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Design of Rigid Pavements for Annavaram Village Street Roads

Gera Ruby Gold
M.Tech scholar,
Nalanda Institute Of Engineering And Technology

T.Venkateswara Reddy ,M.Tech
Assistant Professor,
Nalanda Institute Of Engineering And Technology

ABSTRACT

In the year 2000, around 40 per cent of the 825,000 villages in India lacked all-weather access roads. This constrained economic activities and access to essential services. Nearly 74 per cent of India's rural population, constituting the majority of India's poor, was not fully integrated into the national economy.

The rural roads sector, which is a State subject, also lacked adequate planning and management due to poor coordination between multiple funding streams and agencies. Investing in rural roads was given low priority and viewed in isolation from the need for State and National Highways.

This study presents geometric design of ANNAVARAM village street road. Most of the people in Annavaram village depend on agriculture. The crops harvested needs to be transported to the nearest market place Kavali and Nellore. But, lack of the proper road facilities, the formers was unable to market their crops. Hence, we made an attempt to design the road facility to the Annavaram village, which will help the people for their economic development.

1. INTRODUCTION

India is an agriculture based country and more than 70 percent of the population is residing in the rural areas. The rural traffic consisting mostly agricultural tractors/trailers, goods vehicles, buses, animal driven vehicles, auto- rickshaws, motor cycles, bi-cycles, light or medium trucks carrying sugarcane, quarry material etc.

The road passing through a village/built-up area usually found damaged due to poor drainage of water. Therefore, flexible pavement in the built-up area is to be substituted with the concrete pavement to make it durable and to avoid wastage of nation money on repeated treatments.

The different aspects of design of concrete pavement should be taken care prior to construction for making the same durable and cost effective.

IMPORTANCE OF ROADS

The transportation by road is the only, which could give maximum service to one and all. About 65% of freight and 80% of passenger traffic is carried by the roads. National highways constitute only about 2% of the road networks but 40% of the total traffic. Road transportation requires a relatively small investment for the government. The flexibility of changes in location, direction, speed and timings of travel is not available with any other mode of transportation, except roads. The major objective of the design and construction of roads is to provide adequate load carrying capacity and good ride quality, which permits safe operation of traffic under all weather conditions for short distance travel, road transport saves time.

2. LITERATURE REVIEW

ROAD OR PAVEMENT:

Pavement or Road is an open, generally public way for the passage of vehicles, people, and animals. Pavement is finished with a hard smooth surface. It helped make them durable and able to withstand traffic and the environment. They have a life span of between 20 – 30 years.

Road pavements deteriorate over time due to-

- The impact of traffic, particularly heavy vehicles.
- Environmental factors such as weather, pollution.

PURPOSE:

Many people rely on paved roads to move themselves and their products rapidly and reliably.

FUNCTIONS:

One of the primary functions is load distribution. It can be characterized by the tire loads, tire configurations, repetition of loads, and distribution of traffic across the pavement and vehicle speed.

Pavement material and geometric design can affect quick and efficient drainage. These eliminating moisture problems such as mud and pounding (puddles). Drainage system consists of:

- **Surface drainage**: Removing all water present on the pavement surface, sloping, chambers, and kerbs.
- **Subsurface drainage**: Removing water that seep into or is contained in the underlying subgrade.

TYPES OF PAVEMENTS:

There are various types of pavements depending upon the materials used; a briefs description of all types is given here

FLEXIBLE PAVEMENTS

Bitumen has been widely used in the construction of flexible pavements for a long time. This is the most convenient and simple type of construction. The cost of construction of single lane bituminous pavement varies from 20 to 30 lakhs per km in plain areas. In some applications, however, the performance of conventional bitumen may not be considered satisfactory because of the following reasons

- In summer season, due to high temperature, bitumen becomes soft resulting in bleeding, rutting and segregation finally leading to failure of pavement.
- In winter season, due to low temperature, the bitumen becomes brittle resulting in cracking, ravelling and unevenness which makes the pavement unsuitable for use.
- In rainy season, water enters the pavement resulting into pot holes and sometimes total removal of bituminous layer.
- In hilly areas, due to sub-zero temperature, the freeze thaw and heave cycle takes place. Due to freezing and melting of ice in bituminous voids, volume expansion and contraction occur. This leads to pavements failure.
- The cost of bitumen has been rising continuously. In near future, there will be scarcity of bitumen and it will be impossible to procure bitumen at very high costs.

RIGID PAVEMENTS:

Rigid pavements, though costly in initial investment, are cheap in long run because of low maintenance costs. There are various merits in the use of rigid pavements (Concrete pavements) are summarized below:

- Bitumen is derived from petroleum crude, which is in short supply globally and the Price of which has been rising steeply. India imports nearly 70% of the petroleum crude. The demand for bitumen in the coming years is likely to grow steeply, far outstripping the availability. Hence it will be in India's interest to explore alternative binders. Cement is available in sufficient quantity in India, and its availability in the future is also assured. Thus cement concrete roads should be the obvious choice in future road programmes.
- Besides the easy available of cement, concrete roads have a long life and are practically maintenance-free.
- Another major advantage of concrete roads is the savings in fuel by commercial vehicles to an extent of 14-20%. The fuel savings themselves can support a large programme of concreting.
- Cement concrete roads save a substantial quantity of stone aggregates and this factor must be considered when a choice pavements is made.
- Concrete roads can withstand extreme weather conditions – wide ranging temperatures, heavy rainfall and water logging.
- Though cement concrete roads may cost slightly more than a flexible pavement initially, they are economical when whole-life-costing is considered.
- Reduction in the cost of concrete pavements can be brought about by developing semi self-compacting concrete techniques and the use of closely spaced thin joints. R&D efforts should be initiated in this area.

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TYPES OF CONCRETE PAVEMENTS

PLAIN CONCRETE OR SHORT PAVEMENT SLABS

This type of pavement consists of successive slabs whose length is limited to about 25 times the slab thickness. At present it is recommended that the paving slabs not be made longer than 5, even if the joints have dowels to transfer the loads. The movements as a result of fluctuations in temperature and humidity are concentrated in the joints.

Normally, these joints are sealed to prevent water from penetrating the road structure. The width of the pavement slabs is limited to a maximum of 4.5 m.

REINFORCED CONCRETE

Continuously reinforced concrete

Continuously reinforced concrete pavements are characterised by the absence of transverse joints and are equipped with longitudinal steel reinforcement. The diameter of the reinforcing bars is calculated in such a way that cracking can be controlled and that the cracks are uniformly distributed (spacing at 1 to 3 m). The crack width has to remain very small, i.e. less than 0.3 mm.

