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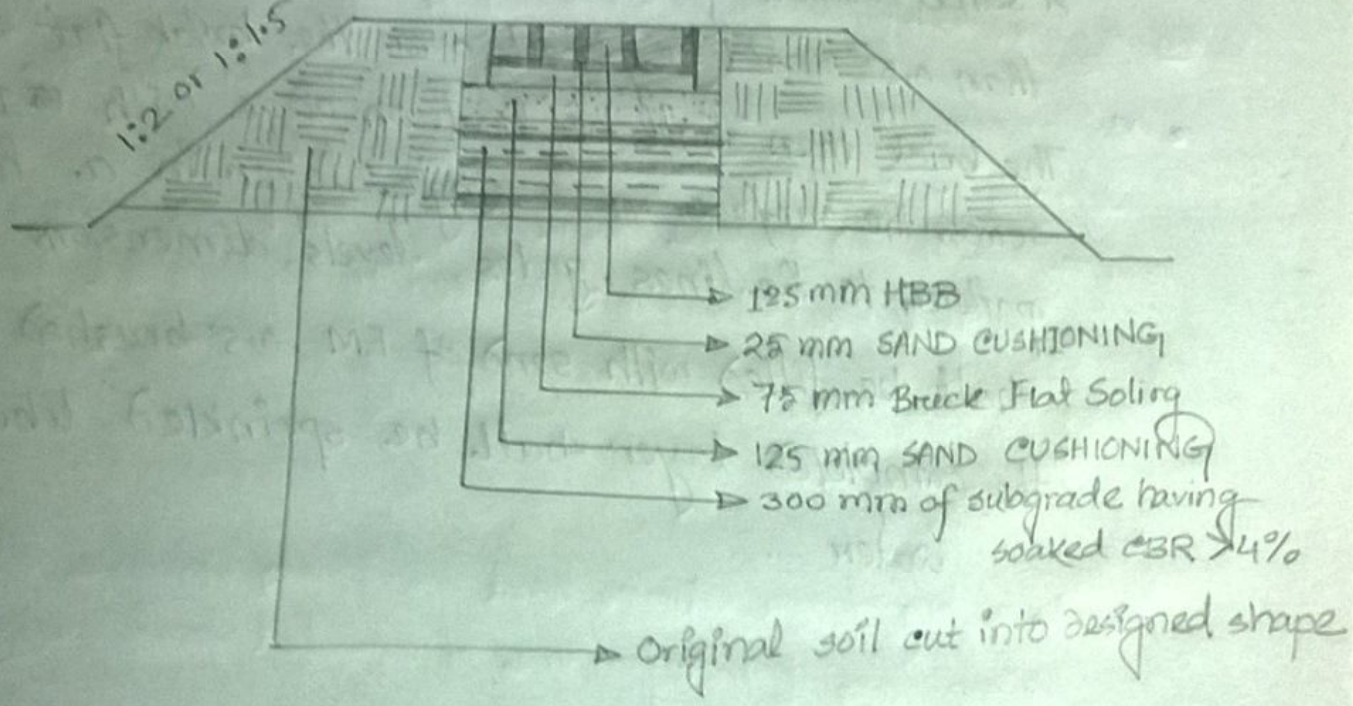
2010-11
5@ "Low cost pavement option may suit budget phasing in a resource constrainted country like Bangladesh".

Discuss the construction of Herring bone bond brick (HBB) pavement with a neat cross-sectional diagram.

→



Description:

This work shall consist of a base composed of bricks, laid on edges in a herringbone pattern, placed on a prepared single layer brick flat soling in accordance with specifications, grades levels, dimensions

Materials:

The materials shall consist of first class or picked Jhama bricks that meets the requirements.

Construction method:

A sand cushion of 25 mm thickness with sand of FM not less than 0.5 would be placed over the brick flat soling. The brick then shall be laid on edge with ≅ 125 mm across the surface in a single layer in a herringbone pattern to the lines, grades, levels, dimensions. The joints shall be filled with sand of FM 0.5 brushed in and the completed layer shall be sprinkled liberally with water.

