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CONSTRUCTION COSTS OF NATIONAL HIGHWAYS

BY

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I understand that serious consideration is being given to the prevailing high costs of construction of national highways. This step is indeed in the right direction and a policy must be devised on this very important issue considering the limitation of resources. While the size of a programme could be considered for curtailment, there could be no compromise on standards set for the national highways.

In a constrained economy like Pakistan matching of any development programme with resources is of prime importance and cannot be seen lightly. Therefore re-prioritization is the first step.

In any highway development programme we have to recognize the functional classifications of rural or intercity highways and urban highways. In this note I will deal only with the intercity or rural highways.

The three important elements for the design of any highway are the traffic needs for the designed life, i.e. capacity of the highway, the design vehicle, the design speed and the pavement design which may be flexible or rigid pavement. All these are aimed at providing an uninterrupted flow of traffic.

While there are considerable potentials in reducing the cost per kilometre in respect of pavement but there can be no compromise in sacrificing the established geometric design standards.

Firstly I will take the geometric standards. For the intercity and inter provincial highways the geometric of lane widths i.e. the standard of 12 feet has been established after years of experiments and observations of the traffic behaviour, dimensions of the vehicle, and dynamics of motor vehicles, the safety aspects and attitude and psychology of road users. In this respect lateral clearance from the edge of the pavement has also been prescribed at the minimum of 10 feet or 3.2 metres for highways. It will not be a very correct approach to reduce the shoulder's width from the existing 10 standard practice. These geometric standards based on the design speed, have been internationally adopted in various conferences of the International Road Federation of which Pakistan is also a signatory for the last 40 years.

The proposed reduction in pavement width from 12 feet to any lesser dimension will be suicidal as it will not provide safe lateral clearance between two commercial vehicles, particularly in view

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of the attitude and habits of our drivers. This specially applies in case of long trailers and long vehicles which have witnessed a high annual growth rate. This will result in frequent side collisions, and multi vehicle accidents and reduced speeds.

On the other hand the reduction in shoulders will lead to lateral restriction and reduced capacity and constant danger to any broken vehicles taking refuge on the shoulders, violating the traffic lane and posing extreme danger to driving vehicles in case of any accident The absence of adequate with of shoulders will also cause lateral movements of the embankment, subsidence and instability to the pavement.

When I was responsible for the construction of Karachi-Malir road (1953-55) by widening existing 12 feet to 44 feet, a 4 lane facility, the width of lane of 11 feet was considered to be ideal. Since that time, studies by various countries revealed that upto a certain level i.e. 30% of commercial vehicles in the traffic mix, 11 feet lane width would have been sufficient for very disciplined traffic operation. Beyond this percentage of heavy commercial vehicle, minimum lane width now considered is as 12 feet for a typical highway traffic volume and mix.

It was the first time that a multi-lane highway facility was developed in Pakistan. In 1974 however the lane width was increased to 12 feet and another carriageway of 4 lanes was added to meet the traffic requirements.

Therefore in consideration of the in-disciplined traffic its heterogenous character and with more than 60% commercial vehicles on our highways, the lane width cannot be in any circumstance reduced from 12 feet.

All the donor agencies who have provided technical assistance to Pakistan right from the First Highway project to the Ivth project through world renowned consultants have also prescribed these standards for Pakistan highways whether provincial or national or international. The national linkages and proposed international linkages all the more make it important that uniformity of standards is provided through out the highway system.

Instead of getting into 21st century we will place ourselves in the 19th century.

SHOULDER'S WIDTH

The shoulder's width have been the subject of a very long debate in the last three decades of 19th century and the first three decades of 20th century. There was a constant evolution in the design width the type of shoulders considering the ever increasing dimension of the vehicles and the operating speeds. In this case the work of ENO's foundation of the United States of America, the studies of TRRL of England, DOT, USA and highway Authorities of Australia, Germany and France and the valuable work carried out by the AASHTO, in their publication entitled The Policy on Geometric Design of Highways and Streets 1994 and earlier edition the work of various consultants engaged in Pakistan from early sentries like Louis Berger Inc. Howard Needle, Freeman Fox etc had also been an excellent contribution in the geo-matric design of highways.