Reinforced pavement slabs

Reinforced concrete pavement slabs are almost never used, except for inside or outside industrial floors that are subjected to large loads or if the number of contraction joints has to be limited.

Steel fibre concrete

The use of steel fibre concrete pavements is mainly limited to industrial floors. However, in that sector they are used intensively. For road pavements steel fibre concrete can be used for thin or very thin paving slabs or for very specific application

MATERIALS USED

Concrete is widely used in domestic, commercial, recreational, rural and educational construction. Communities around the world rely on concrete as a safe, strong and simple building material. It is used in all types of construction; from domestic work to multi-storey office blocks and shopping complexes.

Despite the common usage of concrete, few people are aware of the considerations involved in designing strong, durable, high quality concrete.
There are mainly three materials used primarily-

- Cement
- Sand
- Aggregate

3. EXPERIMENTAL STUDY

LOCATION

We have selected a village named as ANNAVARAM which is located 20 km from kavali. It is an undeveloped village which doesn't have proper transportation facilities. Transportation plays a key role in the development of any village, mandal, towns and cities.

ANNAVARAM village mainly depends on agriculture. For transportation of goods to the markets roads are necessary. To provide proper facilities to the villages during rainy season roads are necessary and we have noticed and we have designed a rigid pavement for the village.

First of all we have visited the village and we have observed the conditions of all-weather roads. Then we have surveyed and recorded the levels of existing ground profile with the help of surveying instruments. Next day we have taken traffic volume data during peak hours and we have taken soil sample from "Annavaram" village.

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LONGITUDINAL SECTIONAL SURVEY

- The operation of taking levels along centre line of any alignment (road, railway, ...etc) at regular intervals is known as longitudinal levelling
- This operation is undertaken in order to determine the undulations of the ground surface along the profile line

CROSS SECTIONAL SURVEY

- The operation of taking levels transverse to the direction of longitudinal levelling is known as cross section levelling.
- Cross section levelling is done in order to know the nature of the ground across the centre line of allignment.

TRAFFIC VOLUME STUDIES

Traffic volume is the number of vehicles crossing a selected cross-section of road per unit time in a particular direction. Due to increase of vehicular traffic congestion occurs, which effects the safe and efficient movement of the traffic. Traffic studies are carried out to analyse the traffic characteristics .the traffic survey for collecting traffic data are also called traffic census. It is measured in PCU/hr.

OBJECTIVES

1. To establish importance of any route or road facility.
2. To desire the priority for improvement and expansion of a road and to allot the funds accordingly.
3. To know the trend of traffic of traffic volume of growth along a particular route.
4. To plan and design of the existing or new facilities for road traffic.
5. To do geometry design and structural design of pavements by using classified traffic volume study.
6. To plan one way street and other traffic regulatory measures by volume distribution study
7. To design the intersection and traffic control devices by turning movement study.
8. To economic feasibility analysis foe new road network or realignment project.

DATA TO BE COLLECTED

The traffic volume study renders the following information:

- Hourly, daily, seasonal and yearly traffic volume variation.
- Volume and direction of traffic.
- Variation of vehicular flow along different approaches of an intersection.

PASSENGER CAR UNIT (P C U)

Different classes of vehicles such as cars, vans, buses, trucks, auto rickshaws, motorcycle, peddle cycles, bullock carts..etc are found to use the common road way facilities without segregation. On most the roads in developing countries like India the flow of traffic with un-restricted mixing of different vehicles classes on the road ways forms the heterogeneous traffic flow.

The basic consideration behind this practice is that different type of vehicle offer different degrees of interference to other traffic and it is necessary to bring all types to a common unit. The pcu value of the vehicle class may be considered as the ratio of the capacity of a road way when there are passenger cars only to the capacity of the same roadway when there are vehicles of that class only. For example, if the PCU value of bus is 3 it gives three times the impact as that given by the car.

PCU values as per IRC

s.no	VEHICLE CLASS	PCU VALUE
1	Passenger car, tempo, agriculture tractor, auto rickshaw	1.0

2	Bus, truck, agriculture tractor-trailer unit	3.0
3	Motor cycle, scooter and pedal cycle.	0.5
4	Cycle rickshaw	1.5
5	Horse drawn vehicles	4.0
6	Small bullock cart and hand cart	6.0
7	Large bullock cart	8.0

4. EXPERIMENTAL WORKS AND PROCEDURES

TTERBERG'S LIMITS:

LIQUID LIMIT TEST

PROCEDURE

1. Mix the soil thoroughly with some distilled water to form a uniform paste
2. Place a portion of the paste in the cup of the liquid limit device and smoothen the surface to a maximum depth of ½" and draw the grooving tool through the sample along the axis of the cup holding the tool perpendicular to the cup at the point of contact
3. Rotate the handle at a uniform rate of about two revolutions per second and count the number of revolutions till the gap between the two halves of the soil closes through a distance of ½". The groove could be closed by the flow in the soil itself but not by slippage between the soil and the cup.
4. Take approximately 10 g of soil in a clean evaporating dish per moisture content determination
5. By changing the water content suitably repeat the experiment to obtain at least 5 sets of values such that the number of blows lies between 10 and 40.

PLASTIC LIMIT

PROCEDURE

1. Mix thoroughly about 40 to 50g of moist soil
2. Make 3 or 4 convenient parts of the soil. Roll the soil on a glass plate with hand until a thread of 3 mm diameter is obtained.
3. If the thread does not crumble, add a little dry soil, mix thoroughly and repeat as above until the thread starts crumbling when reduced to 3 mm dia.
4. Put the crumbled pieces of thread in an evaporating dish and obtain the water content which gives the plastic limit.

GRAIN SIZE ANALYSIS

PROCEDURE

1. Arrange the sieves in the order of decreasing aperture size.
2. Weight out ½ kg. Of the given sample of soil and place it over the top most sieve after placing the sieves in a receiver at the bottom.
3. Close the top sieve with the lid or cover and shake the sieves for about 15 minutes placing the sieves inclined at angle of 15° to the vertical.
4. Determine the weights of soil particles retained on each sieve and tabulate the results.
5. Draw the grain size distribution curve which log aperture size on X axis and percentage passing through each sieve on Y axis. Fit in a smooth curve and determine the values of D_{10} and D_{60}.
6. Calculate the value of uniformity efficient.