5(b) Engineered earth road:

Soil must be shaped into a camber to shed rainwater to each side and then consolidated, as a minimum, with hand rammers for compaction, so that durability is ensured. for many circumstances it is necessary to stabilize or improve the in-situ soils mechanically, either with other selected aggregate or with cement, bitumen etc. Such a road is referred to as Engineered earth roads

Cement treated low cost road surface:

Materials:

1. Portland cement (7-14% by volm)
2. Soil suitable for subgrade.
3. Water

Cement & water content fixed by following testing:

1. Moisture – Density relationship.
2. CBR – Density relationship.

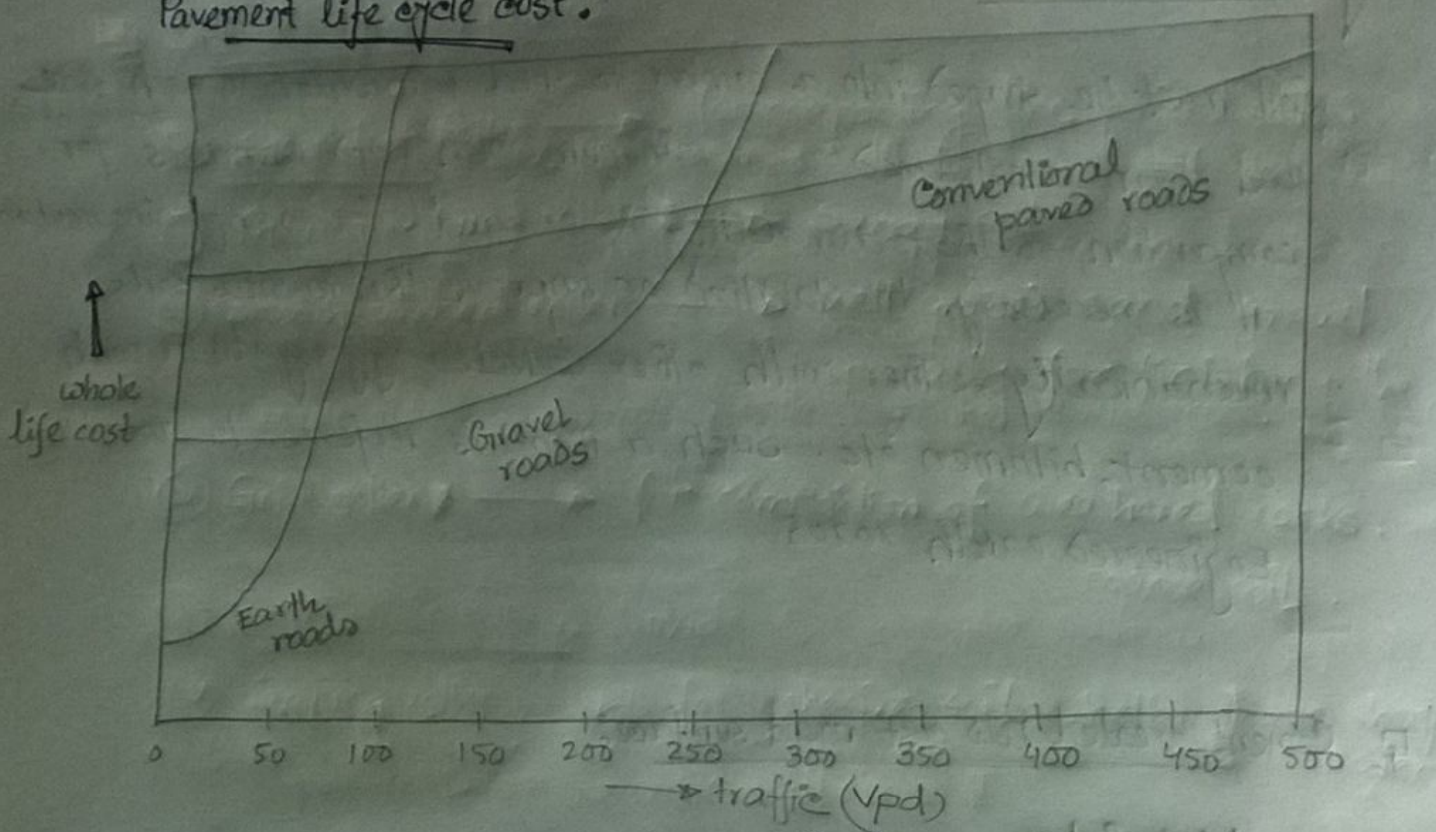
Compactn by:

