Construction of Flexible pavements-An Overview

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Abstract: A highway pavement is a structure consisting of superimposed layers of processed materials above the natural soil sub-grade, whose primary function is to distribute the applied vehicle loads to the sub-grade. The pavement structure should be able to provide a surface of acceptable riding quality, adequate skid resistance, favorable light reflecting characteristics, and low noise pollution. The ultimate aim is to ensure that the transmitted stresses due to wheel load are sufficiently reduced, so that they will not exceed bearing capacity of the sub-grade. Two types of pavements are generally recognized as serving this purpose, namely flexible pavements and rigid pavements. This paper gives an overview of pavement layers, and their Construction.

Keywords: Subgrade; Sub-base; Highway pavement; Setting out; Earthworks.

I. INTRODUCTION

Flexible pavement is any kind of pavement that is not constructed using concrete. In Malaysia the pavement is commonly, constructed by using flexible pavement. Pavements with very low flexural strength and are flexible in their structural behaviour when under a load are called flexible pavements. The layers of this type of pavement reflect the deformation of the lower layers that are beneath the top surface. Thus, if the lower layer is deformed, the surface of the pavement will also be deformed.

The structure of the road mainly consists of the following layers:

i. Sub-grade soil or simply sub-grade.
ii. Sub-base.
iii. Road Base.
iv. Surface layer.

The methods of constructing roads have changed a lot since the first roads were built around 4000 BC made of stone and timber. The first Roman roads were stone paved, built in North Africa and Europe for military operations. Road construction techniques were gradually improved by the study of road traffic, stone thickness, road alignment, and slope gradients, developing to use stones that were laid in a regular, compact design, and covered with smaller stones to produce a solid layer. Modern roads tend to be constructed using asphalt and/or concrete. Very broadly, the construction of roads can be described by three processes:

a) Setting out.
b) Earthworks.
c) Paving construction.

This is carried out following the dimensions specified in layout drawings.

a) Setting out.

A commonly used setting out procedure is the profile board method. A series of boards that show the exact level 1 metre above the completed construction level are placed at intervals along the proposed line of the road. A profile board with a fixed height, called the traveller, is used for controlling the
Excavated levels between these profile boards. By placing the traveller in the sightline between two level boards, it can be seen whether or not the excavation has been carried out to correct levels and adjusted accordingly. The level of each profile board is controlled using a line level which is a short spirit level hung from a nylon string. The line operator moves the string up or down until the bubble is centred. Junctions, hammer heads, turning bays and intersecting curves are laid out in a similar manner.

b) Earthworks.
Earthwork is one of the major works involved in road construction. It involves the removal of topsoil, along with any vegetation, before scraping and grading the area to the finished ‘formation level’. This is usually done using a tractor shovel, grader or bulldozer. Below the formation level, the soil is known as the ‘subgrade’. It is essential that the strength of the subgrade is tested prior to earthwork beginning. Most earthworks are formed by cut-and-fill, and the type of ‘fill’ material must be considered, not only in terms of its physical properties, but on the conditions in which it is to be used, and the methods of compaction. Depending on its quality, compressible subsoil may be removed or stabilised. If the cost of full or partial excavation of subsoil is uneconomical and would be likely to result in consolidation, sand wicks or sand drains may be used. Sand wicks are sand-filled boreholes beneath the road embankment that give greater stability to the soil by decreasing the length that water has to travel in a drainage path, so dissipating water pressure. Sand drains alongside the road are used to intercept ground water. Subsoil drainage should be provided to deal with seepage through pavements and verges, from higher ground and a result of the seasonal rise and fall of the water table.

Subgrade strength
The required thickness of the pavement is determined by the subgrade strength, so it is desirable to make the subgrade as strong as possible. The strength of the subgrade can be achieved by using the following techniques:
- Removal of poor material in cuttings and replacing with selected fill.
- Compacting subgrade to a high dry density.
- Providing adequate subsoil drainage.
- Soil stabilisation methods such as the use of cement, bituminous materials or chemicals.

