CHAPTER 33
ROAD CONSTRUCTION-BANGLADESH PERSPECTIVE
SECTION 155- GENERAL

History of Pavement in Bangladesh

3301. The rigid pavement in Bangladesh was constructed during World War 2 and in early fifties with thickness between 5 to 6 inches (125mm to 150mm); when the volume of traffic was either negligible or very small. The concrete pavement construction was done without following any standard design procedures, modern construction technique and quality control.

After independence of Bangladesh, greatly emphasized on providing paved road connectivity to all Zilla and Upazilla towns and develop paved road network for improving land transport system in the country. During this period, bitumen was comparatively cheaper. So, the obvious choice was to prefer the asphalt pavement to cater for rapid road network construction policy. Thus, since the seventies, cement concrete pavement has become a forgotten type of pavement in Bangladesh.

Soil Characteristics in Bangladesh

3302. According to the LGED manual of Road construction, soil charecteristics of Bangladesh are as following.

a. East, north and north eastern side of Bangladesh is a peripheral hilly region being made up of Neogene and Paleogene sediments whereas its adjoining recent piedmont deposits and the vast distinctive tracts of residual deposits popularly known as the ***Madhupur*** and ***Barind*** clay residuum.

b. In the hilly region, since the sediments derived are related to the various lithological units, the composition of the units plays direct role in determining the nature of the derived sediment deposits. Since shells, clay stones, silt stones and sand stones make up most of the formations of the constituent materials they are also dominant among the materials derived from the formations of the hilly region.

c. Particularly in the north and northeastern part of the country, vast tracts of land is covered either by extensive or isolated remnants of clay residuum with reddish to red brown mottled clay containing little amount of silt and sand. These tracts cover extensive areas in the central and northern zones of ***Dhaka***, north-eastern region in ***Sylhet*** Division and in the central and southern areas of ***Rajshahi***.

d. Most part of these low-lying deltaic country flood plains is a result of an intricate network of rivers with poor channel gradients and rapid siltation. Heavy and high intensity of seasonal precipitation generates a tremendous amount of surface run-off in upper region of the rivers causing the silted channel to over flow which, in turn, contribute to recurrent flooding.

e. When the rivers move from upstream to the down, the gradient of the streams become flatter and flatter consequently the velocity of flow becomes slower and slower. As a result, coarser sediment like sand, deposits at upstream and finer particles like silt and clay wash down to the flooded plains and basins forming clay and silt mantles. The basic characteristics of the flood plain alluvium of the major rivers are as follow:

i. The flood plain sediments of the ***Brahmaputra/Jamuna*** and the ***Meghna*** have a high silt content,

ii. The ***Teesta*** and western part of the ***Ganges*** flood plain sediments are extensively sandy,

iii. The lower part of the ***Ganges/Padma*** flood plain sediments has clay content and partially calcareous.

f. Some of the piedmont deposits occur in the most elevated parts of the country at the foot of the northern and eastern hilly areas. The deposits are mainly sandy with occasional pebbles present in them. These are the results of active torrential erosion in mountains and deposition by river or streams as alluvial and colluvial materials. The composition of such materials ranges from boulders, shingles to gravels mixed with coarse to fine sandy matrix.

