FLEXIBLE PAVEMENTS

1. Introduction

The science of highway engineering raises some fundamental questions as to what is a road or highway, how is it planned and designed and lastly how is it built. By now in the preceding chapters, depending upon the desired strength of the pavement, the aggregate gradations and the type and proportion of binders are decided. These three basic binder medium give rise to a number of construction methods.

One of the main purposes of pavement design is to produce a soil structure system that will carry traffic smoothly and safely with minimum cost. The increase in axle load and phenomenal growth of traffic warrant as much importance in design, construction and maintenance of roads.

2. COMPOSITION AND STRUCTURE OF FLEXIBLE PAVEMENT

Flexible pavements support loads through bearing rather than flexural action. They comprise several layers of carefully selected materials designed to gradually distribute loads from the pavement surface to the layers underneath. The design ensures the load transmitted to each successive layer does not exceed the layer's load-bearing capacity. A typical flexible pavement section is shown in Figure 1. Figure 2 depicts the distribution of the imposed load to the subgrade. The various layers composing a flexible pavement and the functions they perform are described below:

a) Bituminous Surface (Wearing Course). The bituminous surface, or wearing course, is made up of a mixture of various selected aggregates bound together with asphalt cement or other bituminous binders. This surface prevents the penetration of surface water to the base course; provides a smooth, well-bonded surface free from loose particles, which might endanger aircraft or people; resists the stresses caused by aircraft loads; and supplies a skid-resistant surface without causing undue wear on tires.

b) Base Course. The base course serves as the principal structural component of the flexible pavement. It distributes the imposed wheel load to the pavement foundation, the subbase, and/or the subgrade. The base course must have sufficient quality and thickness to prevent failure in the subgrade and/or subbase, withstand the stresses produced in the base itself, resist vertical pressures that tend to produce consolidation and result in distortion of the surface course, and resist volume changes caused by fluctuations in its moisture content. The materials composing the base course are select hard and durable aggregates, which generally fall into two main classes: stabilized and granular. The stabilized bases normally consist of crushed or uncrushed aggregate bound with a stabilizer, such as Portland cement or bitumen. The quality of the base course is a function of its composition, physical properties, and compaction of the material.

c) Subbase. This layer is used in areas where frost action is severe or the subgrade soil is extremely weak. The subbase course functions like the base course. The material requirements for the subbase are not as strict as those for the base course since the subbase is subjected to lower load stresses. The subbase consists of stabilized or properly compacted granular material.

d) Frost Protection Layer. Some flexible pavements require a frost protection layer. This layer functions the same way in either a flexible or a rigid pavement.

e) Subgrade. The subgrade is the compacted soil layer that forms the foundation of the pavement system. Subgrade soils are subjected to lower stresses than the surface, base, and subbase courses. Since load stresses decrease with depth, the controlling subgrade stress usually lies at the top of the subgrade. The combined thickness of subbase, base, and wearing surface must be great enough to reduce the stresses occurring in the subgrade to values that will not cause excessive distortion or displacement of the subgrade soil layer.

