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Solutions for Internal Assessment Test II – Nov. 2017

Sub:	PAVEMENT MATERIALS AND CONSTRUCTION	Sub Code:	10CV763	Branch:	CIVIL

Answer any **TWO FULL** Questions from **PART A** and **PART B** is compulsory

		MARKS	CO	RBT
	PART A			
1 (a)	Explain anionic, cationic and non-ionic emulsions.	[06]	CO1	L3
	Explanation on each types - 2×3=6			

Bitumen emulsions can be divided into four classes.

- Cationic emulsions
- Anionic emulsions
- Non-ionic emulsions
- Clay-stabilised emulsions.

The terms anionic and cationic stem from the electrical charges on the bitumen globules. This identification system originates from one of the fundamental laws of electricity – like charges repel, unlike charges attract.

If an electrical potential is applied between two electrodes immersed in an emulsion containing *negatively charged particles of bitumen, they will migrate to the anode. In that case, the emulsion is described as 'anionic'.*

Conversely, in a system containing *positively charged particles of bitumen, they will move to the cathode and the emulsion is described as 'cationic'.*

The bitumen particles in a non-ionic emulsion are neutral and, therefore, will not migrate to either pole. These types of emulsion are rarely used on highways.

Clay-stabilised emulsions are used for industrial rather than for road applications. In these materials, the emulsifiers are fine powders, often natural or processed clays and bentonites, with a particle size much less than that of the bitumen particles in the emulsion.

(b)	Briefly discuss the desirable properties of bituminous mixes. What are its constituents?	[06]	CO2	L2
	Desirable properties-5 Constituents-1			

Desirable properties

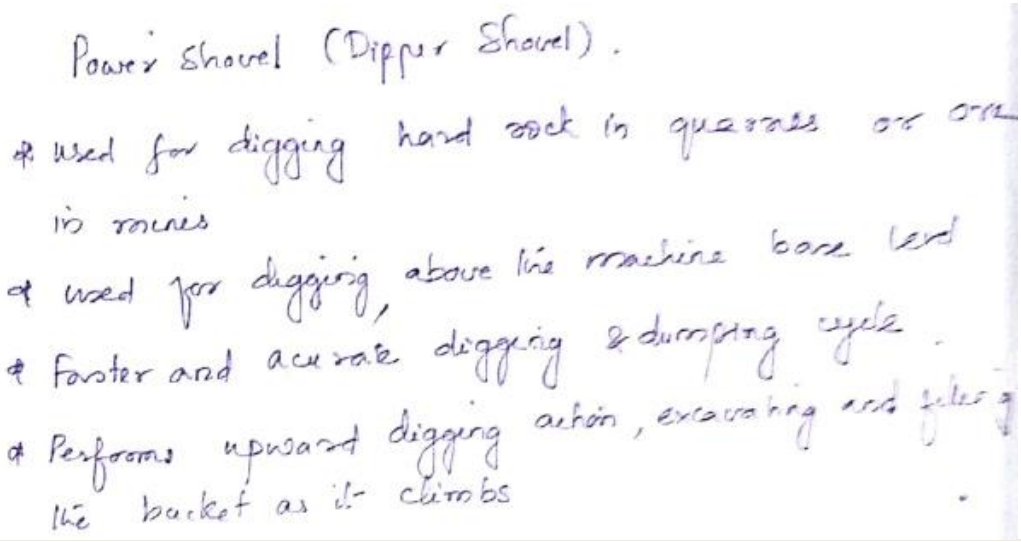
- Adequate stability of the mix to withstand stresses and deformations due to its repeated application of wheel loads.
- Adequate flexibility to withstand fatigue effects (development of cracks) during service life of the pavement.
- Adequate resistance to permanent deformation such as rutting due to movement of heavy wheel loads during hot weather

- Possess adequate resistance to low temperature cracking under traffic movement
- Durability to sustain the adverse weather and repeated traffic loads.
- Possess sufficient air voids to prevent bleeding of the binder
- Possess adequate resistance against moisture induced damages
- Should possess adequate skid resistance even after continued traffic movements
- Hot mix asphalt should have adequate workability of the mix

Constituents are

- Coarse aggregates – gradation should be such that it fulfills the desired gradation
- Fine aggregates – natural or manufactured sand or a mix of both
- Filler- hydrated lime, cement/rock dust/flyash
- Bituminous binder-appropriate type and grade of bituminous binder is selected.