1. Clay/silt soil → pneumatic tyred roller
2. Sandy soil → Vibratory compactor
3. Granular soil → wheel roller.

Field control:

- By monitoring MC, compactn & relevant CBR

Pavement life cycle cost:



Why low cost pavements not low cost in long run:

- Maintenance of gravel is expensive especially for periodic regravelling, which is typically req^d at 3 to 5 years interval. Routine maintenance of a gravel road can be achieved for US $ 250 - 650/km/year, depends on method used. However the need to replace the surface losses by periodic maintenance re-gravelling can cost a further US $ 400 - 2000/km/year.

In a dry season, vehicles and wind can remove of the order of 25 tonnes of dust per km of unsealed road every year.

⑤⑥ Quality Control tests for Earth Embankment construction:

Test name	Quality Control	Verification
① Standard proctor Maximum density	One per soil type	One per soil type
② Density	One per LOT	One per four LOTs and for wet condit^{n}, the first lift not affected by water
③ Soil classification	One per standard proctor max^{m} density	One per standard proctor Max^{m} density.

Standard proctor max^{m}. density determination:

Determine the quality control standard proctor max^{m} density and OMC by sampling and testing materials in accordance with specification.

Density Testing requirements:

Ensure compliance with the requirements by Nuclear density testing. Determine the in-place moisture content for each density test.

Different types of rollers:

① Sheep foot Roller ⟶ for compacting fine grained soils : clay/ silty soil

② Pneumatic tyred rollers ⟶ Sandy soil

③ Smooth wheeled roller ⟶ well graded sand, gravel, asphalt specially for finishing the upper surface

④ Grid roller ⟶ for compaction of weathered rocks, well graded coarse soil.

⑤ Tamping roller ⟶ for cohesive soil ; better than sheep foot roller

6. Roadside mixing plant:

Batch mixing plant: This type of plant is a must for producers who work for several clients at the same time, because the specifications can be easily changed, while maintaining a high level of quality. It guarantees the highest level of flexibility in production and quality of the finished product. Every 40-50 seconds a complete batch is produced, after all the individual components have been weighed and metered seperately

Continuous mixing plant:

In continuous mixing plant there is no interruption in the product^{n} cycle as the rhythm of production is not broken into batches.

As there is no mixing tower or elevator, the system is simplified and cost of maintenance is reduced.

Standard rolling procedure:

① Seal Rolling: Provide two coverages with a tandem steel wheeled roller weighing 5 to 12 tons, following as close behind the spreader as possible without pickup, undue displacement, or blistering of materials. Use vibratory rollers in the static mode for layers of 1 inch or less in thickness.

② Intermediate Rolling: Provide 5 coverages with a self propelled pneumatic tired roller, following as close behind the seal rolling operation as the mix will permit.

③ Final rolling: Provide 1 coverage with a tandem steel wheeled roller, weighing 5 to 12 tons, after completing the seal rolling and intermediate rolling, but before the surface pavement temperature drops to the extent that effective compaction may not be achieved or the rollers begin to damage the pavement.

Asphaltic road surface construction method:

① Preparation of the road base: A prime coat shall be applied and cured to the surface of the granular base material before spreading the premixed aggregates or a tack coat shall be applied to the existing bituminous surface.

② Mixing of bituminous material:

thoroughly mixed together to give a stockpile of aggregate of the req^{d}. grading of sufficient quantity for at least one day's surfacing work.
The laying temp. of the mixture shall not be less than 130°C

③ Rolling:
After laying, the materials shall immediately be compacted using a power driven road roller. ~~The in~~

The bituminous premix shall be compacted using an approved roller (pneumatic tyre ~~to~~ roller of 8-10 ton) and a min^{m}. 5 passes shall be made, ~~at~~ Materials that falls below the min^{m} temp of 90°C should be rejected and replaced.

The finished surface shall be within a tolerance of ±5 mm or of the elevat^{n} shown on the drawing and it shall not vary at any place more than 5 mm from the straight edge 3m long applied to the surface both longitudinally and transverse.

