature stresses can be controlled by post tensioning (e) Thin section (f) More life (g) Less maintenance . Post tensioning is done in longitudinal direction at the time of installation while pre tensioning is done in transverse direction at the time of fabrication . Shear keys are provided for Accurate alignment. Care should be taken for base preparation . These pavements find applications in bridge decks, cross drainage structures, elevated highways/ railways . Expansion Joints are provided to allow movements due to expansion. The ducts are filled with grouting CONCRETE which fill slab voids.The Primary purpose of grouting is intended to provide extra protection against corrosion of the strands and seal all ducts . GHMC Hyderabad implemented this method of pavement with 4 lanes for a length of 2 km in road no 10 in Jublee Hills at a cost of Rs. 230 Lakhs.***

Key words :Precast Prefabricated pavements, Curling , Pre tensioning , post tensioning , Shear keys , ducts , strands ,grouting , joint panel

I. INTRODUCTION

Generally Pavements are two types first is plane concrete pavements and another is reinforced concrete pavements. Unlike flexible pavements, rigid pavements are designed on the basis of Mechanistic – Empherical principles. Slab thickness is determined from the fatigue failure of the slab due to damage caused by cumulative axle loads. The input parameters relate to subgrade support, material characteristics, traffic loads and climate. Several researchers contributed to thickness design of rigid pavements. Westergaard's theory made final modifications in the analysis and design of rigid pavements. In order to have smooth and strong rigid pavements, pre cast, prestressed concrete pavements were introduced on highways. There are several advantages of precast, prestressed pavements. With increasing population, India is in need of construction of more number of highways which are strong and durable. To avoid congetion on pavements, multilane pavements have bacome necessary. Concrete pavements though costlier have served better performance in carring heavy loads with permissible wear and tear. There are two types of concrete pavements practised and designed in our country.

A. Unreinforced concrete pavements
B. Reinforced concrete pavements

In case of unreinforced concrete pavements, load transfer mechanism is implemented using dowel bars in transverse direction. Such Pavements are called jointed dowelled concrete pavements. They are popular in India. In order to counter occurrence of cracks due to repeated application of axle loads and weathering action in different seasons, steel reinforcement is provided in transverse and longitudinal direction. There is no improvement .To structural strength of pavement, but crack width is controlled Another method of reinforcement is to provide continuous reinforcement in longitudinal direction eliminating construction of transverse reinforcement. This method is preferred to

C. Meet heavy traffic on express highways
D. In adverse climatic conditions
E. Where weak sub grades are met

These pavements cost less as they are less number of joints.The above two types of concrete pavements give satisfactory performance for 15 to 20 years. There is third type of pavements are called precast pre tensioned concrete pavement which is constructed speedily and maintenance is less. They serve 30to 35years life.

F. PRECAST PREFABRICATED PAVEMENT

The following are the advantages of these pavements

1) Speedy construction without hindrance and traffic.
2) Flexibility to replace/repair rapidly.
3) Suitable to panels at airports, hospitals and where weather doesn't allow traditional method of construction.
4) No curing is necessary.
5) Quality is ensured.
6) There is no risk to workmen due to safety measures.
7) Occurrence of tensile stresses due to curling of slab and loss of transfer of strength during temperature cycles and axle load repetitions can be controlled with post tensioning technique.
8) Sections are thinner made up of high performance concrete (>M40).
9) Design life is possible upto 30 to35 years.
10) Maintenance is less and durability is higher.

II. CONCEPT OF THE TECHNIQUE

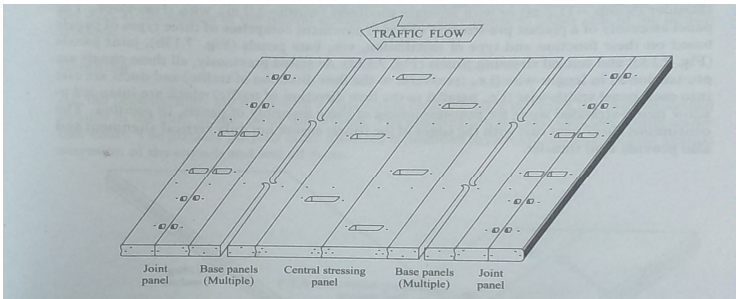

Figure 7.13a *Typical assembly of precast pre-stressed panel layout(Source: Merritt et al., 2004; Courtesy: Federal Highway Administration, USA)*

Typical layout of pavements is given. Full depth precast panels are used for construction of pavements.

Base preparation and vertical alignment of panels is important as shear keys are provide for vertical alignment. Concrete pavements are pre stressed precast panels in longitudinal direction as well as in transverse direction. This bi-directional pre stressing is done through pre tensioning and post tensioning. Pre tensioning of panels is done at the time of fabrication of panels. Post tensioning is done at the time of installation.