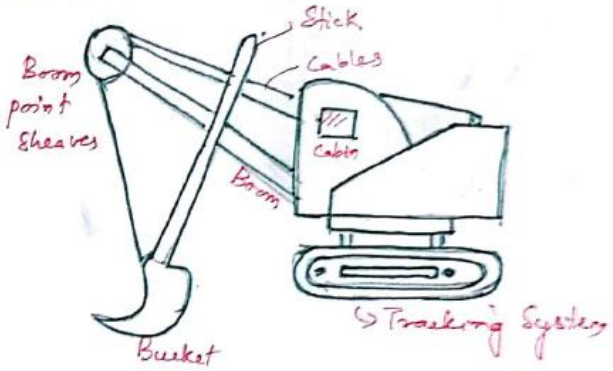
(c)	Explain with sketches, the working principle of Power shovel and Clamshell. Discuss its applications.	[08]	CO3	L2
	Power shovel + Clamshell-2.5+2.5 Fig -1.5+1.5			



Parts:-

1) Boom (2) Dipper stick (3) Bucket

Fig is shown below



Mechanism:-

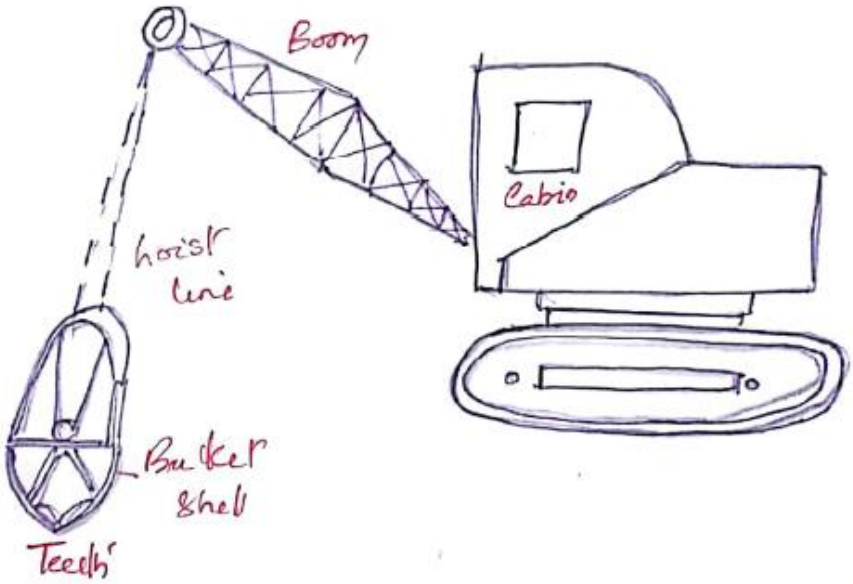
Dipper stick moves back & forth on a shipper drum through a guide system. Shipper drum is mounted on shipper shaft which is passing through the boom and supported at the ends. Shipper drum is mounted on shaft and the drum is rotated by pulling the cable.

Operation:-

* Bucket is brought down by moving the stick on a vertical plane
* Bucket is moved forward & backward by applying brake and clutch.
* Once the bucket is filled, the machine can be swung around for dumping.
* To empty the bucket, the door is opened by unlatching it through drop arrangement.

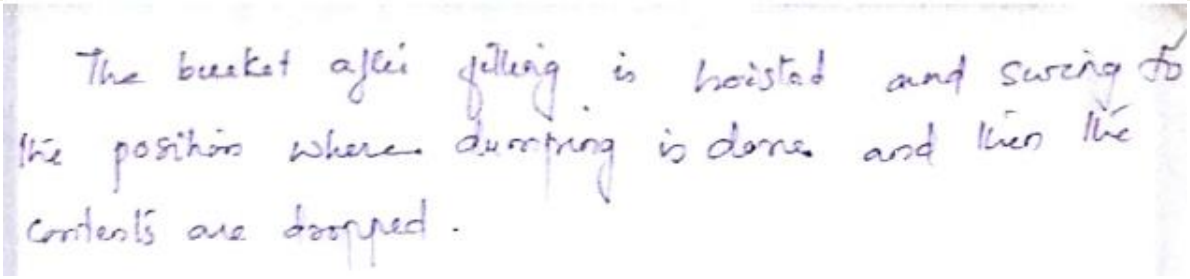
Clam shell

* Has the characteristics of drag line & Crane in Common
* Digging is like a dragline and dumping is like a crane
* Useful for spot dumping of material in a confined space in a vertical plane
* Can be used for handling soft materials only.
* Not very efficient and slow operation.
* For digging trenches
* For charging materials in a bin / Stock pile.
* Accurate dumping



Since the bucket is like a clam fish and has hinged double shell, it is named as Clam shell.