④ Open to traffic:
When initial rolling is completed, commercial traffic could be allowed but max^{m}. speed limit with 30-40 kmph during the first month after construction.

Gantt chart, PERT & CPM:

A Gantt chart is a matrix which lists on the vertical axis all the tasks to be performed. Each row contains a single task identification, which usually consists of a number and name. The horizontal axis is headed by column indicating estimated task duration.

CPM or critical path method ~~charts are~~ the critical path is indicated. A critical path consists that set of dependent tasks, which together take the longest time to complete. Tasks, which fall on critical path, should be noted in some way so that they may be given special attention.

PERT or project evaluation & review technique chart is statistical tool that is used in project management. This chart is a flow chart and used to schedule, organize and co-ordinate tasks within projects.

* PERT chart clearly illustrates task dependency more than Gantt chart
* PERT chart can be much more difficult to interpret, especially on complex project.
* CPM analysis is used for repetitive work and is a deterministic approach.
* PERT chart is used for research type work where time estimation is ~~done~~ probabilistic approach.
* CPM is activity oriented, PERT is event oriented.

Advantages of slipform paving:

(i) Smooth riding surface → Automation & computer control allow slipform pavers to produce very smooth riding surfaces

(ii) High productivity → Large jobs generally require high product^{n}. rates in order to be profitable.

(iii) Uses low slump PCC → low slump PCC is necessary so that the fresh PCC is able to hold its shape. Low slump PCC has higher compression & flexural strength. and uses less water.

Pavement maintenance:

* Alligator crack:

repair: → remove wet material
install drainage.
apply patching to whole depth

* Shrinkage crack:

repair: → fill cracks as earlier.
slurg seal
surface treatment.

* Corrugation & Shoving:

repair: → In case of thin AC surface
scarify, remix and compact
In case of thicker AC surface:

* Raveling:

repair → surface treatment.

* Bleeding asphalt:

repair: → repeated applicat^{n} of hot sand, rock screening. to blot up excess asphalt.
can use pvt. planning machine to remove excess asphalt

* Loss of cover aggregate:

repair: → the pavement needs to be removed and replaced after correct^{n} of any subsurface drainage issue.

* buckling of rigid pavement:

repair: → full depth patch.

General crack repair:

* Small crack < 3 mm wide:

to small to fill, apply fog seal.

* cracks > 3 mm:

filled with asphalt emulsion slurry or asphalt sand mix.