STANDARD PROCTOR TEST (IS HEAVY)

PROCEDURE

1. About 6kg of soil was taken and water added to it
2. The soil was mixed properly and divided into 5parts.

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3. The collar was attached to the mould and placed it on a solid base.
4. First one third quantity of soil was taken and placed it in the mould. It was compacted by giving 25blows of the rammer. The blows should be uniformly distributed.
5. Likewise second and third layer was placed and compacted it.
6. The collar was removed and removed and excess soil projecting above the mould was trimmed of using straight edge.
7. The mould was cleaned outside and weighed.
8. The soil from the mould was removed.

CALIFORNIA BEARING RATIO TEST

PROCEDURE

1. Arrange the mould on the base-plate with distance piece and assemble the extension collar at top.
2. Weight out 6 kgs. Of soil passing through IS 4.75mm sieve.
3. Mix the soil thoroughly with a required percentage of water(10%) and compact the soil in five layers, each layer being compacted by 55 blows by 10 lb (4.5kg) rammer falling through 18% (45.7cm) the blows being distributed uniformly all over the surface.
4. Remove extension piece, trim the soil and remove the base plate and distance piece and reassemble the base plate.
5. Keep a minimum of 10 lb(4.5kg) of surcharge on the sample in the shape of disc weights.
6. Kept the entire mould under a loading frame and set the penetration position on the soil and adjust the proving ring dial and the penetration dial to read zero.
7. Rotate the loading handle at a steady rate of 0.05 inch per minute (1.25mm/min) and note the proving ring dial readings corresponding to penetrations of 25, 50, 75, 100, 125, 150, 175, 200, 250, 300, 400, 500.

FREE SWELLING INDEX TEST:

PROCEDURE

1. Two no. of 10gms oven dried soil specimens passing through 425 µ IS sieve is taken.
2. Each soil specimen is poured in each of the two glass graduated cylinders of 100ml capacity.
3. Then one cylinder is filled with kerosene oil and the other with distilled water up to the 100ml mark.
4. It is to be stirred with a glass rod to remove entrapped air and allowed to settle for 24hrs.
5. After completion of 24hrs the final volume of soil each of the cylinder is readout.
6. Calculate the free swelling index by using formula.

AGGREGATE IMPACT TEST (Dry method)

PROCEDURE

1. The cup shall be fixed firmly in position on the base of the machine and the whole sample is transferred from the measure to the cup and compact it with tamping rod by giving 25 strokes.
2. Compact the sample in the cup by allowing 15 complete free falls of tamping rod from a height of 380 mm above the aggregate top surface.
3. The time interval between two successive blows should not be more than one second.
4. The crushed aggregate is sieved on IS 2.36 mm sieve till no further significant amount passes in one minute.
5. Weigh the aggregate passing through the sieve as B and the remaining portion as C accurately to nearest 0.1 g.
6. If the sum (B+C) differs from A by more than 1 g, the sample is discarded and a fresh test is to be made.
7. Tabulate the observations and results.

SPECIFIC GRAVITY AND WATER ABSORPTION

PROCEDURE

1. The sample is washed thoroughly to remove finer particles and dust and is drained. Then the sample is placed in the wire basket and immersed in distilled water at a temperature of $22^{O}C – 32^{O}C$

for 24 hours ± 30 minutes.

2. Entrapped air is removed from the sample by agitating (dropping) the sample along with the basket in distilled water for about 25 times from 25 mm above the base of the tank at a rate of one drop per second.
3. The aggregate and basket shall be completely immersed in the distilled water during the time of experiment.
4. Shake the basket and the sample and weigh it in water at a temperature of $22^{O}C$ to $32^{O}C$.
5. If it is necessary for them to be transferred to a different tank for weighing, they shall be shaken 25 times as explained above in the new tank before weighing.
6. Remove the basket and the aggregate from water and allow it to drain for a few minutes, after which the aggregate shall be gently emptied on to one of the dry clothes and the basket will be returned to the water, shaken 25 times and weighed.
7. Dry the surface of aggregate with the second cloth, transferring it from the first cloth when it removes no further moisture. Then the aggregate is weighed.
8. Dry the sample in oven at $100^{O}C$ to $110^{O}C$ for 24 hours and then weigh it, after transferring into the air – tight container.

FLAKINESS INEDX TEST

PROCEDURE

1. The sample has to be carefully and properly sieved and nine fractions are to be collected and weighed.
2. Every piece of each fraction shall be gauged for minimum thickness with the help of ISI gauge or in bulk, using a set of sieves having standard elongated slots.
3. This, each fraction is divided into two parts: one consisting of pieces which pass through the corresponding slot in the standard gauge and the other consisting of the remaining pieces of the fraction.
4. Weight of each part is separately taken and the sum of both weights should give the total weight of the fraction.

ELONGATION INDEX TEST

PROCEDURE

1. The sample has to be carefully and properly sieved and nine fractions are to be collected and weighed.
2. Each fraction is then gauged for length with the help of IS length gauge with lengths as given table.
3. Thus, each fraction is divided into two parts: one consisting of pieces which pass through the corresponding length gauge and the other consisting of the remaining pieces of the fraction.
4. Weight of each part is separately taken and the sum of both weights should give the total weight of the fraction.

FINENESS OF CEMENT

PROCEDURE

1. Break down any air-set lumps in the cement sample with fingers.
2. Weight accurately 100 g of the cement and place it on a standard 90 micron IS sieve with the residue left on the sieve.
3. Sieve the sample continuously for 15 minutes.
4. Weigh the residue left on the sieve.

SPECIFIC GRAVITY OF CEMENT

PROCEDURE

1. Clean and dry the specific gravity bottle and weigh it with the stopper (W1).
2. Fill the specific gravity bottle with cement sample at least half of the bottle and weigh with stopper (W2).
3. Fill the specific gravity bottle containing the cement, with kerosene (free of water) placing the stopper and weigh it (W3).
4. After weighing the bottle, the bottle shall be cleaned and dried again.
5. Then fill it with fresh kerosene and weigh it with stopper (W4).
6. All the above weighing should be done at the room temperature of 27c + 10c.