For digging, bucket is lowered with shells open over the surface to be dugged till it makes a good contact with it and then it is closed.



2 (a)	Briefly explain the various factors affecting the selection of road construction equipment's.	[06]	CO3	L1
	Any 6 with brief explanation - 6			

1)

i. Suitability for job conditions: type of job, climatic condition etc
ii. Size of the equipment: Size should be compatible with other units such that it should not remain idle
iii. Standardization: it should be easily understood by operators, easilt repairable, spare parts should be easily available.
iv. Availability of the equipment: it should be available in market easily, and should be of standard repute
v. Availability of spare parts: spare parts should be easily available
vi. Multipurpose equipment's (versatility): it should be able to perform more than one function to improve versatility
vii. Availability of know-how: Highly sophisticated equipment's may not be easily understood by operators though they give excellent performance.
viii. Use in future projects: Should be such that it should be used in future projects and should not become obsolete after one project.
ix. The economic aspects: The cost of unit production should be minimum.
x. Reliability of the equipment: should be reliable
xi. Service support: Service after sales is a major consideration.
xii. Operating requirements: Less fuel consumption should be easy to operate and maintain.

(b)	Explain the principle of Sheep foot roller. Discuss the advantages of a sheep foot roller over other types of roller.	[06]	CO3	L2
	Principle- 3 Comparsion - 3			

This type of roller consists of a drum having many round or rectangular shaped protrusions or "feet" on it. These rollers are also called tamping rollers. In this area below the feet gets compacted whereas there is considerable kneading action to the soil. This ensures uniform mixing of soil with water. he coverage area is about 8 to 12%.

The thickness of compacting layer is kept about 5 cm more than the length of each foot.

Hence it is suitable for clayey soil. However the top layer needs to be compacted using smooth wheeled roller for proper finish. It covers greater width of road when compared to smooth wheeled rollers.

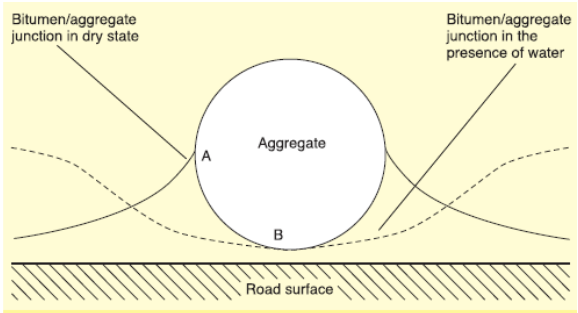
This is the only compactor which has both compaction and kneading action. Vibratory rollers can be applied only for cohesionless deposits.

Pneumatic tyred rollers are suitable for compacting pavement layers

(c)	Explain the mechanism of adhesion failure.	[08]	CO2	L3
	Atleast 6 failures – 6 Sketches – 2			

Failure of the aggregate/bitumen bond is commonly referred to as 'stripping'. The different mechanisms that cause adhesion failure are as follows:

Displacement: If water is introduced at a bitumen/aggregate interface then consideration of the surface energies that are involved shows that the bitumen will retract along the surface of the aggregate. As shown in Figure below, when in contact with water, the equilibrium point at A shifts and the new interface moves or retracts over the surface to point B.