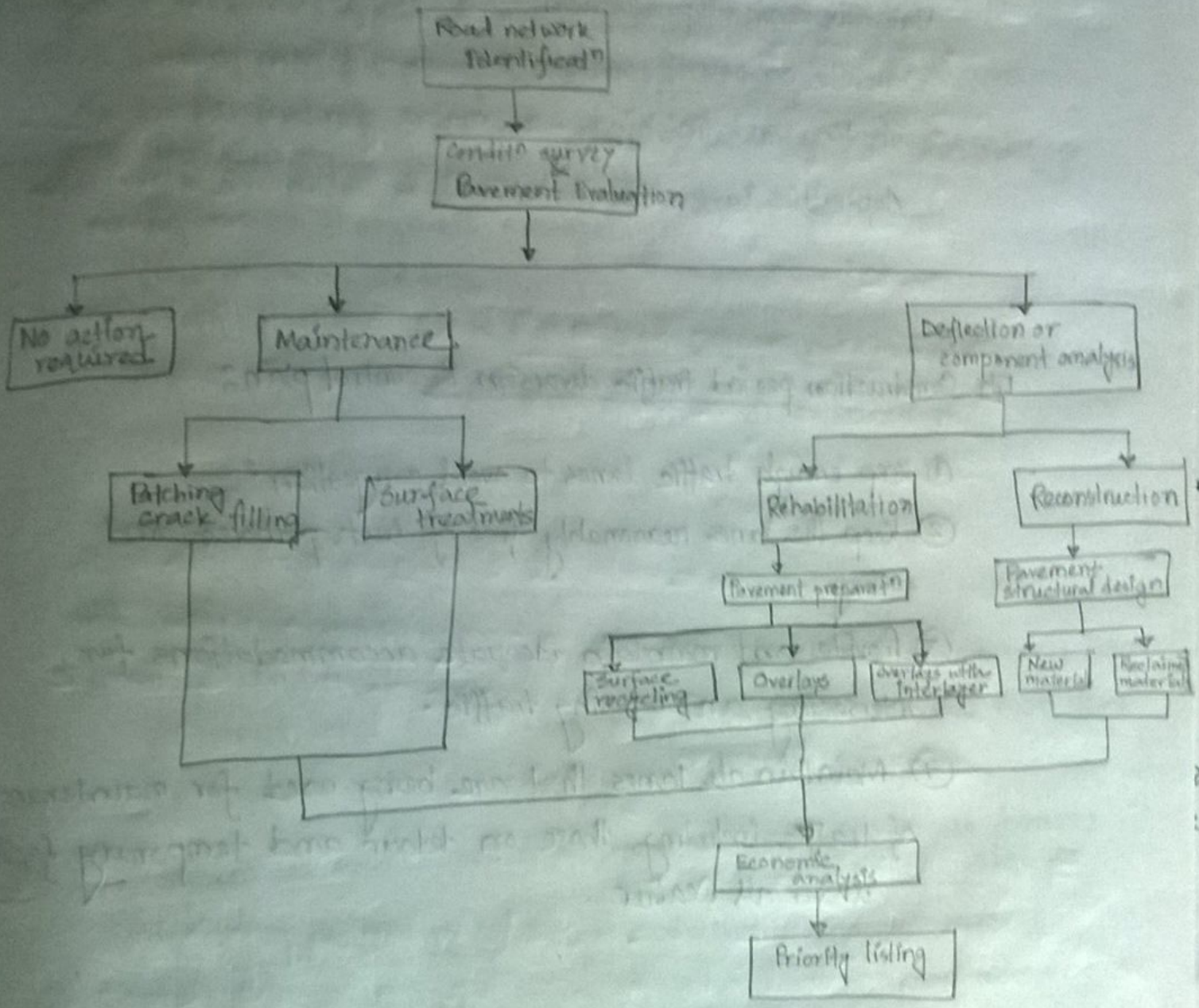
* cracks of 6-25 mm:

are filled with mix of 50% asphalt & 50% sand.

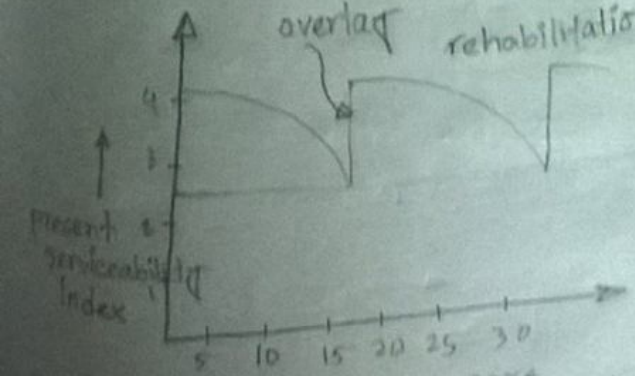
* cracks > 25 mm width:

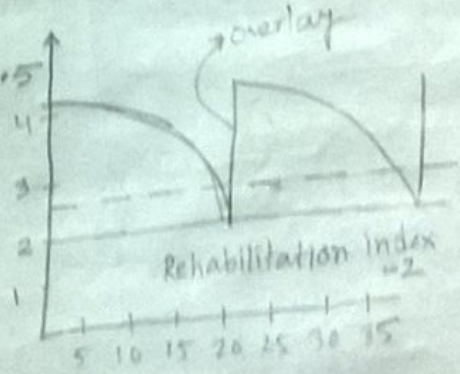
→ make trench 100-150 mm wide & depth of full surface longer
→ fill any cracks at bottom of trench
→ clear through & tack coat it.
→ fill trench with suitable AC surface mix and compact with roller
→ finish to grade.

