

Rigid and Flexible Pavement Designs in Construction



Sarvesh PS Rajput

Abstract: Throughout construction management, the problem of deciding amongst two types of pavements is almost always illustrated in the construction of paving built for the heavy vehicle traffic -fall under flexible and rigid pavements. This study shows the outputs of road measurements, deliberately designed with a capacity of 2350kN for commercial trucks. Herein, 2 research evaluations have been performed, i.e. 2 alternative approaches for flexible and rigid paving are presented, as well as a summary of findings has been included with building design as well as the estimated costs of renovations.

Keywords: Pavement Designs, Flexible Pavement, Rigid Pavement, Traffic Load.

I. INTRODUCTION

There are multiple means of transportation such as water transport, air transport, road transport, Train transport. Transportation through roads are one the most widely used means for transportation and cover the maximum population. The reason for its wider acceptability are many. Some of them are like; the service could reach any individual to their door of the house, to hospital, to schools or market or any place that people use to visit on daily basis. It also allows the liberty of speed and time taken to visit a place. It has yet another advantage in terms of economics too. The construction cost along with maintenance cost is too low in comparison to the number of people getting benefitted out of it. A larger part of credit goes to the technology and material that is getting in the construction of roads that the black topping and white topping. These toppings are getting used on the basis of different conditions such as number of lanes and type of traffic (Wu et al., 2005). Among the many types of structures that is getting used in road construction one is highway pavement. It is adopted looking into needs and durability. High pavement should be understood as a specific structure which is using processed materials getting super imposed over the soil sub grade. So what happens here is that weight of the vehicles are getting distributed to the level of subgrades leading less breakage of roads. Hall et al. (2009) states that while we talk of pavement structure it is important to note that it should maintain the surface in such a way that riding quality is very smooth and at the same time saves from the skidding too.

They further mentions about the light reflecting feature along with noise absorbing features. The objective of this technology is to reduce the pressures exerted by the vehicle in such a way that it remain within limit of the subgrade. Highway pavement further has been divided into two parts. The first one is that of flexible and the second one is that of fixed pavements. Two types of pavements are generally recognized as serving this purpose, namely flexible pavements and rigid pavements (Li et al., 2016).

II. PAVEMENTS

Before we go into the details of pavement structure, it becomes essential to understand the very term. The surface that one use for travelling is known as Pavement. It is essential that the pavement that we move on along with our vehicles should be solid enough to bear our loads. For any vehicle to run safely, one important feature need to be sufficient friction and that is also being provided by the Pavement. While granting the friction it also ensures the weight to be transferred to the soil in spite of the upper surface. Ultimately causing comfort for the person who is driving the vehicle. In the ancient times when the traffic was not so high, people use to commute either on carts pulled by animals or on their own leg. Later the traffic grew and roads started getting constructed. The oldest example for the road is 4000 BC. It was made up by stone or timber. With time, the human civilization saw not just an increase in traffic but also type of traffic has also changed. Now a days the roads see traffic which is carrying very heavy loads. It needed some special roads which could have sustained the heady loads of the traffic.

Highways pavement was one such solution. This is a recent advanced technology wherein in the structure is made up by superimposed layers. These layers are constituted of processed materials. All the processes materials are kept on the natural soil subgrade (Vansauskas & Bogdevičius, 2009).

A Flexible Pavement

As the name propose, the Flexible pavement is having some element of adaptability. In this innovation it is the versatile diversion under burden which is coming about into adaptability. The basic limit of flexible pavements is the resultant of consolidated activity of the various layers of the Pavement. The heap is straightforwardly applied on the wearing course and it gets scattered with profundity in the base, sub base and sub grade layers and afterward at last to the ground. The pavement structure comprises of the bitumen bound materials. It is therefore more versatile than inflexible and increasingly deformable. Amin et al., 2017 expressed about the pertinence of the flexible pavements.

Manuscript received on February 15, 2020.

Revised Manuscript received on February 20, 2020.

Manuscript published on March 30, 2020.

* Correspondence Author

Sarvesh PS Rajput, Assistant Professor, Department of Civil Engineering, Maulana Azad National Institute of Technology, Bhopal (MP).

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an [open access](http://creativecommons.org/licenses/by-nc-nd/4.0/) article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

Rigid and Flexible Pavement Designs in Construction

This strategy is getting utilized in low volume streets just as medium volume streets. Yet, the utilization of flexible pavements in high volume is exceptionally evaluated. With expanding applied wheel stacks alongside load applications, it turns out to be critical to appropriately describe the conduct of subgrade soils and unbound total layers as the establishments of the layered pavement structure (Pereira and Pais, 2017).