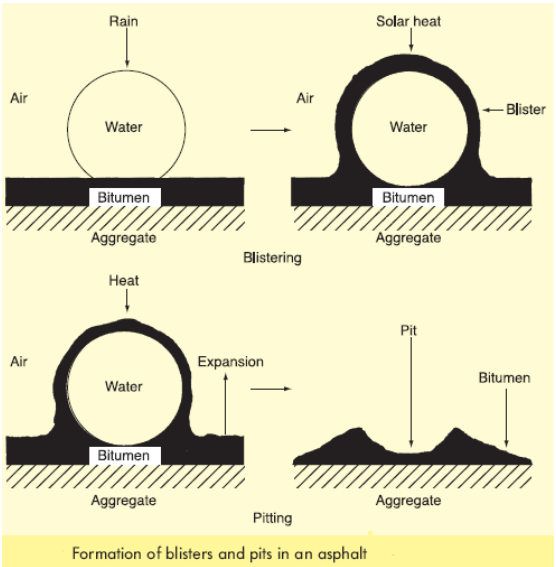


Retraction of the bitumen/water interface in the presence of water

Detachment: Detachment occurs when a thin film of water or dust separates the bitumen and aggregate with no obvious break in the surface of the bitumen film being apparent. Although the bitumen film completely encapsulates the aggregate particle, no adhesive bond exists and the bitumen can easily be peeled from the aggregate surface.

Film rupture: At sharp edges or asperities on the aggregate surface where the bitumen film is thinnest, water can penetrate through the film to reach the surface of the aggregate. This movement of water to the aggregate surface may occur with the water in either a vapour or liquid form. Once this process has started, it is possible for the water to spread between the bitumen and aggregate surface to produce a detached film of bitumen.

Blistering and pitting: If the temperature of the bitumen in a pavement increases, the viscosity of the bitumen will reduce. If this is associated with a recent rainfall, the bitumen may creep up the edges of water droplets to form a blister, as shown. If the temperature is increased, the blister will expand, leaving a hollow or a pit which may allow water to access the surface of the aggregate.



Formation of blisters and pits in an asphalt

Hydraulic scouring: When vehicle passes a saturated pavement, tyre sucks up this water, thereby inducing a compression tension cycle in these surface voids, which may result in disbonding of the bitumen from the aggregate. Suspended dust and silt in the water can act as an abrasive and can accelerate disbonding.

Pore pressure: This type of disbonding mechanism is most important in open or poorly compacted mixtures where it is possible for water to be trapped as the material is compacted by traffic. Once the material becomes effectively impermeable, subsequent trafficking induces a pore water pressure which can lead to loss of bond.

Chemical disbanding: The presence of the water causes the aggregate surface to exhibit a negative surface charge against a slightly negatively charged bitumen. This results in two negatively charged surfaces in contact and repulsion is the result. As more water is attracted to the aggregate surface, disbonding of the bitumen film will finally occur.

3 (a)	Compare the salient characteristics of cutbacks and emulsions and describe under what circumstance each one is used?	[06]	CO1	L2
	Salient charcteristics-2+2 Application-1+1			

Normal practice is to heat bitumen to reduce its viscosity. In some situations preference is given to use liquid binders such as cutback bitumen. In cutback bitumen suitable solvent is used to lower the viscosity of the bitumen. From the environmental point of view also cutback bitumen is preferred. The solvent from the bituminous material will evaporate and the bitumen will bind the aggregate. Cutback bitumen is used for cold weather bituminous road construction and maintenance. The distillates used for preparation of cutback bitumen are naphtha, kerosene, diesel oil, and furnace oil. There are different types of cutback bitumen like rapid curing (RC), medium curing (MC), and slow curing (SC). RC is recommended for surface dressing and patchwork. MC is recommended for premix with less quantity of fine aggregates. SC is used for premix with appreciable quantity of fine aggregates.

Bitumen emulsion is a liquid product in which bitumen is suspended in a finely divided condition in an aqueous medium and stabilised by suitable material. The bitumen content in the emulsion is around 60% and the remaining is water. When the emulsion is applied on the road it breaks down resulting in release of water and the mix starts to set. The time of setting depends upon the grade of bitumen. Three types of bituminous emulsions are available, which are Rapid setting (RS), Medium setting (MS), and Slow setting (SC). Bitumen emulsions are ideal binders for hill road construction. Where heating of bitumen or aggregates are difficult. Rapid setting emulsions are used for surface dressing work. Medium setting emulsions are preferred for premix jobs and patch repairs work. Slow setting emulsions are preferred in rainy season.

