

# Road Pavement Design in One of Oversea Sewage Treatment Plant

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**Abstract:** Three methods are used for Road Pavement Design for access road and internal roads to DasherKandi Sewage Treatment Plant in Bangladesh, the method, standards and ESA for design of the road are introduced, the issues of design standard for Sewage Treatment Plant, traffic increase rate and seal coat for asphalt concrete of the road are discussed, some of the propose is made to minimize different understanding in execution of the contract, it provides necessary references for similar oversea project in similar country.

**Keywords:** Sewerage Treatment Plant; access road and internal roads; pavement design; standard

## 1. Project Introduction

The DasherKandi Sewerage Treatment Plant in Bangladesh is one of the largest Sewerage Treatment Plant (STP) in southern Asia, the project are includes of the Sewage Lift Pumping Station, 4.8km long GRP Sewage Conveyance Pipeline, Sewage Treatment Plant and Sludge Incineration system. The design capacity of sewage treatment of the Plant is 500MLD. The Employer is Dhaka WASA, the Consultant is HEC for the Project and the project is run over by Powerchina Chengdu Engineering Corporation Limited, Construction Engineering Corporation (CEC).

According to the contract, the length of the access road is 790m, the elevation of start of the access road is 6.3m, the width of the road is 6.3m, the shoulder of the road is 0.5m both sides, the total length of the road is 7.0m. The existing road is earth road and it will be updated to the permanent asphalt concrete road. The access road is divided to the two sections: The length of the first section of the road is 514m, this section is part of the planned to be developed new town road; the second section is 276m including of the length of the bridge. The access road is the only road to the Sewage treatment Plant. The pavement design for the first section of the road is as same as the township road and the second section of the road is the newly to be developed road and it is as same pavement structure as the internal roads in Sewage Treatment Plant. Since there is shortage of the road construction materials locally, therefore, the local design method and standard has to be considered, the design results is outlined as follows.

## 2. Design Condition

### 2.1 Flexible pavement design

The flexible pavement design is adopted since the flexible pavement has the self-healing properties. If any deformation occurs in flexible pavement within itself due to heavier load than expected, it can recover it to some extent with time under favorable weather condition but any damage is permanent for rigid pavement. It will be easy for the maintenance even if there are any defects at Operation and Maintenance (O&M) period and also it will be easy for any

maintenance works in future.

### 2.2 Design method

Pavement design as per Road and Highway Department (RHD) of 2005 is used for the road pavement structure design.

### 2.3 Maximum sludge per day from STP

According to the design, the maximum sludge per day for the Sewage Treatment Plant is 127.63T/d. This value is the basis of the road pavement design of Equivalent Standard Axial Load (ESA) for the plant.

## 3. Road Pavement Design

### 3.1 Design life

The design life for the road shall be 10 years for the feeder road in rural area, but 20 years is adopted to find the maximum traffic volume.

### 3.2 The traffic growth rate

The Traffic growth rate in the Sewage Treatment Plant shall be zero for the Operation and Maintenance period, however 7% is considered for the estimation of the maximum traffic volume.

### 3.3 Cumulative ESA

The cumulative growth factor under the above condition is:

$$\text{Cumulative ESA} = [(1+r)^n - 1]/r$$

Taken  $n=20$  and  $r=7\%$  in the above formula, the Cumulative ESA for the Sewage Treatment Plant is 41.

### 3.4 Design speed of the road

The design speed for the access road and internal roads inside the Sewage Treatment Plant is 30km/h.

### 3.5 Cross slope of the road

The cross slope of the road proposed is 2.5% for asphalt concrete road.

**Table 1.** Average daily traffic in the DSTP in O&M Periods

Type of traffic	Flow /day	Weight of hauling (T)	Weight of material to be taken (T)	ESA Factor	ESAs/ day	Annual ESAs	Purpose
Large Truck with dual axel (15T)	9	15	135	4.8	43.2	15768	To take residue away
Medium truck with single axle (10T)	3	10	30	4.62	13.86	5058.9	For necessary maintenance
Light truck (5T)	4	5	20	1	4	1460	For Laboratory and others
Large bus, 20 sits	4			1	4	1460	For works
Mini bus, 10 sits	4			0.5	2	730	For visiting
<b>Total</b>	24		185			24476.9	
Cumulative growth factors						41.0	
Accumulative ESAs						1003553	
Accumulative ESAs (M)						<b>1.00</b>	

### 3.6 ESAs for the Sewerage Treatment Plant

To taking away dry sludge, 9 No. of heavy trucks with dual axle and with 15 Tons capacity will be far enough. Considering water bower for washing and cleaning, large bus to take staffs to work, and medium truck for necessary

repair works, and wheel loader for the loading the residue inside the STP, the average daily traffic in the Sewerage treatment plant in Operation and Maintenance period is calculated and shown in Table 1 above.