B Rigid Pavement

When it comes to rigid pavements it can be placed in both way. That means it can be placed directly on the pre-made sub-grade. It can also be placed on a single layer of granular or stabilized material. It is significant to note what Elghriany et al., 2016 stated. They said rigid pavement constitute only one layer. It therefore insignificant to call it base or sub-base course. In the case of rigid pavement it is the slab action that distributes the load. The construction material used in this case is Portland cement concrete (PCC). In case of rigid pavements the parameters for analysis should be plate theory. Plate theory should be assumed as a simplified version of layer theory which consider concrete slab to be medium thick plate. The medium thick plate remain plane before loading and remains plane after loading too.

III. METHOD

The present research try to bring out the findings of pavement but specific to Industrial area, where in the designing is done by keeping in mind the heavy designed for traffic of heavy trucks. The weight ranges up to 2,350 KN. First, the circumstances got reviewed relating to pavement support, traffic loads and climatic-hydrologic conditions. Then after designing for flexible as well as rigid pavements have been analyzed. Moreover the comparative analysis of the results have also been studied.

IV. DESIGN OF FLEXIBLE PAVEMENT

A. Using Group Index Method

The structure is planned so that each layer including materials gets load from the upper layer and gives the heap to the following layer. Along these lines the heap in various layers is diminished all things considered. The structure is made so that the greatest burden bearing layer (for example the top layer) will involve the most costly materials and the least burden bearing layer (for example the lower/base layers) would be comprised of the most affordable materials. Thusly, the thickness of layers would shift with CBR of soil and it would influence the expense of the pavement. The accompanying sub-segments portray the different factors and parameters engaged with structure of flexible pavement of street according to Indian Roads Congress (IRC) 37-2001.

Group Index is function of percentage material passing 200 mesh sieves (0.074mm), liquid limit and plasticity index of soil and is given by equation:

$$GI = 0.2a + 0.005ac + 0.01bd$$

B. California Bearing Ratio Method

Hakeem and Carmany in 1948 gave plan strategy dependent on stable-meter R-esteem and cohesion-meter Computed-esteem. In light of execution information it was built up by Hakeem and Carmany that pavements thickness shifts legitimately with R worth and logarithm of burden redundancies. It changes conversely with fifth foundation of Computer esteem. The articulation for pavement thickness is given by the observational condition.

$$T = K (TI) (90 - R)/C1/5$$

Design Traffic

Computation of design Traffic in terms of cumulative number of standard axles to be carried by the pavement during design life.

$$N = \frac{365 A [(1+r)^n - 1]}{r} \times F \times D$$

Design calculations

Combined number of vehicles every day over the street acquired from the traffic volume study =3414. At that point, the underlying traffic after the time of opening = 3414(1+0.05)^{0.5} = 3498. Vehicle harm factor F = 4.5 (taken from IRC: 37-2001, statement 3.3.4.4) as the area of site is plain landscape. Path circulation factor for a 2-path carriage way D = 0.75 (from IRC: 37-2001 condition 3.3.5.1). Accept the plan life of the pavement = 15 years.

Table I.Cumulative standard axles catered during different periods

Year	2019	2025	2030	2035
Design Traffic in terms of msa	4	23	54	92

V. DESIGN OF RIGID PAVEMENT

Design a concrete solid pavement for a two-path single carriage way. The complete two-way traffic is 3498 business vehicles for each day toward the finish of development period. The design parameters are: Grade of the concrete cement =M40 CBR estimation of sub-grade= 8%. Modulus of sub-grade response (k) =5kg/cm² Elastic modulus of concrete= 3x10⁵kg/cm², Poison's proportion = 0.15. Coefficient of warm coefficient of cement =10x10⁻⁶/Rate of traffic increase= 0.05 (IRC 37:2012).

Design

Present traffic = 3414 CVPD, Design life = 30 years. The thickness of concrete solid layer dCB,KP, is controlled by the normal nature of concrete solid blends and class C-30/37 (Amin et al., 2015). Thicknesses of pavement layers are resolved dependent on an accepted estimation of CBR of 10%:

- Concrete solid layer, class C-30/37: d = 26cm,
- Interlayer (concrete adjustment): d = 15cm,

- Unbound squashed stone: $d = 35\text{cm}$.
- For the new concrete solid pavement, the thickness of an unbound supporting layer of rock grain blend should sum:
- Heavy traffic load, min 25cm,
 - Medium or low traffic load, min 20cm.
- Besides, the length of solid pieces must not surpass 6m.