The subgrade strength will decrease as moisture content increases so protection may be required if it is to be left exposed for any length of time. Protection covering can be either:
- Medium gauge plastic sheeting with 300 mm laps.
- Sprayed bituminous binder with a sand topping.

c) Paving construction
Once the subgrade has been prepared and drainage or buried services installed, the paving construction can begin. Paving can be either flexible or rigid. There are pros and cons to each type, with one being selected over the other depending on the specific needs of a project. Rigid pavements tend to have lower maintenance costs, a longer design life and higher flexural strength; but flexible pavements tend to have lower construction costs and have a higher ability to expand and contract with temperature and so do not need expansion joints.

Flexible paving
Flexible paving consists of materials applied in layers directly over the subgrade to which the traffic loads are distributed. To prevent permanent deformation, and therefore an uneven running surface, the
thicknesses of individual layers must be capable of distributing such loads. The subgrade is compacted with the sub-base on top of it. On top of this is laid the surfacing which is made up of the base layer and the wearing course.

**Surfacing**
The wearing course is the upper layer of bituminous material, often denser and stronger than the base layer. The thickness depends on the material specification and the amount of wear that is expected. Desired properties are good non-skid capabilities, minimal glare and acceptable durability. The main materials that are used are hot rolled asphalt (HRA), dense bitumen macadam (DBM), dense tar macadam (DTM) and porous asphalt (PA). PA is especially suitable as it is an open-graded material that is designed to allow rapid drainage of surface water, thereby reducing spray as well as tyre noise. The base will typically have a minimum thickness of 60 mm and is usually made of dense bitumen macadam or asphalt. It is laid with the appropriate crossfalls and gradients.

**Sub-base**
This is placed in a layer usually not exceeding 150 mm over the subgrade after waterproofing is complete. Various materials can be used but it is common for crushed stone or dry lean concrete (such as 1 : 15) laid and compacted by heavy rollers.

**II. FLEXIBLE PAVEMENT CONSTRUCTION PROCESS**

**Preparation of Sub-Grade Layer**
Prepare the sub-grade layer, it is done after placing the drainage system, piping and electric cable. The sub-grade surface will be compacted levelled and be cut to make camber as in plan. If the material of the soil did not have a good quality, it will be changed with suitable material. Base formation covers with 50-75mm sand layer or quarry dust and will be compacted with 8-10 tone compactors. This job must be done to prevent the clay from absorbing into the stone layer of sub-base and reduce the shear strength of the pavement.

**Construction And Compacting The Sub-Base**
After the sub-base has been prepared with list materials, it will be placed and constructed into two layers if the thickness is more than 150mm. Every layer will be compacted according to the plan. Sub-baselayer must be compacted carefully with compactor machine. Compactors with rubber roller can compact 120mm layer in 12 times. Compacting should start from the side of the road hen slowly towards the middle of the road in horizontal way. In super-elevated bends compaction machine will start at the lowest part and slowly towards the higher level. The finished part should not be more than 20mm from the plan.

**Construction Of Road Base**
Before road base is constructed, sub-grade surface and sub-base must be formed perfectly and compacted enough. The lowest layer and sub-base must be prepared at least distance of 200m from the base construction. The road base in Malaysia is commonly constructed with a material known as crusher run. This material is place and compacted to on the surface of the road. The road base must be constructed in two layers of same thickness. Each layer should not exceed 150mm.
Construction Of Road Surface
The road surface is constructed with bitumen materials, such as concrete asphalt, macadam bitumen and so on. The constructed should be free from dust and waterproof. To construct the surface layer, the base course must be prepared first. Prime coat is poured onto the road base surface to be a binder between the road bases and the base course. To pour the prime coat, the temperature must be according to the specifications stipulated. Base course is built on one layer only with a pavers’ machine. After this layer is constructed, it is placed before it is compacted. The surface is checked and corrected if there are any differences. The compacting must be done immediately. It should be compacted from the side towards the middle of the road. It there is a super elevated bend, then it should be compacted from lower part to higher part. The type of compactors must be according to the specifications. Finally wearing course is prepared. Like always, base course should be cleaned before tack coat is poured. The compacting job is done the same way as the base course.

III. CONCLUSION
The purpose of this study is to understand the basic construction procedure of flexible pavements. Also the pavement may be left for sometime after the surfacing is done for curing. For flexible pavements usually 24hours of curing period is sufficient. The road is opened to traffic immediately without causing hindrances to moving traffic.

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