

Exploring Methods of Replacement of Concrete

Road in Two Days

Deepak Sundrani, Yusuf Inamdar

Abstract: In India, repairing / replacing of concrete road takes weeks, sometimes months and sometimes years. At many places Bitumen roads are preferred because they can be repaired very fast. However in some South East Asian countries, city roads made of concrete, are replaced in two days. In a four lane road, two lanes are dug up on Saturday, the rubble is transported away and fresh ready mixed concrete is poured on Sunday and on Monday the traffic commences as usual on the new concrete road. Thus on the two days when traffic is thin because of offices having holidays is utilized to replace the concrete road. On next Saturday and Sunday, the process is repeated for the balance part of the concrete road. Time saving is the biggest benefit. The trouble caused to innumerable city persons travelling can be drastically cut. If we can calculate the benefit of this, then the benefit cost ratio will be much more than one. The paper attempts to explore the various possible methods of replacing a concrete road in two days.

Keywords - Concrete road, sulphur concrete, tremix concrete.

I. INTRODUCTION

A high quality concrete pavement requires to be in proper level to drain off rain water, and it should also have high wear resistance, high compressive strength, high abrasion strength, reduced shrinkage and minimum water permeability. The biggest problem in replacing a concrete road is that it takes a lot of time, vis-à-vis a bitumen road. However in some South East Asian countries, concrete roads are replaced in two days.

II. REPLACEMENT OF CONCRETE

Concrete roads can be replaced in two days by various ways:

2.1 Vacuum dewatered concrete (Tremix concrete)

In this method excess water from concrete is removed vacuum process. The excess water from the concrete is removed immediately after placing and vibration, and reducing the water : cement ratio to an optimum level. Therefore, adopting the Tremix method facilitates use of concrete with better workability than what is normally possible.

A lowered water : cement ratio automatically leads to a noticeable improvement in almost each of the concrete properties.

2.1.1 Execution

In this method, initially, poker vibration is done, especially at the panel edges. This results in proper compaction of the concrete and hence elimination of voids and entrapped air.

However poker vibration does not give a levelled surface. It is therefore important to combine this vibration with surface vibration (screeding), in order to obtain a vibrated concrete with a levelled surface with a proper slope to drain off excess rain water. Two passes with surface vibrator are normally made. The Surface Vibrator is guided by two men, standing on either side of the panel.

Vacuum dewatering process removes surplus water always present in the concrete. This is done using the Vacuum Equipment comprising of Suction Mat Top Cover, Filter pads and Vacuum Pump. The process starts immediately after surface vibration.

Filter pads are placed on the fresh concrete leaving about 4 inches of fresh concrete exposed on all sides. The Top Cover is then placed on the filter pads and rolled out till it covers the strips of exposed concrete on all sides. The Top Cover is then connected to the vacuum pump through a suction hose and the pump is started.

Vacuum is immediately created between the filter pads and the top cover. Atmospheric pressure compresses the concrete and the surplus water is squeezed out. This process lowers the water content in the concrete by 15-25%.

The dewatering operation takes approximately two minutes per centimetre thickness of the pavement. The dewatered concrete is compacted and dried to such an extent that it is possible to walk on it without leaving any foot prints. This is the indication that concrete has been properly dewatered and ready for finishing.

The finishing operations - Floating & Trowelling take place immediately after dewatering. Floating operation is done with Floating disc. This ensures aftermixing of sand & cement particles, further compaction and closing the pores on the surface. Floating operation generates skid-free finish.

Trowelling is done with Trowelling blades in order to further improve the wear resistance, minimize dusting and obtain smoother finish. After that wirebrushing should be done so that the surface is not smooth because in rainy season it may cause skidding of vehicles.

Suction Mat of special grade multilayered polymer sheets alongwith reinforced distance cushions on the Filter Pads ensure sufficient cross-sectional area to squeeze out and remove excess water from the concrete. This design is a prerequisite for effective dewatering [1]

2.1.2 Benefits of Vacuum dewatered concrete [2]

1. Compressive strength increases by upto 60%
2. Tensile strength increases by @ 70%
3. Cement consumption is reduced to the extent of 40%, no cement is required separately for finishing the surface.
4. Abrasion resistance increases by @ 60% resulting in less wear and tear of the surface
5. Shrinkage of concrete is reduced and pavement warps less.

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Due care should to be taken for providing camber in the centre of the road for draining water. If necessary. steel fibre reinforcement may also be provided.

In India, Amreli Nagar Palika (Gujarat) floated a tender of construction of roads by tremix method in May 2009 for Rs. 1.33 crores.

2.2 By using sulphur concrete

The second method could be by using Sulphur concrete which obtains its strength much faster than Portland cement concrete as shown in the figure 1

Sulphur concrete has greater strength properties than Portland cement concrete. This includes abrasion resistance, compressive strength, tensile and flexural strength. Its fatigue resistance is also very high. Further, since no water is used in mixing, hence no connected pore structure is formed. Thus it has very low permeability and excellent freeze-thaw durability. The setting of sulphur concrete does not involve any exothermic reaction.

Tensile, compressive and flexural strength are greater than those obtained with conventional Portland cement. Sulphur concrete sets rapidly achieving a minimum of 70% to 80% of ultimate compressive strength within 24 hours.[3]

Water is not required for manufacture or curing, hence it may be ideal where water is scarce. Also where temperatures are below freezing point (in Ladakkh etc) it can be easily used.