The Karachi-Hyderabad Super Highway constructed in 1970 set an excellent model for future highway development. The width of shoulder is governed by the minimum lateral clearance for the designed operating speed, the safety during refuge, and to have a practical capacity as near to the ideal capacity.

When construction of the Capital of Pakistan Islamabad in 1962 started in full swing, the writer was responsible for construction of roads, highways and bridges in the capital territory comprising of the Islamabad Highways from Airport to Zero Point, the Kashmir Highway from Dhokari Chow to Peshawar Road, principal roads and sectoral streets. It was observed that the Aabpara road and a dual carriageway facility with two lanes each side was designed by M/s Doxiades with 5 feet wide ditch for the storm water drainage in the middle and only 3 feet shoulders on the ditch side. The writer wrote a note to the then Director General, CDA and Irrigation Engineer, that this was going to prove highly unsafe and death trap because of the narrow shoulders.

However it was decided at the level of Chairman CDA that since the consultant have designed so it should not be changed. On the very first day of commencing the work in the Islamabad Secretariat buildings, three cars fell into the ditch including one of Joint Secretary Communication, Mr. Ijlal Hussain. These incidents drew rapt attention of the CDA and it was decided to provide and RCC cover on the 6 feet wide ditch (storm water drain). It was followed suit on Attatruk Avenue. But at what cost.

The best solution was to have underground piped storm water drainage to provide adequate median/ shoulders for each carriageway. This would have also met the turning radius requirements.

It may be further pointed out here that even the rural and feeder roads like Farm t market Roads are being provided with 12 feet wide pavement and 6 feet shoulders on each side. To reduce these geo-metrics for the national highways will mean a retrograde for all the future development.

Let us not do it for reducing the cost of construction of highways.

There are other positive potentials to achieve the objective of reduction of construction cost. The pavement structure is the single largest element of cost in any highway project. In this respect I have already provided you with a copy of my "Treatise on Flexible Pavement Design" which may kindly be gone through. The principal observation and recommendation in this Treatise for reduction in cost and to combat high early rate of pavement distress in Pakistani conditions of illegal axle loads and high tyre pressure are :

i) We should not follow the mechanistic analytical design method for pavement section unless we have our own laboratories to establish the elastic characteristics of each material.

ii) We should adopt larger size aggregate base course or water bound macadam instead of

aggregate with present specified gradation with maximum size less than 1 inch. In water bound macadam bases the maximum size is passing 2 ½ sieve and the gradation to be adopted to have a dense material.

iii) We should provide pressure spray asphalt grouting on the water bound macadam instead of doing the prime cost or tack coat.

iv) We should ensure metal to metal contact in the stone pieces of the aggregate base.

v) With the high ambient temperatures for much longer periods in the year in our country, the normally used temperature relationship based on M.A.A.T. does not hold good with temperatures higher than 40°C for more than 4 months in most of the plains and which reach upto 52°C in Punjab, Sindh, Balochistan and even in NWFP for about two months.

vi) We should minimize the number of asphalt course layers which are prone to failures due to illegal axle loads and higher tyre pressure which can be matched with a Boeing Jamboo in terms of LCN, though said to be an uncontrollable situation which is also quite unacceptable. With only one layer of asphalt as a wearing course any distress due to rutting etc. only one layers pavement all the asphalt layers have to be remove or reconstructed, even in early life.

vii) Harder bitumen should be used preferably of 30/40 penetration instead of 60/70 penetration.

viii) We should resort to stage construction instead of providing pavement for the 20 years life. The minimum design period should be restricted to 10 years life to which further strengthening can be done after evaluation of the pavement at the expiry of 10 years. **This will enable us to have more milage with the same resources without curtailing the geometric standards.**

SPECIFICATIONS

The present specifications regarding aggregate base course material and asphalt concrete aggregates required drastic changes. In this connection recommendations for changes have already been made vide our letter No. ACC/NHA/95/2647, dated 25th October 1995 given to NHA, copy enclosed. The principle amendments proposed pertain to the shape of the crushed aggregate.