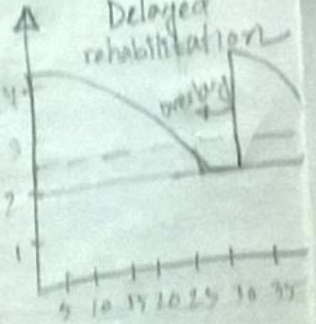
road network construct^{n}, monitoring and maintenance task:



How road rehabilitation decision is reached using pavement life cycle:







- Compaction → Rammer, grid roller
- Hot mix asphalt production → rotary drum cold milling machine
- Concrete pavement construction → slipform paver
- Grading and finishing → motor graders
- Asphaltic layer construction → Pneumatic tyre roller or pavers.

- Construction period traffic diversion & control plan:

① Keep enough traffic lanes to avoid congestion.
② Keep the lanes reasonably free of dust, potholes and rutting
③ Provide and maintain adequate accommodations for intersecting and crossing traffic.
④ Maintain all lanes that are being used for maintenance of traffic, including those on detour and temporary facilities under all weather.

Tools & signs:

(i) Work zone signs.
(ii) High intensity flashing lights.
(iii) Barrier wall
(iv) Guardrail
(v) Portable changeable message sign.
(vi) Warning devices.

Embankment

Materials for embankment:

Acceptable materials for embankment construction are broken PCC pavement and PCC rubble but eliminating material that does not compact into a enduring roadbed.

Complete the embankment using max^{m} particle sizes as follows:

In top 12" → 3½"

In 12"-24" → 6"

In depth below 24" → not to exceed 12" or the compacted thickness of the layer, whichever is less.

Dry fill construction Method:

Restrict the compacted thickness of the last embankment lift to 6" max^m.

Materials with up to 15% fines: Construct the embankment in successive layers with lifts up to a max^m compacted thickness of 12".

Materials with greater than 15% fines: Construct the embankment in successive layers with lifts up to a max^m compacted thickness of 6"

Alternately, for A-1 plastic material & A-2-4 materials with greater than 15% fines construct embankment using thick lift construction in successive layers of not more than 12" compacted thickness.

Hydraulic Method:

When the hydraulic method is used, as far as practicable, place all dredging material in its final position in the embankment by such method. Place and compact any dredged material that is rehandled, or moved and placed in its final position by any other method.

When placing fill on submerged land, construct dikes prior to begining of dredging and maintain the dikes throughout the dredging operation.

Compaction of Embankments:

Uniformly compact each layer, using equipment that will achieve the req. density. as the compaction process progress, shape and manipulate each layer as necessary to ensure uniform density.

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Construction quality and monitoring for embankment:

① In final shaping of the surface of earthwork maintain a tolerance of 0.3 ft above or below the plan cross section.

② Shape the surface of shoulders to within 0.1 ft of the plan cross section.

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Bituminous pavement recycling involves:

→ Removing existing pavement to full or partial depth
→ Reducing the reclaimed material to suitable size for reprocessing
→ Blending reclaimed material with virgin aggregate and liquid asphalt
→ Relaying the materials as base.

Advantages:

1. Economy
2. Conservation of natural resources.
3. Improvement of pavement strength.

Construction of concrete pavements:

Steps:

(I) Preparation and preliminary finishing of subgrade.
(II) Placing of forms
(III) Final finishing of the subgrade.
(IV) Installation of joints.
(V) Batching of aggregate and cements.
(VI) Mixing & placing concrete.
(VII) Placing and finishing concrete.
(VIII) Slipform paving

Engineered Earth roads

* Bituminous soil stabilization:

Materials:

- Well greaded sand, clay : very fine ones are avoided.
- Rapid / Medium / low curing liquid asphalt.
- Medium / low setting emulsion
- Water.

Field control:

By monitoring compactⁿ & relevant CBR value

compaction equipment:

Pneumatic tyred roller

* Oiled Earth surfaces:

Materials:

1. Silt and clay
2. low curing liquid asphalt.
3. Medium curing cutback asphalt.
4. Slow setting emulsion
5. Water.

Compaction equipmnt: Pneumatic tyred roller.

Lime stabilization:

Materials:

- Plastic clay soil.
- Lime (3-6% by vol^{m})
- Water.

cement & water content fixed by following lab test^{n}:

- M-D relat^{n}ship
- CBR - Density relat^{n}ship

Field control:

- By monitoring MC, compact^{n} & relevant CBR

Low cost road options

Very Imp

*** ## Alternative road surface improvements schedule:

Sheet