A. EXPERIMENTS AND NECESSARY EQUIPMENT AND STAFF PROVISION

One km of 4 lane highway road is proposed for construction of this type of pavement on Hyderabad-Warangal highway connecting Yadagiri Gutta temple to Raigiri railway station (10km). The study involves the following work components:-

1) Estimate traffic in both the directions in a year.
2) Study of sub-grade soil and determine CBR value at key locations.
3) Design precast panels in M30 concrete and pre stressing before installation.
4) Test the sample panels in laboratory for design load.
5) Install prefabricated re stressed panels in one km stretch in one lane and provide shear keys.
6) Post tensing of these panels during installation on highway in longitudinal direction.
7) Test the performance by running designed load.

This system facilitates post tensioning of assembly of panels, in position. The shear keys cast with the edges provide vertical alignment and load transfer.Once the panels are positioned, the post tensioning strands are fed into post tensioning ducts and pulled through all the panels to the post tensioning anchors. Each post tensioned panel acts independently and allow expansion and

contraction. The length of such post tensioned assembly of panels can be adjusted by increasing or decreasing the number of base panels between joint panels and the central stressing panels.

The longitudinal post tensioned strands are placed in the pockets and tensioned using dog-bone or ring-anchor coupler. The post tensioning sequence begins with the tendons passing through the duct at the middle of the central stressing panels.

B. Grouting

The ducts are filled with quick setting concrete after grouting the post tensioned strands in the joint panels. The grouting activity also includes filling under slab voids. The grouting is intended to provide extra production against corrosion of strands and to seal all the ducts

C. Assembly Of Precast Panels

The panels are positioned transverse to the flow direction of traffic. Typical layout of pre-caste panel assembly is shown fig :2.

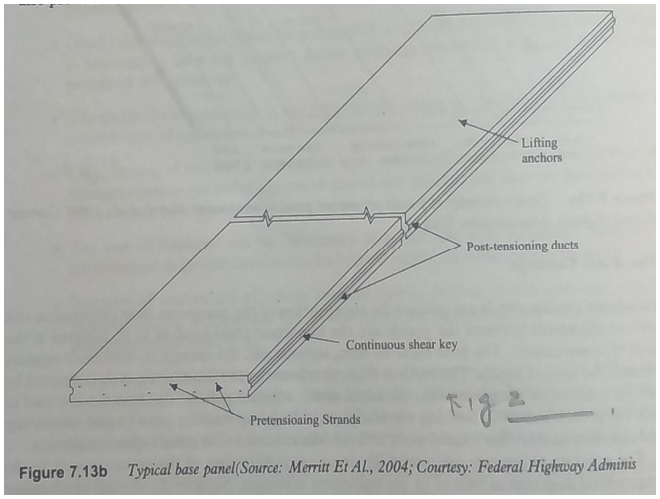

Figure 7.13b *Typical base panel(Source: Merritt Et Al., 2004; Courtesy: Federal Highway Adminis*

The panels covers both lanes and also have shoulders of 3.00m on either side. Total length of pavement is 11.20m. There is camber provided. The panel assembly comprises of Three types of panels based on the function and type of installation. Those three types of panels are :

1) Base panel. (fig : 2)
2) Joint panel. (fig: 3)
3) Central stressing panel. (fig : 4)

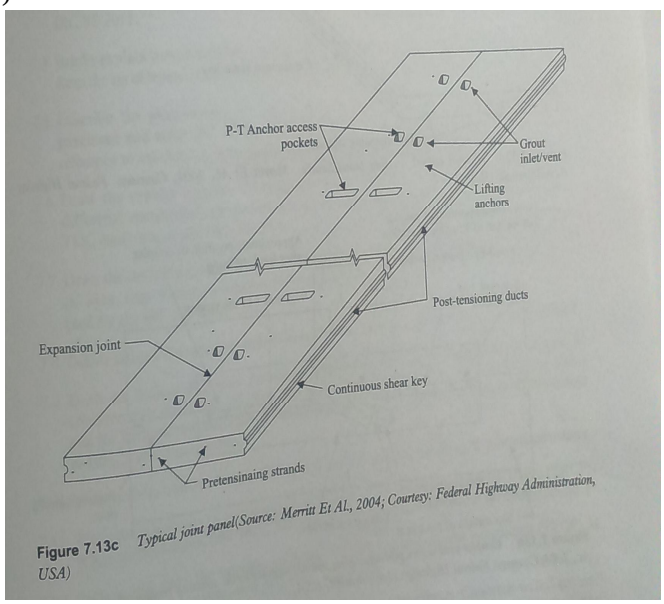

Figure 7.13c *Typical joint panel(Source: Merritt Et Al., 2004; Courtesy: Federal Highway Administration, USA)*