NORMAL CONSISTENCY OF CEMENT

PROCEDURE

1. Take 400 gm. cement sample.
2. Prepare a paste with about 28% (by weight of cement) water by taking care that the gauging time is from 3 to 5 min. The gauging time is counted from the instant of adding of water to dry cement until the mould is filled.
3. Place the Vicat's mould on a non-porous plate. Fill the mould with cement paste. Smooth off the surface of the paste by making it level with top of the mould. To expel air, shake the mould slightly. Take care that the time required for this operation should be 3 to 5 minutes.
4. Place the mould on a non-porous plate under the Vicat's plunger of 10mm diameter Bring the plunger down so as to touch the surface of the cement paste and gently release allowing it to penetrate into cement paste. Carry the operation immediately after filling the mould. Note the penetration of the plunger from the bottom of mould indicated on the scale.
5. Prepare trial paste with varying percentage of water until the amount of water necessary for standard consistency (which permits plunger to penetrate about 5 to 7 mm from bottom of the mould.) is determined.

INITIAL SETTING TIME OF CEMENT

PROCEDURE

1. Prepare a neat cement past by gauging 400gms cement with 0.85P water, where P is the normal consistency of the given sample of the cement.
2. The gauging time is between 3 and 5 minutes the gauging time is counted from the instant of adding of water to dry cement.
3. Fill the vicat mould with the prepared past and level is to the top of the mould. The cement block thus prepared is know as the test block.
4. Place the test block on a non porous plate and set it bellow the vicat needle. Lower the needle to make contact with surface of the test block.
5. Quickly release the needle and allow it to sink. Not the reading.
6. Repeat the experiment until the needle fails piercing the block at a level 5 to 7 mm from bottom.

FINAL SETTING TIME OF CEMENT

PROCEDURE

1. Prepare a neat cement past by gauging 400gms cement with 0.85P water, where P is the normal consistency of the given sample of the cement.
2. The gauging time is between 3 and 5 minutes the gauging time is counted from the instant of adding of water to dry cement.
3. Fill the vicat mould with the prepared past and level is to the top of the mould. The cement block thus prepared is known as the test block.
4. Place the test block on a non porous plate and set it bellow the vicat needle. Lower the needle to make contact with surface of the test block.
5. Quickly release the needle and allowing it to penetrate into the test block.
6. The cement is said to be finally set when the needle makes an impression on the test block and the attachment fails to do so.
7. The time elapsed between this stage and the instant when the water was added to the cement is called the final setting time.

BULKING OF SAND

PROCEDURE

1. Pour the dump sand in to a 1000 ml measuring cylinder up to at least 200 ml mark(h1).
2. Fill the cylinder with water and stir well (sufficient water should be poured to submerge the sand completely and it can be see that the sand surface is now below it's original level).
3. Take the reading at the sand surface (h2).

NORMAL CONSISTENCY OF CEMENT CONCRETE BY SLUMP CONE TEST

PROCEDURE

1. Mix the thoroughly, 2.5kg of cement and 5kg of sand and then add 10kg of 20mm coarse aggregate again mix thoroughly.
2. Add water corresponding w/c ratio of 0.55 and

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mix until a homogenous mix is prepared.

3. Grease the cone and fill it with the prepared concrete mix in four layers, compacting each layer by 25 blows of the tamping rod uniformly about the cross section of the mould.
4. Strike of the top width a trowel so that the material is exactly filled .
5. Remove the cone immediately by lifting it carefully in the vertical direction.
6. As soon as the concrete settlement stops, measure subsidence of the concrete which gives the slump value.
7. Repeat the procedure with w/c ratios 0.6,0.65, etc…

5. RESULTS

CALCULATION OF NORMAL SOIL

LIQUID LIMIT TEST

S.NO	of soil taken (gms)	Water added (%)	No.of blows
1	300	84	42
2	300	90	30
3	300	96	20
4	300	102	5

From graph, liquid limit = 31%

PLASTIC LIMIT TEST

Weight of the empty container (W1) gm	Weight of container + wet soil (W2)gm	Weight of container +dry soil (W3)gm	Water content = {(W2-W3)/(W3 W1)}x100
14	60	52	21.05%

Plastic limit = 21.05%

PLASTICITY INDEX

I.P = L.L – P.L

=31 - 21.05

=9.95

GRAIN SIZE ANALYSIS

S NO	Sieve No.	rture size in mm	Wt. of particles	%Wt. Retained	Cumulative Percentage Wt. retained	% passing through (100 - (6))
1	2	3	4	5	6	7
1	4.75mm	4.75	410	41	41	59
2	2.36mm	2.36	138	13.8	54.8	45.2
3	1.18mm	1.18	213	21.3	76.1	23.9
4	600µ	0.600	96	9.6	85.7	14.3
5	425µ	0.425	55	5.5	91.2	8.8
6	300µ	0.300	43	4.3	95.5	4.5
7	150µ	0.150	35	3.5	99	1
8	75µ	0.075	9	0.9	99.9	0.1

SPECIMEN CALCULATION

From graph:

D_{10} =0.45 mm

D_{30} =1.5 mm

D_{60} =4.8 mm

Coefficient of uniformity $c_u = D_{60} / D_{10}$

= 4.8/0.45

= 10.64

Coefficient of curvature $c_c = D^2 / (D \; x D \;)$

= $1.5^2/(4.8x0.45)$

= 1.04

The soil is well graded sand.

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STANDARAD PROCTOR TEST (is heavy)

S L N	OBSERVATIONS& CALCULATIO	1	2	3	4
1	OUNT OF SOIL IS TAKEN (gm)	6000	6000	6000	6000
2	OUNT OF WATER ADDED (ml)	180	360	540	720
3	WEIGHT OF EMPTY MOULD	6617	6617	6617	6617
4	WEIGHT OF MOULD+COMPACTED SOIL W2 (gm)	109139	11363	11283	11151
5	WEIGHT OF COMPACTED SOIL W3 (gm)	4296	4746	4666	4534
6	BULK DENSITY	2.025	2.238	2.20	2.138
7	DRY DENSITY	1.82	2.02	1.986	1.93

Volume of the mould	=	$\Pi/4 \times d^2 \times h$
From graph,	=	2120.57 cm^3
Maximum dry density	=	2.02 gm/cc
Optimum moisture content	=	6 %.