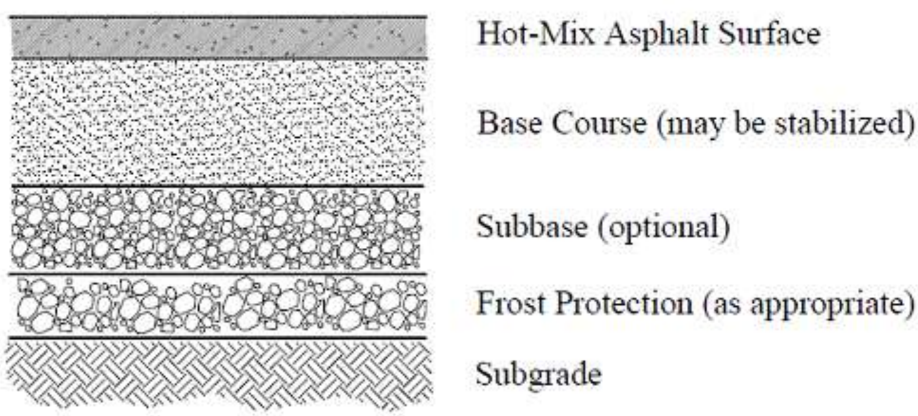

Fig 1: Typical flexible pavement structure

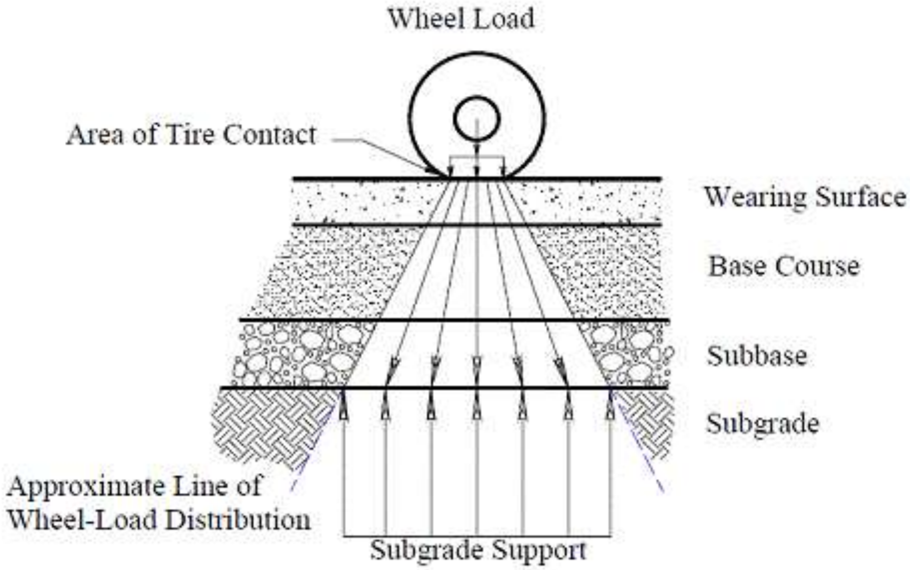

Fig 2: Distribution of load stress in flexible pavement

3. Types of Highway Construction

The highway types are classified as below:

(i) Earth road and gravel roads

(ii) Soil stabilized roads

(iii) Water bound macadam (WBM) road

(iv) Bituminous or black-top roads.

4. Granular sub base layer:

4.1 INTRODUCTION

Aggregates are used in granular base and subbase layers below the driving surface layer(s) in both asphalt concrete and Portland cement concrete pavement structures. The aggregate base layers serve a variety of purposes, including reducing the stress applied to the subgrade layer and providing drainage for the pavement structure. The granular base layer is directly below the pavement surface and acts as the load bearing and strengthening component of the pavement structure. The granular subbase forms the lowest (bottom) layer of the pavement structure, and acts as the principal foundation for the subsequent road profile, provides drainage for the pavement structure, and protects the structure from frost.

Granular bases are typically constructed by spreading the materials in thin layers of 150 mm (6 in) to 200 mm (8 in) and compacting each layer by rolling over it with heavy compaction equipment.

4.2 MATERIALS

Aggregates used in granular base and subbase applications generally consist of sand and gravel, crushed stone or quarry rock, slag, or other hard, durable material of mineral origin. The gradation requirements vary with type (base or subbase).

Granular base materials typically contain a crushed stone content in excess of 50 percent of the coarse aggregate particles. Cubical particles are desirable, with a limited amount of flat or thin and elongated particles. The granular base is typically dense graded, with the amount of fines limited to promote drainage. Granular subbase is also dense graded, but tends to be somewhat more coarse than granular base. The requirement for crushed content for granular subbase is not required by many agencies, although provision of 100 percent crushed aggregates for base and subbase use is increasing in premium pavement structures to promote rutting resistance.

4.2.1 Specification of material –

1. The materials to be used for the work shall be natural sand, moorum, gravel, crushed
2. Stone or combination depending on grading requirement.
3. The materials shall be free from organic or deleterious constituents & should conform to
4. One of the three grading given in table 400-1.
5. The gradings in Table 400 – 1 are in respect of close graded granular sub base material.

IS Sieve Designation	Percentage by weight passing the IS sieve		
	Grading – I	Grading – II	Grading – III
75.0mm	100	-	-
53.0mm	80 – 100	100	-
26.5mm	55 – 90	70 – 100	100
9.5mm	35 – 65	50 – 80	65 – 95
4.75mm	25 – 55	40 – 65	50 – 80
2.36mm	20 – 40	30 – 50	40 – 65
0.425mm	10 – 25	15 – 25	20 – 35
0.075mm	3 – 10	3 – 10	3 – 10
(BR Value min)	30	25	20

Table 400 – 1

5. FLEXIBLE PAVEMENT SUBGRADES

5.1. Factors to Be Considered.

The information obtained from the explorations and test previously described should be adequate to enable full consideration of all factors affecting the suitability of the subgrade and subsoil. The primary factors are as follows:

- The general characteristics of the subgrade soils such as soil classification, limits, etc.
- Depth to bed rock.
- Depth to water table (including perched water table).
- The compaction that can be attained in the subgrade and the adequacy of the existing density in the layers below the zone of compaction requirements.

- The CBR that the compacted subgrade and uncompacted subgrade will have under local environmental conditions. in-place densities are satisfactory.
- The presence of weak of soft layers in the sub-soil.
- Susceptibility to detrimental frost action.

5.2 Compaction.

The natural density of the subgrade must be sufficient to resist densification under traffic or the subgrade must be compacted during construction to a depth where the natural density will resist densification under traffic. Table 4 shows the depth, measured from the pavement surface, at which a given percent compaction is required to prevent densification under traffic. Subgrades in cuts must have natural densities equal to or greater than the values shown in Table 4. Where such is not the case, the subgrade must be compacted from the surface to meet the tabulated densities, or be removed and replaced in which case the requirements for fills apply, or be covered with sufficient select material, subbase, and base so that the uncompacted subgrade is at a depth where the in-place densities are satisfactory. In fill areas, cohesionless soils will be placed at no less than 95 percent of ASTM D 1557 maximum density nor cohesive fills at less than 90 percent of ASTM D 1557 maximum density.