Concrete Roads

Eng. Mhabat Shareef Abdullah

Researcher: Mhabat Shareef Abdullah

Degree : bachelor in civil engineering of Salahaddin university Erbil, 1998

ID Number:4481 Member of the Kurdistan Engineers Union

Work experience: From the first time I started working in the presidency of the municipality of Sulaymaniyah until today for 24 years We supervised many service projects such as:

Complementary.

Roads paving (concrete - Asphalt)

One of the most important observations I made during my work experience is that After a few years Concrete streets will face many problems like:

A-cracks.

B-fissures.

C-surface erode.

-These problems result from several reasons such as:

1-Whether

2-Lack of machinery and expert staff.

3-Lack of quality inspection for concrete factories.

From this perspective, we realized the importance of preparing a research about concrete roads.

The purpose of this research:

1-For the purpose of changing my rank to consulting engineer

2- For the purpose of benefiting readers and those interested in this topic.

Why concrete roads have be prefered ?

Environment

• In a life cycle approach, concrete roads compare favourably. • As a result of their stiffness, concrete roads reduce fuel consumption and CO2 emission (for trucks even up to 3.9 %). • 10 to 25% of the CO2 released in the production and construction of a concrete road, is absorbed again during its lifecycle. • Concrete is a chemically stable material that is safe for soil and groundwater. • At the end of its life, a concrete road can be 100% recycled. • The bright colour of concrete limits the heating-up effect and smog formation in urban areas.

Economic factors

• The long lifetime and low maintenance characteristics make concrete roads up to 25% cheaper in the long term.

Due to the bright color of concrete the investment and electricity costs for lighting may be reduced by 30%.

• Competition in materials for road construction has a positive impact on the market situation.

There are different types of monolithic pavements

1-Plain concrete - 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 m, 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.

2-Continuously reinforced concrete.

• Continuously reinforced concrete pavements are characterized 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 I to 3 m).

• The crack width has to remain very small, i.e. less than 0.3 mm.

ther rigid pavement types.

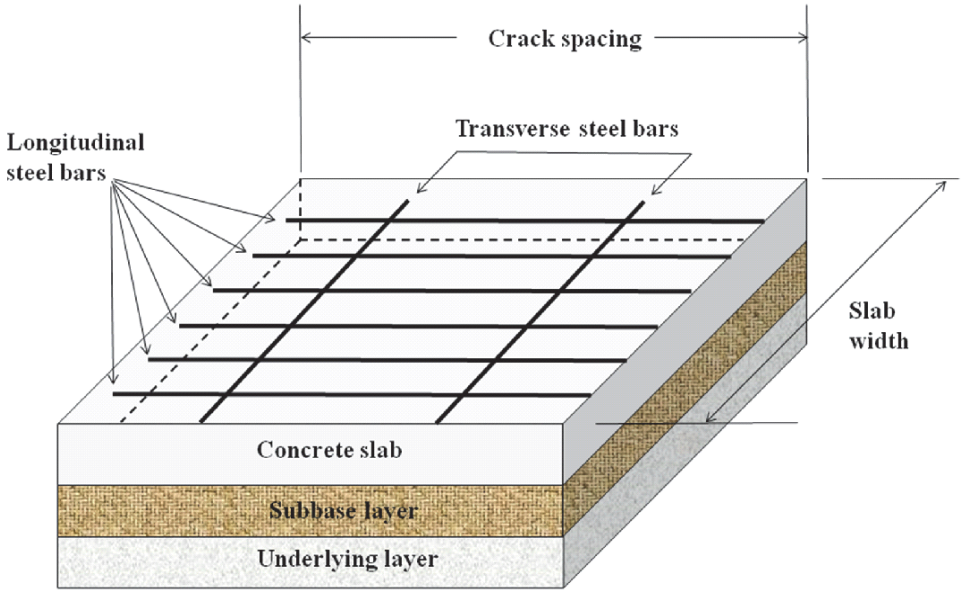

Fig. 1 General configuration of CRC pavement

PREPARATION OF THE SUBGRADE OR THE BASE.

• The road subgrade has to be prepared carefully, in order to realize everywhere a pavement structure of an adequate and uniform thickness. This allows to provide a homogeneous bond between the concrete slab and its foundation which is important for the later behavior of the pavement structure.

• For roads with a base, drainage of the water must be provided. Mud, leaves, etc. have to be removed.

• When the base is permeable, it should be sprayed with water in order to prevent the mixing water from being sucked out of the concrete.

• However, if the base is impermeable (e.g. if the concrete is placed on a watertight asphalt concrete interlayer) it can be necessary under warm weather conditions to cool down this layer by spraying water on the surface.

-The following points are important for roads without a foundation:

- drainage of all surface water;
- good compaction of the subgrade;
- filling and compaction of any ruts caused by construction traffic;
- it is forbidden to level the subgrade by means of a course of sand.

If the subgrade has to be levelled, it is advisable to do this by using a granular material: either slag or coarse aggregate e.g. with a grain size 0/20;

- provide an additional width of the subgrade for more lateral support.

It must always be avoided that water is sucked from the cement paste into the substructure or the base. This can be accomplished by either moderately moistening the subgrade, or by applying a plastic sheet on the substructure of the pavement. The latter work must be done with care, to prevent the sheet from tearing or being pulled loose by the wind.

MIXING AND TRANSPORT OF CONCRETE.

• Concrete mixing plant.

• The concrete mixing plant must have a sufficient capacity in order to be able to continuously supply concrete to the paving machines. The mix constituents and admixtures have to be dosed very accurately.

• The equipment for loading the materials shall be in good condition and shall have sufficient capacity to be able to continuously feed the bins. The content of the cement silos and the water tank al proportion to the production rates.