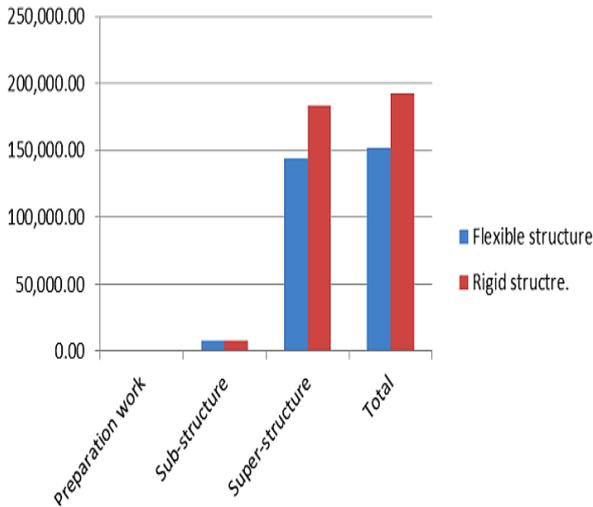


Fig 1. Estimated cost of development of pavements

Table II. Result Analysis

Total thickness of the flexible pavement crust	640 mm
Total thickness of the slab of rigid pavement	270 mm
Dowel bar	32 mm
Dowel bar Length	500 mm
No. of dowel bars (rigid pavement)	5
Tie bar diam.	12 mm
Tie bar length	580 mm
No. of tie bars	4
Projected cost of flexible pavement including maintenance work every five years	Rs. 1,157,022 /-
Projected cost of rigid pavement	Rs. 2,24,53,270/-

VI. CONCLUSION

In the context of the pavement plan and its development, the analysis of the monitor situation with all the variables which determine the future framework is remarkably extremely important. First, the needs of the clients and the environmental conditions that include existing area highlights, climatic conditions, work conditions as well as the operational loads need to be considered. A subdivision of the CBR approach according to IRC 37-2001 is described as a viable pavement for a Black Cotton Soil strategy, rather than as an inexpensive solution. It is observed that flexible pavement is circumspect to lower quantities of transportations. After certain span and exceedingly high maintenance costs, the existence of a flexible paving is roughly 15 years, the first time being low cost and to be compensated with higher costs for the further maintenance. The longevity of the rigid pavements is far greater than that

of the flexible pavements, which has a resilient period of about 40 years or double age that of the flexible pavements, also, the maintenance cost is low.

REFERENCES

1. Wu, X., HU, S. J., CUI, Y. P., & MA, Y. J. (2005). Study on Evaluation of Harmonious Development between Transportation and Economy [J]. Journal of Beijing Jiaotong University (Social Sciences Edition), 2.
2. Hall, J. W., Smith, K. L., Titus-Glover, L., Wambold, J. C., Yager, T. J., & Rado, Z. (2009). Guide for pavement friction. Final Report for NCHRP Project, 1, 43.
3. Li, Q., Qiao, F., & Yu, L. (2016). Impacts of pavement types on in-vehicle noise and human health. Journal of the Air & Waste Management Association, 66(1), 87-96.
4. Vansauskas, V., & Bogdevičius, M. (2009). Investigation into the stability of driving an automobile on the road pavement with ruts. Transport, 24(2), 170-179.
5. Amin, S. R., & Amador-Jiménez, L. E. (2017). Backpropagation Neural Network to estimate pavement performance: dealing with measurement errors. Road Materials and Pavement Design, 18(5), 1218-1238.
6. Pereira, P., & Pais, J. (2017). Main flexible pavement and mix design methods in Europe and challenges for the development of a European method. Journal of Traffic and Transportation Engineering (English Edition), 4(4), 316-346.
7. Elghriany, A., Yi, P., Liu, P., & Yu, Q. (2016). Investigation of the effect of pavement roughness on crash rates for rigid pavement. Journal of Transportation Safety & Security, 8(2), 164-176.
8. Jain, S., Joshi, Y. P., & Goliya, S. S. (2013). Design of rigid and flexible pavements by various methods & their cost analysis of each method. International Journal of Engineering Research and Applications, 3(5), 119-123.
9. Amin, M. S. R., & Amador-Jiménez, L. E. (2015). Pavement management with dynamic traffic and artificial neural network: a case study of Montreal. Canadian Journal of Civil Engineering, 43(3), 241-251.