(b)	How is the extent of bitumen stripping estimated in the lab? Explain the principle of static immersion test used to evaluate adhesion failure of bitumen in the presence of water.	[06]	CO1	L2
	Determination of stripping- 2 Static immersion test and its disadvantages-4			

Determination of stripping of bitumen: The categories are:

- Static immersion tests (Looking into solution of Question No 3)
- Dynamic immersion tests
- Chemical immersion tests
- Immersion mechanical tests
- Immersion trafficking tests
- Coating tests

	➢ Adsorption tests ➢ Impact tests ➢ Pull-off tests. Static immersion tests This is the simplest type of test and consists of aggregate being coated with bitumen that is then immersed in water. The degree of stripping is estimated by a visual inspection after a period of time. For example, in the total water immersion test, 14mm single-size chippings are coated with a known quantity of bitumen. The coated aggregate is then immersed in distilled water at 25ºC for 48 hours. The percentage of bitumen stripped off the aggregate is assessed visually. The fundamental problem with this method is its subjective nature, resulting in poor reproducibility. However, the experienced operator may be capable of ranking the aggregates in relation to their performance in situ. It must be recognised that in some cases, an aggregate with good laboratory performance may perform poorly occasionally on the road and those with poor static immersion test results may perform satisfactorily in practice.			
(c)	Explain the working principle of Scrapers and Pavers.	[08]	CO3	L2
	Scrapers-4 Pavers-4			
	Scrapers: Dip their own load as they move forward. ➢ They combine operations of digging, loading, hauling and discharging. ➢ A cutting blade which can be raised or lowered upto 20cm is pulled up through the earth causing it to travel up the face of the blade into the bowl of the scraper. ➢ When the bowl is filled, apron is lowered to prevent slippage and cutting edge is raised. After haulage, the material is dumped by lowering the cutting edge to the desired height above the fill and operating the front apron. ➢ The blade then serves as a strike off beam. ➢ They are of two types (i) towed scrapers – short hauls, 150-500 m, speed of 10 kmph (ii) motorized scrapers – longer hauls, 500-1000 m, speed of 30 kmph or more Pavers: are indispensable for laying hot-mix laid bituminous specifications. It is self-propelled, capable of laying the bituminous material to any desired thickness and partially compact using a vibrating screed. Has a hopper where the rear-dump trucks can discharge the mix Pavers can be crawler mounted (more stable) or mounted with rubber tyres to permit a greater degree of movement. Using a screeder the dumped material can be spread. Pavers operate at a speed of 1.5-1 m/min			
	PART B			
4 (a)	A bituminous concrete mix is prepared with aggregtes A, B and C mixed in the proportion A:B:C = 40:50:10. The respective specific gravity of A, B C and bitumen are 2.7, 2.8 3.0. the bitumen content by weight of aggregates is 5%. Determine the following: (i) Maximum theoretical density (ii) % air voids in the total mix (iii) Voids in mineral aggregate (iv) Voids filled with bitumen given	[10]	CO2	L3

	that a specimen of this mix weighs 1251.5 g in air and 720.60 g in water. (iv) actual weight of bitumen in percentage			
	(i) Maximum theoretical density (ii) % air voids in the total mix (iii) Voids in mineral aggregate (iv) Voids filled with bitumen (iv) actual weight of bitumen in percentage - 2×5=10			

(i) Maximum theoretical density

Specific gravity of the mix = $G_m = \frac{1251.5}{1251.5-720.6} = 2.36$

Mass of aggregate in the mix = $\frac{1251.5}{1+0.05} = 1191.9\ g$

Mass of A = $\frac{40\times1191.9}{100} = 476.76\ g$

Mass of B = $\frac{50\times1191.9}{100} = 595.95\ g$

Mass of C = $\frac{10\times1191.9}{100} = 119.19\ g$

Mass of bitumen =1251.5-1191.9 = 59.6 g

Theoretical specific gravity = $G_t = \frac{1251.5}{\frac{476.76}{2.7}+\frac{595.95}{2.8}+\frac{119.19}{3}+\frac{59.6}{1.02}} = 2.57$

Theoretical density = $G_t \times 1 = 2.57\ g/cc$

(ii) % air voids in the total mix

$$V_v = \frac{G_t - G_m}{G_t} = \frac{2.57 - 2.36}{2.57} = 8.17\%$$

(iii) Voids filled with bitumen

$$G_t = \frac{\frac{59.6}{1.02}}{\frac{1251.5}{2.36}} = 11.02\%$$

(iv) Voids in mineral aggregate, VMA = 8.17+11.02=19.19%

(v) Actual weight of bitumen = 59.6 g