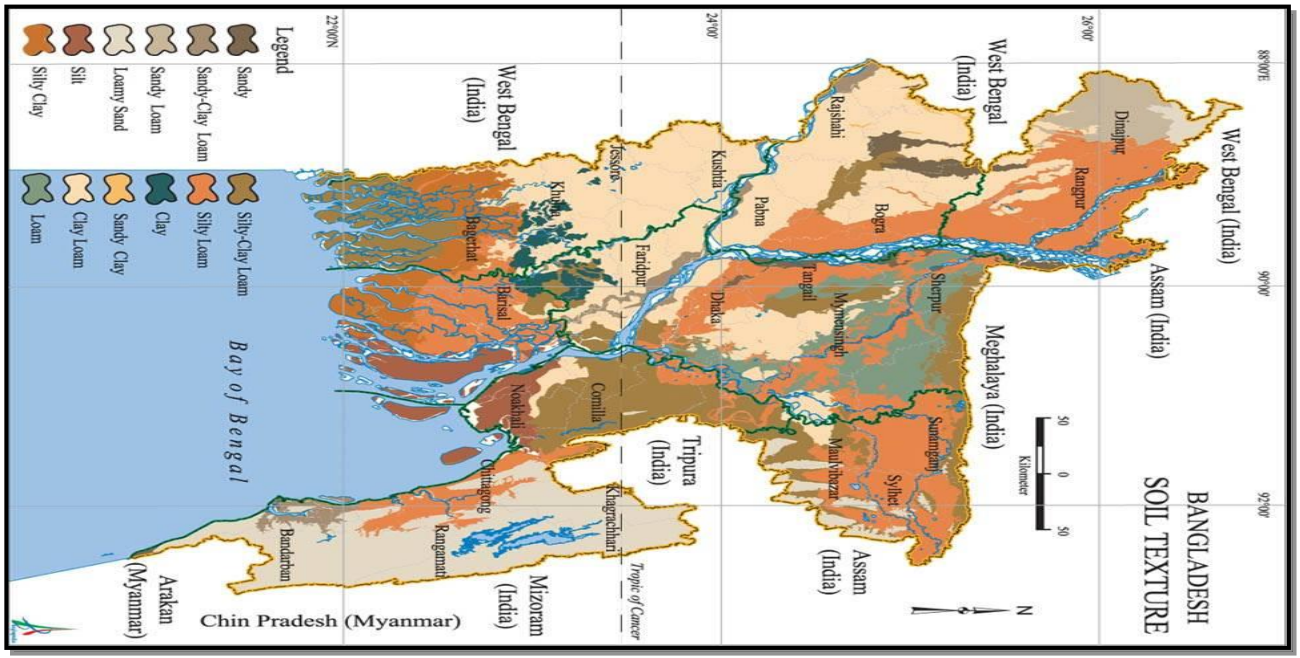

Figure33.-1: Soil Map of Bangladesh.

Earth Works Components

3303. Earth Work. For the construction of any road irrespective of its category, either we need to fill the embankment to raise the road above flood level or cut it down to bring it to its formation level.

a. Fill.

(1). The topographic condition of Bangladesh is such that most of the road constructions require embankments rather than cuttings. Almost 85 percent area of our country is a major deltaic region and it is underlain by deltaic and alluvial deposits of the Ganges, the Brahmaputra/Jamuna and the Meghna rivers systems. Fortunately, this deltaic and alluvial soil is most suitable for agricultural purpose but unfortunately it is not that much suitable as road construction material.

(2). Moreover, when a high embankment is needed to cross a gully or at an approach to water crossing, the embankment itself imposes a substantial amount of load on the underlying soil and a settlement should always be expected for such type of underlying soil. Situation is more aggravated when organic soil is used for filling during construction and it is very much frequent in the area of southern, southwestern and northwestern part of the country.

(3). In spite of low quality of soil encountered frequently, embankment filling of the road should be constructed with the locally available soil to avoid long hauling distance in order to reduce the excessive construction cost.

(4). But the selection of source and borrow pits should be done carefully by an experienced and qualified person because the quality of material may vary even the sources are not very far from each other. But in any case, organic materials like peat, black cotton soil and mug must not be used for filling purpose as these materials are highly compressible. Also, pure silt is better to avoid.

b. Cutting.

(1). In the hilly areas of the country where the alignment of the road passes through the hills and valise alternately, the designer needs to be careful to balance cutting with filling to minimize wastage and reduce hauling distance in order to make the construction cost-effective.

(2). Machine or manual excavation method is generally employed for earth and soft rock cuttings. But for the very hard rock excavation, blasting may sometimes be required to make the job faster.

(3). Proper planning in the initial stage is essential to optimize the use of machinery and materials. The drainage problem is always associated with cuttings which demands a careful consideration although the longitudinal side ditches may be universally used for the purpose.

(4). Cutting through sound rock can often stand at or near vertical, but in weathered rock or soil the conditions are more unstable. Instability is usually caused by an accumulation of water in the soil and slips occur when this accumulation of water reduces the natural cohesion of the soil and increases its weight. Thus, the design and construction of the road should always promote the rapid and safe movement of water from the area above the road to the area below.

(5). Under no circumstances should the road impede the flow of water internally or externally or the road embankment stands as a barrier to water movement. In rock cutting, the side slopes may be taken from 1/4 to 1 horizontal to 1 vertical depending upon the rock quality designation and climatic condition.

(6). The subgrade in cutting requires special attention to meet the requirement of the specified subgrade properties. Most of the cases the soil properties are prescribed in the specification and the minimum requirements are outlined.

(7). As such during construction when cutting reaches at the top level of subgrade, the soil sample should be collected and tested in the laboratory whether the soil satisfies the required properties or not.

(8). If the soil is found to meet the specification, the area should be scarified up to the required depth as stated in the specifications and the moisture content should be brought to the optimum level either by aeration or by spraying water as the case may be and compacted up to the specified degree of compaction.

(9). If the soil in place fails to satisfy the required properties, the soil in question should be removed (at least 600mm from the top) and replaced with specified soil and the subgrade should be prepared accordingly.