2.2.1 Handling and placing

A production plant will resemble a small bitumen plant. The composition of a typical sulphur concrete is shown in Table 1 :

Table 1 : Components of sulphur concrete

Component	Weight percent
Sulphur modifier	1.2
Sulphur	11.6
Coarse aggregate	43
Fine aggregate	39
Mineral filler	5.2

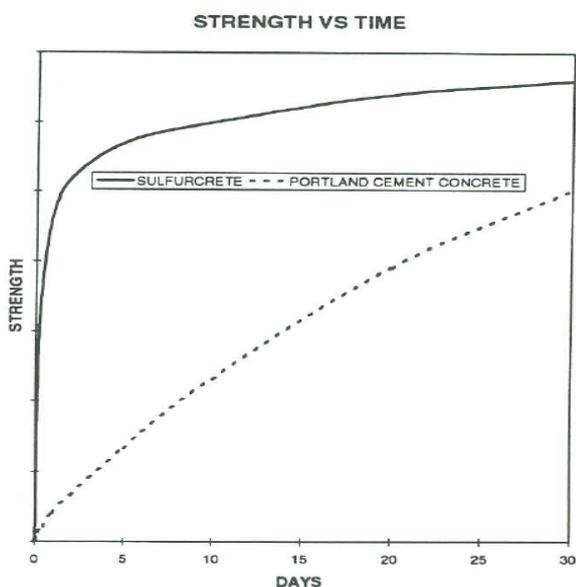


Fig 1 : Comparison of gain of strength for sulphur concrete and Portland cement concrete

Gradation of aggregates is very crucial. Also, the aggregates and mineral filler have to be heated upto 140 degree centigrade to ensure that there is no moisture, because moisture will cause harm to the polymer and binding will be affected.

The moulds for sulphur concrete must be dry . Once poured sulphur concrete will begin to solidify as the material cools. Finishing the surface by wire-brushing must be done before the surface begins to solidify.

Physical properties of sulphur concrete

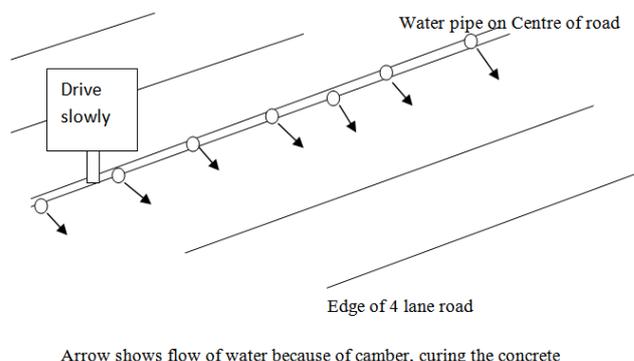
Similar to Portland cement concrete, the specific properties of sulphur concrete depend on the mix design. Typical values of properties of sulphur concrete are as shown in Table 2:

Table 2 : Properties of sulphur concrete

Compressive strength	40-65 MPa
Tensile strength	4.0-6.3 MPa
Flexural strength	8.3 to 11.1 MPa
Modulus of rupture	9.2 – 12.7 MPa
Modulus of elasticity	4.1 MPa
Linear coefficient of expansion	8.5 x 10 ⁻⁶ /Degree Centigrade
Linear shrinkage	0.01 %
Moisture absorption	Less than 0.45%
Density	2400 kg/cubic metre

2.3 Design a higher grade concrete and use one day strength.

The third method is to design a higher grade concrete and using rapid hardening cement and silica fume, so that the one day strength will be enough for taking the load of vehicles. While traffic can be started within 24 hours, simultaneously curing can be carried out by putting a perforated pipe in the centre of the road (similar to drip irrigation) , as shown in Fig. 2, with a board proclaiming 'Wet Surface, Drive Slowly' and curing to be carried out till concrete attains full strength.



Arrow shows flow of water because of camber, curing the concrete

Figure 2 : Curing of concrete road

2.4 Steam curing

The fourth method can be by steam curing which would require cement preferably having a high heat of hydration. This method will require special portable arrangement for creating and passing steam in airtight moulds and steam will be possible only on the top surface and sides, because the bottom surface will not be accessible.

2.5 Using precast panels

The fifth method could be to use large precast panels . Just like girders of bridges are made and using cranes, the girders are lifted and placed. Similarly, using portable cranes , the precast sections can be lifted and placed. These precast segments could be made of prestressed concrete also but made with suitable slope (1 in 50) on wearing surface for draining off water. These precast segments may be made with steam-curing also.

III. CONCLUSIONS AND RECOMMENDATIONS:

The paper explores the various ways in which the concrete road can be replaced in two days. New roads can also be made using these techniques. In many cases it may appear to be expensive than conventional methods of construction. Similar to the fact that if a road designer has two options , of a straight road and a road with curves, he designs a road with curves although a road with curves is longer and hence expensive than a straight road, because if the road is straight, the driver is likely to go to sleep and cause accidents. Similarly an important aspect that has to be considered is the cost of time. Time is money. The cost of time and inconvenience caused to the commuters suffering has to be calculated. There is no benefit in seeing thousands of commuters suffer and burn fuel and waste time causing a national wastage on the pretext that the ways and means for rapid construction are costlier than conventional methods.

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