CALIFORNIA BEARING RATIO TEST

Moisture content added (w) = 6 %,

γd= 2.02 gm/cc

.N O	Penetration dial gauge		Load dial gauge	
	ial gauge reading	ration(mm)=rea ding x L.C	oving ring reading	in kg=proving ring reading x L.C
1	0	0	0	0
2	25	0.5	0.18*0.02=0.036	7.2
3	50	1	0.3*0.02=0.06	12
4	75	1.5	0.52*0.02=0.1044	20.8
5	100	2.0	0.84*0.02=0.168	33.6
6	125	2.5	1.28*0.02=0.256	51.2
7	150	3.0	1.82*0.02=0.364	72.8
8	175	3.5	2.6*0.02=0.52	104
9	200	4.0	3.12*0.02=0.624	124.8
10	250	5.0	4.2*0.02=0.84	168
11	300	6.0	4.9*0.02=0.98	196
12	400	8.0	6.0*0.02=1.2	240
13	500	10.0	6.82*0.02=1.364	272.8

From graph

Load at 2.5mm penetration = 168 kg

Load at 5mm penetration = 272.8 kg

CBR value at 2.5mm penetration =

(penetration load/standard load) x100

= (168/1370)*100

= 12.26 %

CBR value at 5.0mm penetration =

(penetration load/standard load) x100

= (272.8/2055)*100

= 13.27 %

FREE SWELL INDEX TEST

Free swell index test = [V_d-V_k]/V_k X100%

V_d = 12ml

V_k = 8ml

Free swelling index = 50 %

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CALCULATION OF AGGREGATE AND CEMENT TESTS

AGGREGATE IMPACT TEST

Sl. No.	Weight of aggregate in measure	Weight of aggregate passing through 36 mm sieve	Weight of aggregate retained on 36 mm sieve	ercentage passing	average
	A	B	C	(B/A)x100	
1	390	17	372	4.36 %	4.83 %
2	390	20	370	5.13 %	
3	400	20	380	5 %	

The aggregate impact value of the given aggregate is =4.83 %

SPECIFIC GRAVITY & WATER OBSORPTION TEST

OBSERVATIONS:

sxzWs ms?AsddddSdzi]f;afeVQ

Weight of water equal to the volume of the

WKWQ

QSFNaggregate

Specific gravity = W3 / (W3– (W1– W2))= 2.56

Water Absorption = ((W3 – W4) / W4) X 100 = 0.48

FLAKINESS INDEX TEST

Size of aggregate		Weight of fraction (consist at least 200 pieces) (g)	Size of thickness gauge (mm)	Portion of aggregate passing through the thickness gauge (g)
Passing through sieve	ained on sieve			
25	20	2000	10.8	370

Percentage of flakiness index = X/W*100

= 370/2000*100

= 18.5 %

ELONGATION INDEX TEST

Size of aggregate		Weight of fraction (consist at least 200 pieces) (g)	Size of thickness gauge (mm)	Portion of aggregate Retain on the length gauge (g)
Passing through sieve	Retained on sieve			
25	20	2009	32.40	230

Elongation index = X/W*100

= 230/2009*100

= 11.5 %

A DGK]Q'/FVASWeight of saturated aggregate suspen

FINENESS OF CEMENT TEST

Weight of the cement taken on IS 90 microns sieve: 100 g Weight of residue on sieve after sieving = 6 g

= W3–(W1–W2)=81 g Weight of oven dry aggregate W4

Fineness =(weight of residue/weight of the initial sample)*100

= (6/100)*100

= 6%

SPECIFIC GRAVITY OF CEMENT

Weight of empty bottle: W1 g = 44.1 g

Weight of bottle + Cement: W2 g = 70.0 g

Weight of bottle + Cement + Kerosene W3 g = 106.2 g Weight of bottle + Full Kerosene W4 g = 83.8 g

Specific gravity of Cement Sc = W2 - W1 / ((W4 - W1)-(W3- W2))*Sk

(Here: Sk=0.79) = 3.14

NORMAL CONSISTENCY OF CEMENT

Amount of water (%)	Initial reading (mm)	Final reading (mm)	Depth of penetration from bottom (mm)
28	31	35	4
30	32	38	6

Normal consistency of given cement sample is=30 %

INITIAL SETTING TIME OF CEMENT

Weight of cement taken = 400gms. Amount of water added = 102ml Initial setting time of cement = 60 minutes

FINAL SETTING TIME OF CEMENT

Weight of cement taken = 400gms.
Amount of water added = 102ml
Final setting time of cement = 500 minutes
.

BULKING OF FINE AGGREGATE

Percentage of bulking = [(h1-h2)/h2]*100
= [(300-270)/270]*100
= 11.11 %

DETERMINATION OF CONSISTENCY OF CEMENT CONCRETE BY SLUMP CONE TEST

w/c ratio	Slump(cm)
0.50	2
0.55	15
0.60	22

The consistency of the concrete mix for given proportions has been determined. The concrete mix collapsed at a w/c ratio of = 0.6

REDUCED LEVELS

FOR STREET "A":

STATION	CHAINAGE	BACK SITE	I.S	F.S	H.I	R.L	REMARKS
		1.17			101.77	100	
	L1		2.106			99.664	
0	0		2.09			99.68	
	R1		2.108			99.662	
	L1		1.19			100.58	
10	10		1.17			100.6	
	R1		1.25			100.52	
	L1		1.108			100.662	
20	20		1.11			100.66	
	R1		1.2			100.57	
	L1		1.01			100.76	
30	30		1.015			100.755	
	R1			1.07		100.7	
		2.00			102.7	100.7	
	L1		1.16			101.54	
40	40		1.217			101.483	
	R1		1.24			101.41	
	L1		0.94			101.715	
50	50		0.975			101.725	
	R1		0.85			101.85	
	L1		1.19			101.51	
60	60		1.2			101.5	
	R1			1.22		101.48	
		2.0			103.48	101.48	
	L1		1.26			102.22	
70	70		1.222			102.258	
	R1		1.225			102.225	
	L1		1.26			102.22	
80	80		1.16			102.32	
	R1		1.1			102.38	
	L1		1.245			102.235	
90	90		1.235			102.245	
	R1			1.25		102.23	

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FOR STREET "B":