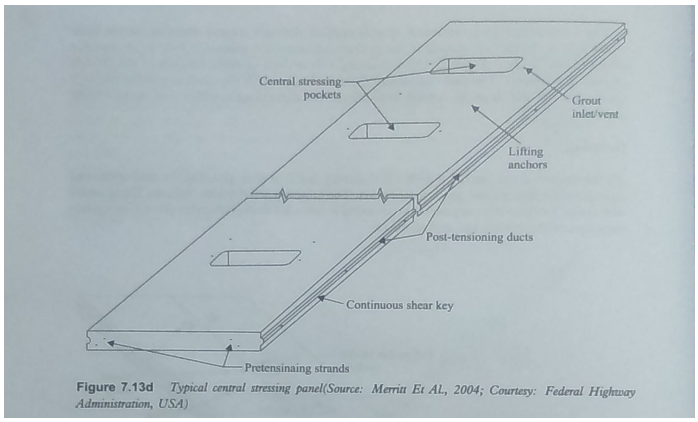

Figure 7.13d *Typical central stressing panel(Source: Merritt Et AL, 2004; Courtesy: Federal Highway Administration, USA)*

All those panels are pre tensioned as length wise and ducts are cast into each panel and the curve.

III. CONCLUSIONS

A. Rigid pavements is designed considering vehicle strength, Vehicle damage factor, Growth rate, lane distribution of traffic
B. Provision is made for drainages and material strength of subgrade, base and surface course
C. Temperature effects on concrete slab are computed for Hyderabad region

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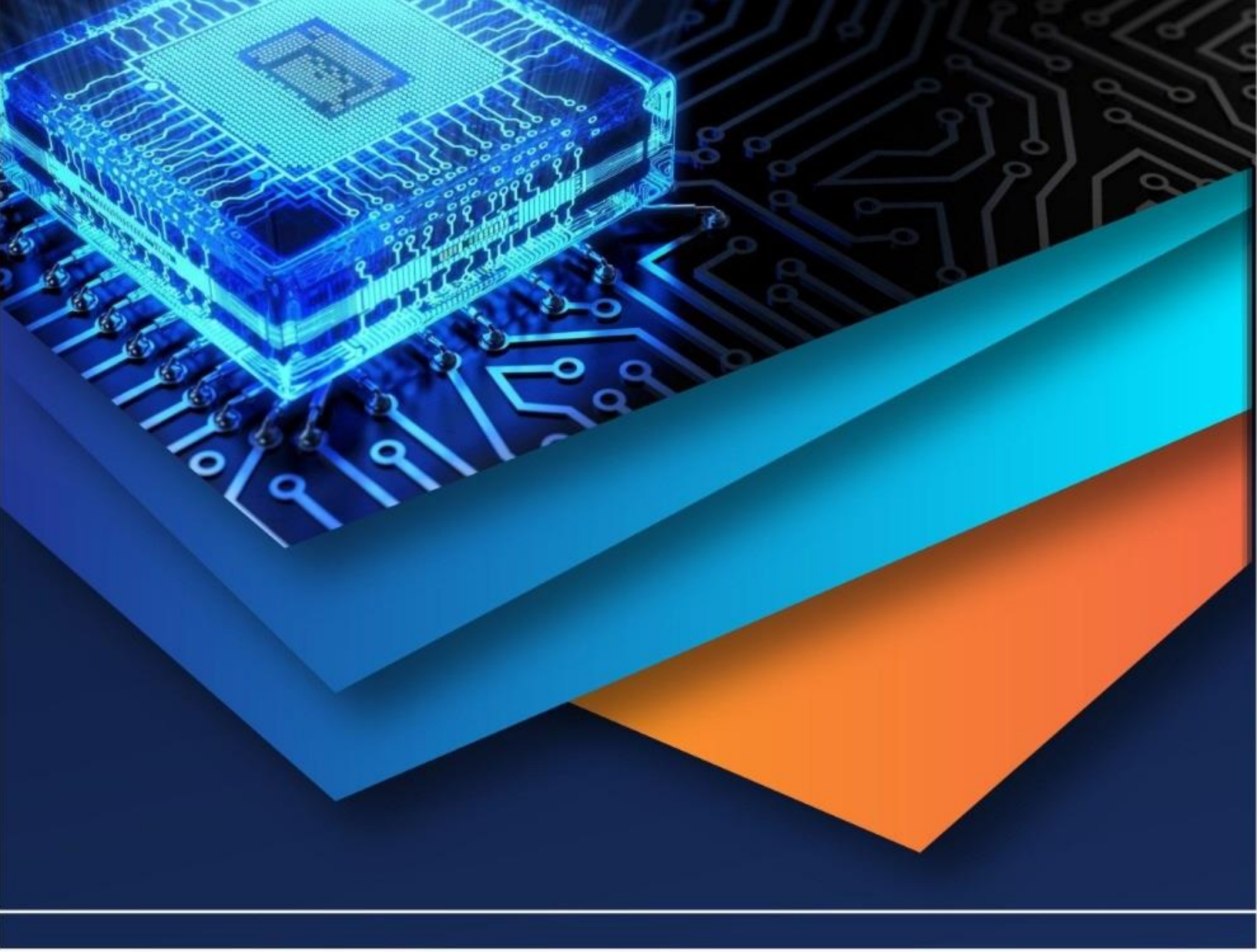

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