TRANSPORTATION ENGINEERING

COURSE CODE- RCI4C002

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SYLLABUS

Module-I (10 hrs)

Modes of transportation, importance of highway transportation, history of road construction. Principle of highway planning, road development plans, highway alignments requirements, engineering surveys for highway location. Geometric design- Design controls, highway cross section elements, cross slope or camber, road width, road margins, typical cross sections of roads, design speed, sight distance, design of horizontal and vertical alignments, horizontal and vertical curves.

Module-II (10 hrs)

Highway Materials:- Properties of subgrade , sub-base , base course and surface course materials , test on subgrade soil, aggregates and bituminous materials. Traffic Engineering:- definition , fundamentals of traffic flow , traffic management, prevention of road accidents , elements of transport planning , highway drainage

Module-III (9 hrs)

Design of Highway Pavements: Flexible pavements and their design, review of old methods, CBR method, IRC:37-2012, equivalent single wheel load factor, rigid pavements, stress in rigid pavement, IRC design method (IRC:58-2011).

Module-IV (9 hrs)

Highway Construction: Construction of various layers, earthwork, WBM, GSB, WMM, various types of bituminous layers, joints in rigid pavements, Hot Mix Plants, Construction of Rigid Pavements

Module-V (7 hrs)

Highway Maintenance: Various type of failures of flexible and rigid pavements.

Books:

• Highway Engineering, by S.K.Khanna and CEG Justo, Nem Chand & Bros.
• Transportation Engineering-Highway Engineering by C Venkatramaiah, Universities Press.
• A course in Highway Engineering by Dr. S.P. Bindra, Dhanpat Rai Publications.
• Principles of Highway Engineering and Traffic Analysis by Mannering Fred L., Washburn Scott S. and Kilaresk Walter P., Wiley India Pvt. Ltd
• Traffic Engineering and Transportation Planning by Kadiyali, L.R.,Khanna Publishers
• Transportation Engineering and Planning by Papacostas, C.S. and Prevedouros, P.D.,Prentice Hall.

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Module IV

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Lecture 38

Highway Construction

Earthwork

For various civil engineering projects like road work, irrigation canal project, tank survey, earth moving, etc, the calculation method used are different. Some of these methods were introduced before the invention of computers and are still being continued. This document discusses about the industry practices of various methods of volume calculation so that the users can finally choose the right one for their project.

Earthworks

Earthworks are engineering works created through the moving and/or processing of massive quantities of soil or unformed rock. Earthwork is done to reconfigure the topography of a site to achieve the design levels. Earthwork involves cutting and filling to achieve the required topography.

Cutting

Cutting is the process of excavating earth material from a work location to achieve the desired topography.

Filling

Filling is the process of moving the excavated material or additional earth material to a work location to achieve the desired topography.

Applications of Earthwork

Typically, earthwork is done in the following projects:

- Road works
- Railways
- Irrigation project such as canals and dams
- Other common earthwork applications are land grading to reconfigure the topography of a site, or to stabilize slopes

(I) - WBM (Water Bound macadam) roads construction:

The water bound macadam road construction technique was given by the John Macadam. This technique in present day is used as given below.

For WBM construction we use three materials:

Aggregates

Screeners

Binders.

Aggregates:

We use the aggregates of different grades. IRC(Indian Roads Congress) has classified the coarse aggregates into 9 grades, according to their size.

For the construction of the WBM roads aggregates are used in the sub-base, base and surface course and so the aggregates are divided into 3 grades according to their size.

Grade 1 - particles of size 90 mm to 40 mm.

Grade 2 - particles of size 63 to 40 mm.

Grade 3 - particles of size 50 to 20 mm.

The grade 1 aggregates having size of 90 mm to 40 mm are preferred for the sub-base material and grade 2 for the base and grade 1 for the surface course. However, if we only use the WBM as the surface course, it gets deteriorated fast due to abrasion with the traffic so, bituminous surfacing over the WBM is general practice.

Screeners are the aggregates of the smaller sizes, generally 12.5 mm or 10 mm, for grade A and grade B. They are of the same chemical composition as of the coarse aggregates.

For economic considerations IRC has suggested non plastic materials such as, crushed over burnt bricks, moorum, gravels, etc. provided the liquid limit of the material is less than 20%, plasticity index is less than 6.0% and the portion of fines passing 0.075 mm sieve is less than 10%.

However if crush-able type of aggregates are used, use of the screeners may be disposed off.

Binders:

Binders, are the layers of materials which are laid after the compaction of the aggregates and the screening materials one after the another. Kankar dust or lime stone dust may be utilized if locally available.

The binding material with plasticity index value of 4% to 9% is used in surface course construction; the plasticity index of binding course material should be less than 6% in the case of the WBM layers used as base course or sub-base course, with bituminous surfacing.

However if the screening used are of crushable material like moorum or soft gravel, there is no need to apply binding material, unless the plasticity index value is low.

(II) - WMM(Wet mix macadam) road construction:

Aggregates used are of the smaller sizes, varies between the 4.75 mm to 20 mm sizes and the binders(stone dust or quarry dust having PI(Plasticity Index) not less than 6%) are premixed in a batching plant or in a mixing machine. Then they are brought to the site for overlaying and compaction.

The PI (plasticity Index) of the binding material is kept low because it should be a sound and non plastic material. If the plasticity index is more then there are the chances of the swelling and more water retention properties. So this value should be kept in mind.

Comparison of the WBM and WMM road construction:

Although the cost of construction of the WMM is said to be more than that of the WBM sub-base and bases but the advantages given below will compensate for that. Here are the points of difference:

The WMM roads are said to be more durable.

The WMM roads gets dry sooner and can be opened for traffic withing less time as compare to the WBM roads which take about one month for getting dry.

WMM roads are soon ready to be black topped with the Bituminous layers.

WMM roads are constructed at the faster rate. The consumption of the water is less in case of the WMM roads.

Stone aggregates used in WBM is larger in size which varies from 90 mm to 20 mm depending upon the grade but in case of the WMM size varies from 4.75 mm to 20 mm.

In case of WBM, stone aggregates, screenings and binders are laid one after another in layers while in WMM, aggregates and binders are premixed in the batching plants and then brought to the site for overlaying and compacting.

Materials used in the WBM are the stone aggregates, screenings and binder material(Stone dust with water) while in WMM material used are only stone aggregates and binders.

Quantity of the WBM is generally measured in cubic meters while that of the WMM in sq. meters.