STATION	CHAINAGE	BACK SITE	I.S	F.S	H.I	R.L	REMARKS
		2			104.23	102.23	
	L1		1.2			103.03	
0	0		1.1			103.13	
	R1		1.21			103.02	
	L1					103.0	
10	10		1.23			103.04	
	R1		1.19			103.015	
	L1		1.215			102.8	
20	20		1.43			102.82	
	R1		1.4			102.83	
	L1		1.63			102.6	
30	30		1.615			102.615	
	R1	1.235		1.65	103.805	102.58	
	L1		1.445			102.37	
40	40		1.43			102.385	
	R1		1.435			102.38	
	L1		1.57			102.245	
50	50		1.56			102.55	
	R1		1.56			102.55	
	L1		1.645			102.17	
60	60		1.64			102.175	
	R1	1.14		1.645	103.31	102.17	
	L1		1.425			101.285	
70	70		1.405			101.905	
	R1		1.345			101.965	
	L1		1.465			101.845	
80	80		1.47			101.84	
	R1		1.5			101.81	
	L1		1.525			101.785	
90	90		1.53			101.78	
	R1			1.52		101.79	
		1.3			103.09	101.79	
	L1		1.785			101.305	
100	100		1.825			101.265	
	R1		1.85			101.24	
	L1		1.6			101.49	
110	110		1.635			101.455	
	R1		1.61			101.48	
	L1		1.585			101.505	
120	120		1.56			101.53	
	R1			1.54		101.54	
		1.36			102.9	101.54	
	L1		1.91			100.99	
130	130		1.9			101	
	R1			1.89		101.01	
		1.4			102.41	101.01	
	L1		1.65			100.76	
140	140		1.66			100.75	
	R1		1.63			100.78	
	L1		1.42			100.99	
150	150		1.45			100.96	
	R1		1.43			100.98	
	L1		1.81			100.6	
160	160		1.81			100.6	
	R1			1.75		100..66	
		1.44			102.1	100.66	
	L1		1.645			100.455	
170	170		1.65			100.45	
	R1		1.665			100.435	
	L1		1.05			100.535	
180	180		1.49			100.61	
	R1		1.395			100.705	
	L1		2.0			100.1	
190	190		2.05			100.05	
	R1			1.66		100.44	

FOR STREET "C":

STATION	CHAINAGE	BACK SITE	I.S	F.S	H.I	R.L	REMARKS
		1.02			101.02	100	
	L1		1.3			99.72	
0	0		1.305			99.685	
	R1		1.33			99.69	
	L1		1.305			99.715	
10	10		1.35			99.67	
	R1		1.335			99.685	
	L1		1.37			99.65	
20	20		1.34			99.68	
	R1		1.37			99.65	
	L1		1.48			99.54	
30	30		1.498			99.522	
	R1			1.49		99.53	
		1.52			101.05	99.53	
	L1		1.485			99.535	
40	40		1.47			99.58	
	R1		1.47			99.58	
	L1		1.75			99.3	
50	50		1.78			99.27	
	R1		1.77			99.28	
	L1		2.5			98.55	
60	60		2.9			98.15	
	R1			2.5		98.55	
		1.31			99.86	98.55	
	L1		1.55			98.31	
70	70		1.5			98.36	
	R1		1.6			98.2	
	L1		1.87			97.99	
80	80		1.65			98.21	
	R1		1.77			98.09	
	L1		1.88			99.98	
90	90		1.86			98	
	R1			1.89		97.97	
		1.42			99.39	97.97	
	L1		1.53			97.86	
100	100		1.52			97.87	
	R1		1.545			97.845	
	L1		1.725			97.685	
110	110		1.7			97.69	
	R1		1.71			97.68	
	L1		1.915			97.475	
120	120		1.91			97.48	
	R1			1.91		97.48	

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FOR STREET “D”:

STATION	CHAINAGE	BACK SITE	I.S	F.S	H.I	R.L	REMARKS
		1.03			101.03	100	
	L1		1.35			99.68	
0	0		1.3			99.73	
	R1		1.35			99.68	
	L1		1.305			99.725	
10	10		1.3			99.73	
	R1		1.35			99.68	
	L1		1.3			99.73	
20	20		1.35			99.68	
	R1		1.37			99.66	
	L1		1.35			99.68	
30	30		1.39			99.64	
	R1			1.39		99.64	
		1.5			101.14	99.64	
	L1		1.4			99.74	
40	40		1.39			99.75	
	R1		1.405			99.735	
	L1		1.75			99.39	
50	50		1.7			99.44	
	R1		1.73			99.41	
	L1		1.9			99.24	
60	60		1.95			99.19	
	R1			1.89		99.25	
		1.31			100.56	99.25	
	L1		1.5			99.06	
70	70		1.5			99.06	
	R1		1.55			99.01	
	L1		1.8			98.76	
80	80		1.85			99.71	
	R1		1.79			98.77	
	L1		1.79			98.77	
90	90		1.8			98.76	
	R1			1.79		99.77	
		1.39			101.16	99.77	
	L1		1.49			99.67	
100	100		1.5			99.66	
	R1		1.545			99.615	
	L1		1.53			99.63	
110	110		1.5			99.68	
	R1		1.54			99.62	
	L1		1.8			99.36	
120	120		1.83			99.33	
	R1			1.79		101.12	

TRAFFIC VOLUME STUDY DATA

DATE : 16/02/2016

WEATHER : SUNNY

DAY : TUESDAY

LOCATION : ANNAVARAM

	8:00AM TO 10:00AM	12:00PM TO 2:00PM	4:00PM TO 6:00PM
AUTOS	5	2	6
BUSES	4	0	4
BIKES	6	6	8
CYCLES	10	10	10
TRACTORS	2	3	2

TIME		AUTO	MINI BUS	MAIN BUS	TRACTOR	BIKE	BYCYCLE	PCU
START	END	1.0	3.0	3.0	1.0	0.5	0.5	
8:00	8:15	1	1	0	1	1	2	6.5
8:15	8:30	1	1	0	0	2	1	5.5
8:30	8:45	1	1	0	0	0	0	4.0
8:45	9:00	0	0	0	0	0	0	0
9:00	9:15	0	0	0	0	1	2	1.5
9:15	9:30	0	0	0	1	1	2	2.5
9:30	9:45	0	0	0	0	2	1	1.5
9:45	10:00	0	0	0	0	0	2	1.0
12:00	12:15	1	0	0	1	2	2	4.0
12:15	12:30	0	0	0	0	0	1	0.5
12:30	12:45	0	0	0	0	0	0	0
12:45	1:00	1	0	0	1	1	2	3.5
1:00	1:15	0	0	0	0	0	1	0.5
1:15	1:30	0	0	0	0	1	1	1
1:30	1:45	0	0	0	1	0	2	2.0
1:45	2:00	0	0	0	0	2	1	1.5
4:00	4:15	1	0	0	1	1	2	3.5
4:15	4:30	0	0	0	0	1	0	0.5
4:30	4:45	1	1	0	0	0	2	5
4:45	5:00	0	2	0	0	2	0	7
5:00	5:15	0	1	0	0	3	1	5
5:15	5:30	2	0	0	1	0	3	4.5
5:30	5:45	0	0	0	0	0	2	1
5:45	6:00	2	0	0	1	1	0	3.5