1. **3.2 Definitions of General**

Page G-10 Replace definition of Boulder with the following definition:

" A hard durable stone or rock fragment, usually rounded by weathering or abrasion, with an average dimension of 15 cm or more, but not less than 15 cm shorter side"

Page G-11 add the following definition of Cuboid:

Cuboid : Crushed stone particles with each face fractured and in roughly cuboid shape.

Page G-13 Replace definition of Gravel with following new definition:

" Small sized stone, shingle or rock fragments usually rounded in shape formed from rocks or boulders by glacial or weathering action".

II. Item 202 Aggregate Base Course

202.2 Material Requirements

Replace 202.2 Material requirements with the following:

"Mater for aggregate base course shall consist of crushed hard durable boulder, rock or stone fragments. It shall be clean and free from organic matters, lumps of clay and other deleterious substances. The material shall be of such nature that it can be compacted readily under watering and rolling to form a firm, stable base for both flexible and rigid pavements".

a) The gradation curve of the material shall be smooth and withing the envelope limits for Grading A or B given below.

Grading requirements for Aggregate Base Material.

SIEVE DESIGNATION		MASS PERCENT PASSING	
Standard	Alternative	Grading A	Grading B
mm			
50.00	2 inch	100	100
25.20	1 inch	70-95	75-95
9.50	3/8 inch	30-65	40-75
4.75	No.4	25-55	30-60
2.00	No.10	15-40	20-45
0.425	No. 40	8-20	12-25
0.075	No.200	2-8	5-15

The material shall be well graded such that the coefficient of University D60/D10 shall be greater that four (4), where D60 and D10 are the particle diameters corresponding to 60% and 10% respectively passing (by weight) in a grain size analysis curve.

b) Crushed aggregate (material retained on sieve No.4) shall consist of 100%

angular material obtained from crushing of blasted rock or boulders of more than 15 cm size in the least dimension, such that all faces of each piece are fractured faces in cuboid shape. The rock or the boulder source shall be approved by the Engineer.

III. Item 203 Asphalt Base Course Plant Mix

In 203.2.1, delete second and third para and replace with the following :

Crushed aggregate (material retained on sieve No.4) shall consist of 100% angular material obtained from crushing of blasted rock or boulders of more than 15 cm size in the least dimension, such that all faces of each piece are fractured faces in cuboid shape. The rock or boulder from which aggregate shall be obtained , should be of uniform quality, geology and petrology throughout the quarry. The rock or the boulder source shall be approved by the Engineer. Naturally broken, and laminated material shall not be allowed. The material when rested for stability of bituminous mix show satisfactory stability. The material retailed on No.4 Sieve shall not contain more than 8% by weight of flat and/or elongated particles (ratio maximum to minimum 5:1).

COSTS OF INDIVIDUAL INGREDIENTS

Another important aspect to be looked into is that of cost of individual ingredients, viz improved sub-grade, sub base, base and asphalt concrete aggregates and asphalt surfacing aggregates. In the last few years there has been considerable increase in prices of each item for the National Highways, when compared with the similar works in provincial departments.

Therefore it is strongly felt that a special committee may be constituted to consider the potential of determining realistic costs.

In conclusion I strongly feel that we should have a national consensus on the issue of cost reduction in highway construction by holding a national seminar of all concerned which must consider all the elements of highways design and the traffic needs of modern times well as the costs of individual ingredients of highways construction.

We should not in a hurry reverse our development standards and instead of going into 21st century step back in the 19th century. No donor agency or private sector would like to participate in highway development programme with truncated standards.

I will pleased to elaborate any point or points, as and when required.