3304. **Side Slope Selection**. The most neglected part of our road construction is the construction of side slopes and in some cases the shoulder. Although the shoulders and the side slopes are done once at the initial construction stage, no proper care is taken during the maintenance period. As a result, not only traffic flow capacity of a road is reduced but also threatens to failure of the road as a whole in many occasions. Following steps are required to be followed in order to obtain a stable embankment.

a. The first step in obtaining a stable roadway embankment is the careful selection of alignment of the road in respect of topography and drainage

b. The second step is the proper design of the embankment and cut slopes

c. The third step is the use of proper construction materials and techniques to obtain the required stability.

3305. The following factors should however be kept in mind while choosing the side slopes:

a. The type of soil of which the slope is made of.
b. The climatic conditions, specially the amount of annual rainfall in the area.
c. The adequacy of drainage.
d. The nature and characteristics of the surface layer.

3306. The most common practice in the country is to protect the slope from erosion by growing a suitable type of vegetative cover like grass at the top. Most of the soils used in slope construction contain some degree of cohesive material which is conducive to such a treatment. But purely cohesionless soils may not easily support vegetation. For such type of soil, a cover of 25 to 30 cm layer of clay soil may be uniformly laid and stabilized before turfing with grass. Cement concrete block riprap and brick mattressing are in common use at high approaches of the bridges or where the wave action is a major threat to the embankment. Some of the slope protection techniques are given below:

a. Sowing seeds for vegetable/grass turfing
b. Transplantation of ready-made turfs of grass
c. Use of straw with cow dung as mulch
d. Vegetative turfing with jute netting or coir netting
e. Loose stone riprap (this technique may be used in the hilly areas)
f. Grouted stone riprap (where slopes are steep and stones are readily available)
g. Cement concrete block riprap
h. Reinforced concrete slope protection
i. Brick mattressing
j. Sand-cement gunny bag riprap

Pavement Distresses due to Local Weather Conditions

3307. Most of roads and highways in Bangladesh are flexible construction. For situational circumstances, these flexible pavements suffer from several distresses beyond the constructional fault. The situational circumstances are mainly due to weathering factors like heavy rainfall and resulting flooding & submergence and hot summer temperature. Both submergence and hot weather coupled with overloading conditions cause premature failure of pavement in the form of reveling,

potholes, bleeding/flushing, loss of skid resistance etc. As a result, every year a large amount of money need to spend by different organizations for the maintenance purposes. In this Article distresses of flexible pavement that are caused by the submergence and hot weather conditions are explained with special focus on susceptibility of flexible pavement with the local weather condition as compared to the rigid pavement.

a. Submergence Problems

(1). Bangladesh is a riverine country and situated in a flood prone region in the sub continental. During the rainy season and subsequent occurrence of flood, often a substantial part of the total land area of Bangladesh goes under water and in consequence a large amount of road networks become submerged for a considerable period of time.

(2). Due to this submergence condition, flexible pavements suffer a serious type of distress called **raveling** where the aggregate and binder become separated due to stripping effect and in the absence of proper bonding loss of aggregates start. Eventually, potholes with different sizes and depths developed on the pavement surface and riding quality or its present serviceability index deteriorated severely and road become unworthy for riding.

(3). In urban areas, due to the lack of sewerage facilities as well as maintenance problems, roads suffer submergence condition immediately after moderate to heavy rainfall. When rain or floodwater washes away, bituminous pavement seriously deteriorates. In the rural or sub-urban areas, roads mainly suffer from seasonal floods. Flood water flashes over the national or regional highway.

(4). At this moment, when truck, bus or such type of heavy vehicles run over the pavement, cracks are developed due to tension force at the upper surface of the pavement layer particularly near the tire contact areas and water enters into the pavement layer through these cracks or void spaces. As vehicle moves forward, tire creates compression on the same surface that was under tension few moments ago.

(5). At that time the water that entered into the surface developed pore pressure and come out forcefully to release the pressure. This ejection of water breaks the bond between

aggregates and help stripping of binder from the aggregates. With the movement of vehicles, this process of successive tension (ingress of water) and compression (ejection or digress of water) on the wearing surface causes serious distress in the form of raveling and premature failure of the pavement. The mechanics of pavement raveling process under submerged condition can be seen from the following Figures.