TIME		NUMBER OF VEHICLES	PCU/HOUR
START	END		
8:00	9:00	13	16
9:00	10:00	12	6.5
12:00	1:00	12	8
1:00	2:00	12	5
4:00	5:00	14	16
5:00	6:00	17	14

TRAFFIC VOLUME DATA FOR PAST 5 YEARS:

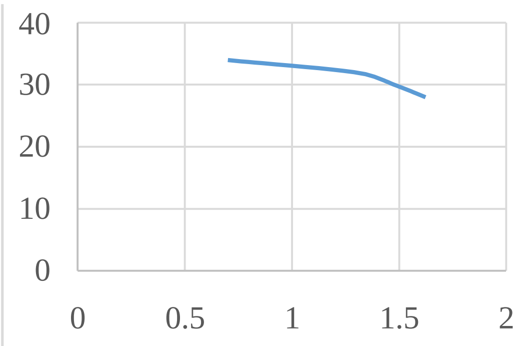
YEAR	VEHICLES	INCREASING VEHICLES
2011	58	
2012	70	12
2013	85	15
2014	100	15
2015	120	20

By using trend analysis traffic growth for twenty years Tn = 120(1+4) n

= 120(5)20

= 263.93

GRAPHS



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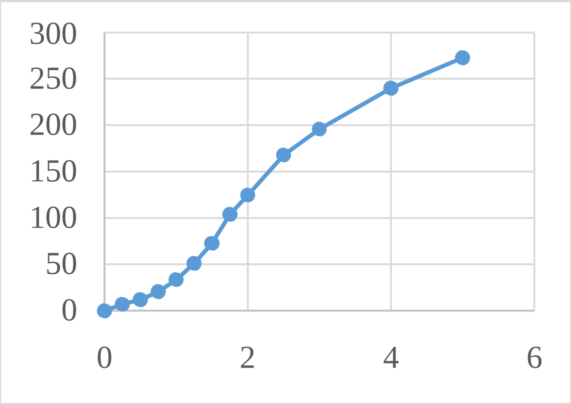
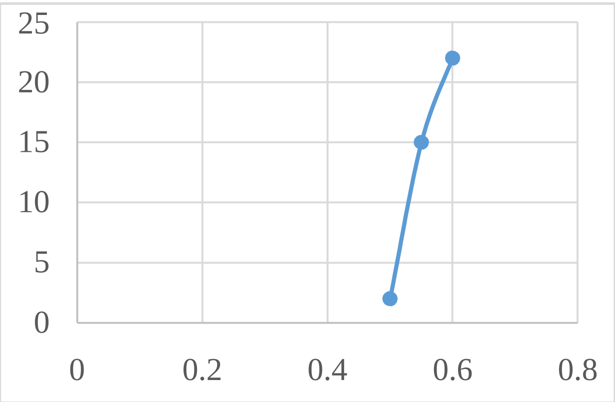
Liquid limit graph
On x-axis: no of blows
y-axis:water content (%)



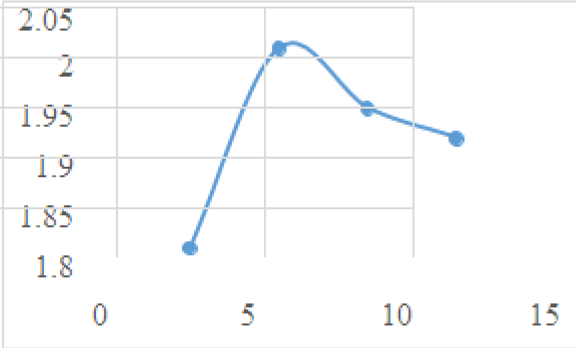
California bearing ratio graph
On x-axis: penetration in mm

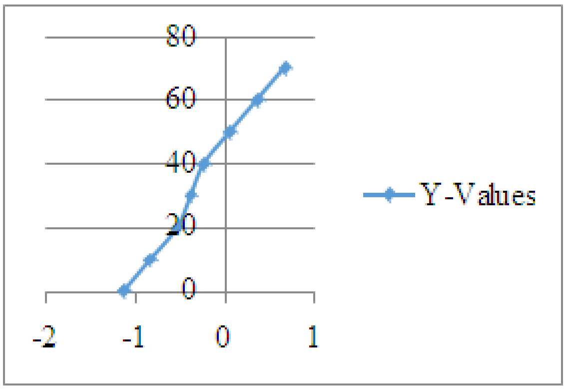
On x-axis: size of aperture y-axis: load in kg

y-axis: %of passing



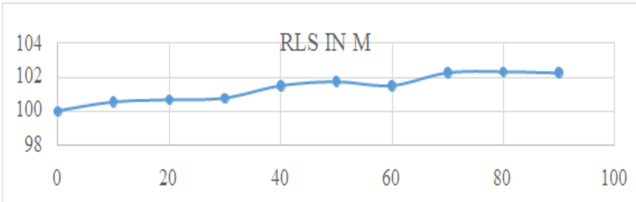
slump cone test
On x-axis: water/cement ratio
y-axis: slump in cm



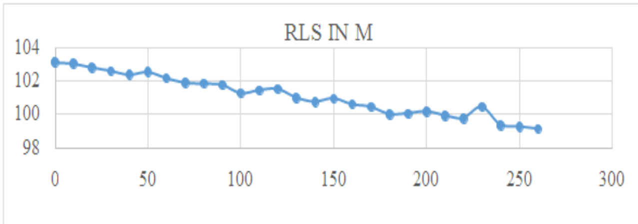


LONGITUDINALPROFILING:

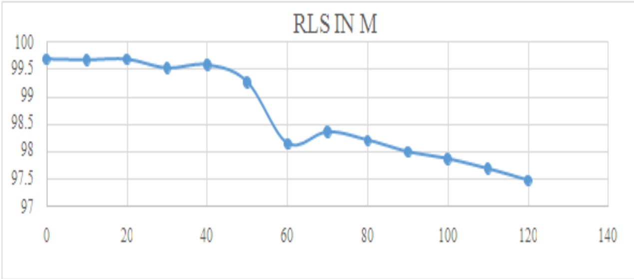
FOR ROAD "A":