Table 1 show that the maximum daily traffic inside the STP is 24 Passenger car units (PCU), the results above shows that the ESAs for the Dhaka Sewage treatment plant is 1Million ESAs.

#### 4. Pavement Structure Design

4.1 The pavement design as per local method

The pavement structures design is made as per RHD and the result is shown in Table 2 below:

**Table 2.** Pavement structure design result

Pavement Layer	Thickness (mm)	Soaked CBR (Min)	TFV Min (kN)	ACV Max (%)	LA A Min (%)	PI Max (%)	LL Max (%)	Compaction requirement	DCP Max Value	Construction tolerance	RHD item
Seal coat	7										3.12
Tack coat	0										3.7
Asphalt concrete	40							98% MDD			3.6
Prime coat	0										3.8.3.2/ 3.11
Road Base course	175	50% at 98%M DD	90	35%	40%	5%	20%		3.5mm / blow	±10mm	3.3.2
Road Subbase course	150	25% at 98%M DD	75	38%		6%	25%	98% MDD	3.5mm / blow	±15mm	3.2
Improved Subgrade	150	8% at 95%M DD				15%	50%	95% MDD	22mm/ blow	±20mm	2.8
Brick on End edge of the road										±3mm/ m	3.13.6
Total	515										

In table above, bitumen of 60/70 shall be used; Type II material is specified for the Base and Subbase as per RHD; DCP test frequency is 500m<sup>2</sup>/1no and Manual method for seal and AC Base course is adopted as per RHD; the application rate of RC 30 or RC70 for tack coat is 0.45L/m<sup>2</sup>; prime coat of MC30 with spraying rate of 1.0L/m<sup>2</sup> shall be applied to the base after compacted and tested; grading of AC and seal coat using manual method is shown in Table 4 below. Application temperature for Bituminous materials shall follow the Technical Specification of RHD.

4.2 The pavement design as per structure number method

As double checking, the pavement design as per structure number as per AASHTO method is used, and when CBR of subgrade is 5% and over, the total structure thickness is 490mm which is close to the local method of total pavement thickness of 515mm.

4.3 The pavement design as per CBR method of Japanese method

The same result is get when CBR method of Japanese road pavement designs is used.

#### 5. Construction Design

### 5.1 Material for asphalt concrete

Bitumen with penetration of 60/70 is specified for the work.

### 5.2 Construction method

The same construction method as per described in the is adopted for the construction.

### 5.3 Compaction test frequencies

According to the local standard that DCP test can be used for the compaction density test, as least one test at three places in 500m<sup>2</sup> will be test at least once. This test is taken shortest time than any other test method and with high efficiency.

## 6. Discussion

It is noticed that there is two road design standard, one is Local Government Engineering Department (LGED), one is Road and Highway Department (RHD). The road design life shall be 10-years and traffic increase rate shall be 5% as per LGED, according to this LGED the road design life is 40% of that RHD. According to LGED it is not required for AC road, but it is has to be provided according to RHD. The higher standard is used here for the road pavement design for the Sewage Treatment Plant, and the result shall be in conservation.

Since the aggregates shall be imported oversea, therefore, for the economically construction of the road in Bangladesh, the burnt clay brick is allowed to be used as base and subbase material after crushed.

In order to save time and to avoid unnecessary time consumption during execution of the contract, the clear technical specification shall be specified before signing of the contract.

## 7. Conclusions

According to the Pavement Design guide of Road and Highway Department of Bangladesh, the road pavement structure is designed for the road of the first modernized Sewage Treatment Plant in Bangladesh, it is double checked by using CBR and structure number method. The pavement structure from top to down is 7mm thick seal coat, 40mm thick asphalt concrete, 175mm thick Base, 150mm thick subbase and 150mm thick subgrade. The total thickness of the Pavement is 515mm. this pavement design will be used for the access road, internal roads inside the Sewage Treatment Plant and the road in Sewage Lift Pumping Station. The minimum compaction shall be 95% for the improved subbase and 98% for the other structure layer.

DCP test can be used for the replacement of sand replacement for site density test since this method is quick, fast and with higher efficiencies. The technical speiation shall be determined before sign of the contract to minimum different understanding and time consumption in execution of the contract.

## Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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