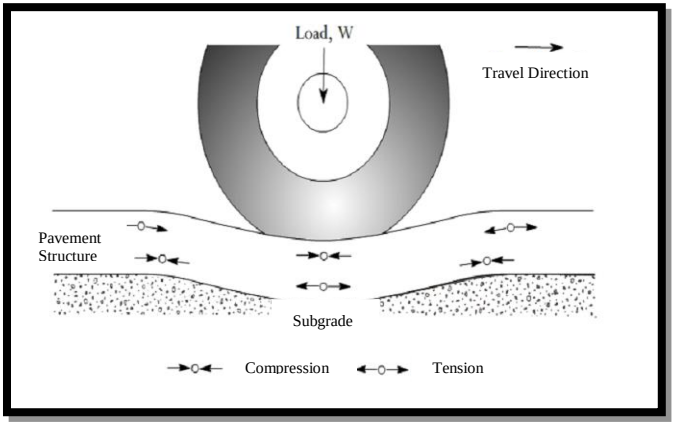

Figure33-2: Pavement Deflection Result in Tensile and Compressive Stresses In Pavement Structure

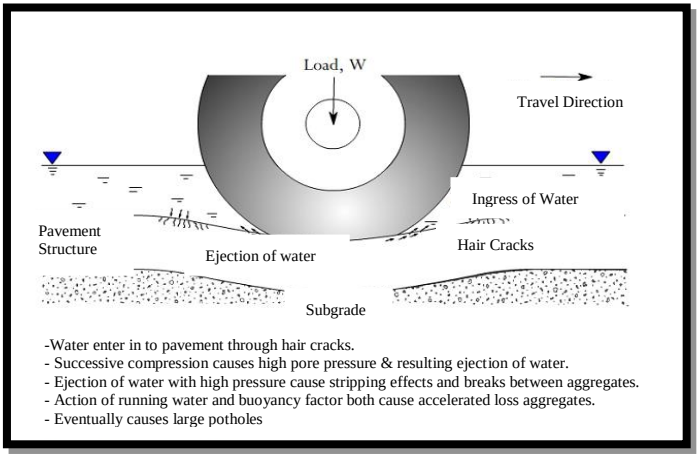

Figure33-3: Pavement Failure Under Submerged Condition

(6). In the absence of appropriate traffic control and enforcement measures, plying of heavily loaded vehicles during the submergence condition also act as a catalyst in the development of premature pavement distresses. In consequence, each year after rainy season flexible pavement-based roads and highways of Bangladesh needs recurrent rehabilitation work and thereby besides immense suffering to the motorists it increase the life cycle cost of flexible pavements. A few snap shots are presented below to depict the problems associated with the pavement submergence.

b. Flushing due to hot Climatic Condition

(1). Bangladesh is situated in a tropical region; where in a typical mid day ambient temperature of bituminous black top surface often rises above 42ºC. This high summer temperature along with the presence of overloaded vehicles in the traffic stream causes a severe type of distress called flushing.

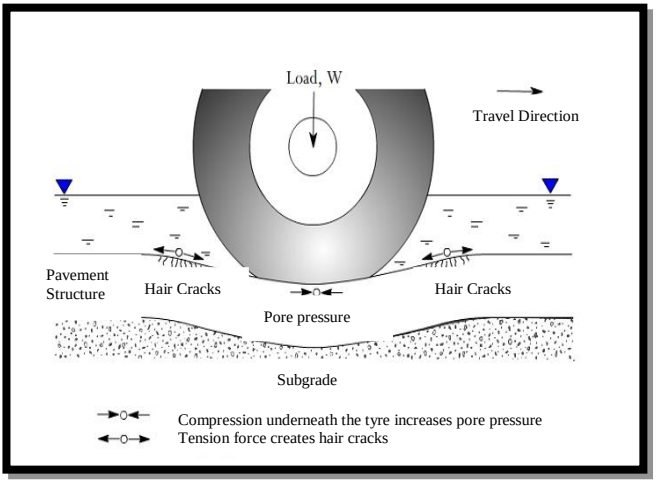

Figure33-4: Pavement Failure Under Submerged Condition

Figure33-5:Plying of Heavy Vehicles Under Submerged Condition

Figure33-6.Pavement Deterioration After Rainy Season

(2). Flushing (or bleeding) is indicated by an excess of bituminous material on the pavement surface, which presents a shiny, glass-like reflective surface that may become sticky in hot temperatures. As bleeding in the form of excessive asphalt cover up the surface aggregates it reduces skid resistance and at extreme case it often causes instability to moving vehicles due to sticky surface and thereby makes roadway operation hazardous for the motorists.

(3). The pavement with skid-resistance less surface becomes more slippery and dangerous particularly during rainy days. Moreover, another common drawback of the bitumen surfaces is their inherent property of becoming soft under high temperatures. Due to poor creep behavior of bituminous binder, the soft surface course loses its stability and is easily rutted and deformed particularly by the stopped or parked vehicles.

In contrast cement concrete is not so susceptible to the temperature and can withstand high temperatures without any softening. This property is likely to be of great value in tropical countries like Bangladesh. The following photographs show the slippery surface and wheel paths on the soft flexible pavements that are caused by binder's bleeding problem.