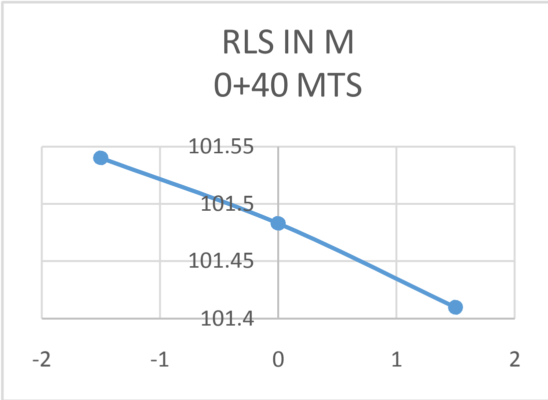


FOR ROAD "B":

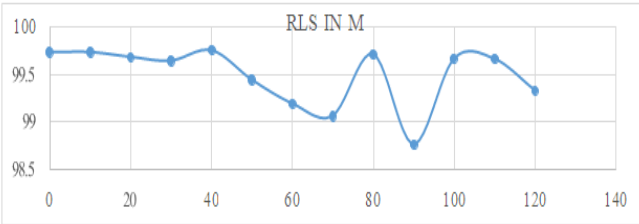


FOR ROAD "C":



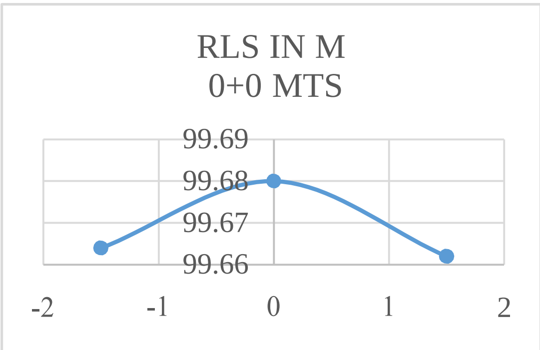


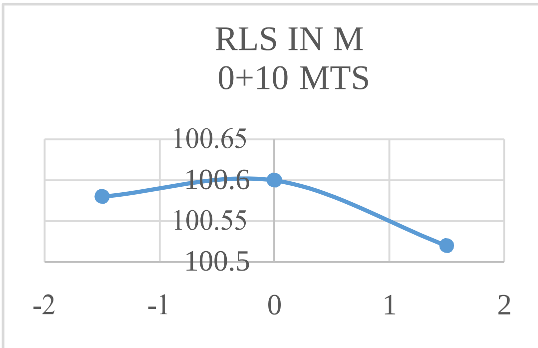
FOR ROAD "D":

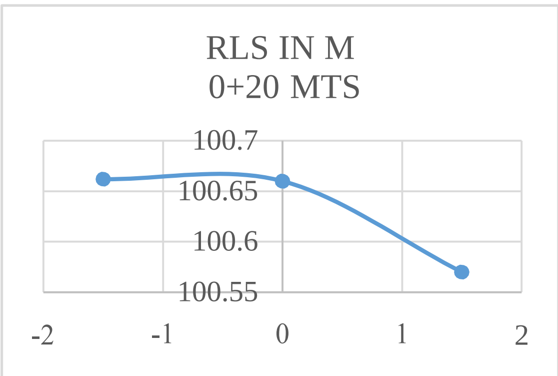


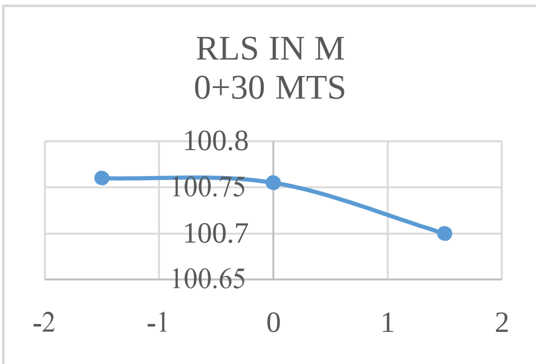
CROSS SECTIONAL LEVELLING:

FOR ROAD "A":









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Design considerations:

1. ***Design wheel load = 5100 kg (IRC 58)***
2. Present traffic = 28 commercial vehicles per day
3. Design life = 20 years
4. Traffic growth rate = 4%
5. Temperature variation = 19ºc (IRC 58)
6. Modulus of subgrade reaction :k =6.0 kg/cm^3
7. Concrete flexural strength =32 kg/cm^2 (IS 456)
8. E =3x10^5 kg/cm^2 (IS 456)
9. μ = 0.15
10. Coefficient of thermal expansion of concrete = 10x10^{-6}/ºc

Design:

select 20 cm thickness, contraction joints spacing L = 1.25m and W =3m

E = 3 X10^5, μ = 0.15, k = 6,

Radius of relative stiffness l =

$$\sqrt[4]{\frac{EXh\char`^3}{12(1-\mu\char`^2)K}}$$

$$\sqrt[4]{\frac{3X10^{5X}20\char`^3}{12(1-0.1562)X6}}$$

= 76.24 cm

l=125

$$\frac{L}{l}=\frac{270}{70.05}$$

= 1.64

From figure no 22.4 for L/l= 1.64, c = 0.1.

, c = 0.1

f_{te} = 2 kg/ cm^2

Residual strength of concrete = 32-2 = 30 kg/ cm^2

For edge load condition, figure no 22.3,

h = 20 cm

k =6 kg/cm^3

f_e= 29 kg/cm^2

Traffic volume data for last 5 years

YEAR	VEHICLES	INCREASING VEHICLES
2011	58	12
2012	70	15
2013	85	15
2014	100	20
2015	120	

CONCLUSIONS

Rigid pavements have a high compressive strength, which tends to distribute the load over a relatively wide area of soil. Other advantages include - Low maintenance costs, Long life with extreme durability, High value as a base for future resurfacing with asphalt, decreasing base and sub grade requirements, Ability to be placed directly on poor soils, No damage from oils and greases and Strong edges.

On the other side, Flexible pavements consist of a series of layers, with the highest quality materials at or near the surface. The strength of a flexible pavement is a result of building up thick layers and thereby distributing the load over the sub grade; the surface material does not assume the structural strengths as with rigid pavements. Some of the other advantages include – adaptability to stage construction, Availability of low-cost type that can be easily built, Easy to repair frost heave and settlement and resistance to the formation of ice glaze.

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