• Furthermore it is useful and even essential to have a communication system between the concrete mixing plant and the construction site in order to coordinate the batching and paving operations.

-Transport of the concrete;

Sufficient trucks must be available to continuously supply the paving machines. The number depends on the yield at the construction site, the loading capacity of the trucks and the cycle time

The necessary measures have to be taken to prevent changes of the water content and temperature of the concrete during transport.

Fixed-form concrete paving.

A-Setting up the side forms

• In order to place the side forms properly the alignment of the road has to be staked out carefully. This is usually accomplished by driving iron rods firmly into the subgrade soil or the base at a spacing of maximum 5 m.

After the elevations corresponding to the top of the forms have been marked on the rods, they are connected with a string line that represents the top of the forms. The form sections have to be properly supported on the base at all points.

• The inner surfaces of the forms shall be installed vertically and on line. In curved areas shorter or bent form sections are used, so as to better match the alignment of the curve.

B-Equipment

• All equipment necessary for executing the paving must be present on site and has to function properly.

• This concerns primarily: manual needle vibrators and vibrating screed, equipment for floating the concrete surface, for applying the curing compound, for sawing the joints, etc.

• The profile of the finishing equipment has to be even, in order to obtain a good final pavement smoothness. To check this, a gauge is placed at each end of the screed to be controlled. Subsequently, a string is tensioned between the two gauges and the distance between the string and the finishing surface of the screed is measured at various points. Another method consists of checking the evenness with a level and leveling rod.

• The consolidation equipment has to generate uniform vibrations with the right frequency and amplitude.

C-Execution

The concrete is supplied by truck mixers or is dumped between the forms and spread with a crane. The drop height of the concrete mix has to be limited and the concrete has to be placed gradually so as to prevent segregation or pre-consolidation. The supply and the placement of the concrete should be synchronized to the same rate, on the one hand to avoid interruptions in the placement of the concrete and on the other hand to avoid that too much time is elapsing between depositing and finishing the concrete. Spraying water on the fresh concrete in order to improve the workability shall be avoided by all means.

• The concrete is consolidated with manual needle vibrators and a vibratory screed The consolidation is realized first with the manual vibrators, in particular along the edges and subsequently with the vibratory screed. The freshly placed concrete edges are strutted by the side forms or by adjacent linear elements or existing paving slabs.

Especially when the aggregate of the concrete surface is to be exposed later, it is not advisable to carry out manual corrections behind the finishing screed because these can be detrimental for the final homogeneity of the surface. The finishing is completed using a hand float attached to a handle by a double hinge.

Execution of joints

• All the equipment that is necessary to make joints in the fresh or hardened concrete must be present at the construction site. and

The saw blades have to be suitable to the quality of the concrete, i.e. to the hardness and the abrasion resistance of the aggregates. It is useful to have spare equipment available in case of a defect.

• The beam for making a construction joint shall be rigid and shall allow the realization of a straight joint perpendicular to the axis of the road.

• This beam has to be adapted to the type of pavement (jointed pavement, continuously reinforced concrete pavement).

Transverse joints

1- Contraction joints

• Crack onsets are executed to avoid uncontrolled ("wild") cracking of the concrete by shrinkage

. Contraction joints have a crack onset which extends to a depth of one third of the slab thickness and can be equipped with dowels.

• On main roads, the contraction joints are usually made by sawing. The saw cutting should occur as soon as possible, usually between 5 and 24 hours after placement of the concrete.

Making crack onsets for contraction joints in the fresh concrete is a technique that is practically no longer applied except for country roads or municipal roads whenever the traffic intensity and evenness requirements permit so.

To make such a joint, a thin steel blade (no more than 6 mm thick) is vibrated into the fresh concrete to a depth of 1/3 of the slab thickness.

The joint can be made both with flexible and with rigid joint strips. In the first method, a thin plastic strip twice as wide as the depth of the crack point plus 2 cm is laid on the fresh concrete. The steel blade is positioned in the middle of the strip and is subsequently vibrated into the fresh concrete. In the second method the rigid joint strip is inserted into a groove priory made by vibrating the steel blade in the concrete. The top of the strip must be flush with the pavement surface.

After having made the crack onset, the concrete surface along the joint should be smoothened again. However, manual corrections should be kept to a minimum as much as possible, since they can cause spalling of the joint edges later.

2 Expansion joints

The execution of expansion joints requires special attention when using slip form paving machines.

-Special attention shall be paid to the following:

the wooden joint filler board shall be firmly attached to the base by means of metal stakes, so that it cannot move while the concrete is being placed; the height of the joint filler board shall be slightly (2 to 3 cm) shallower than the thickness of the concrete slab, in order not to hinder the placement of the concrete. As soon as the slip form paving machine has passed, the concrete above the joint filler board shall be removed over a width at least equal to the thickness of the board, so that no "concrete arch" is made at the top of the joint;

expansion joints shall always be provided with dowels, even for roads with less intense traffic. At one end of each dowel a cap filled with a compressible material accommodates the movements of the concrete.

B-Transverse joints

- Construction joints

• Construction joints - also called end-of-day or working joints - are made at the end of the daily production or when the paving process is interrupted for at least 2 hours. The face of these joints is plane, vertical and perpendicular to the axis of the pavement. They are always doweled.

• Upon resuming the paving the fresh concrete is placed against the concrete that has already hardened. The concrete is consolidated on both sides of the joint with a separate manual needle vibrator.

Sealing the joints

Transverse and longitudinal joints are usually sealed with a joint sealant to prevent water infiltration under the paving slabs in the future. To this end, hot or cold joint sealants or prefabricated joint strips are used. To achieve a durable seal, this work must be done with the utmost care.

the dimensions of the joint sealant reservoir are given for contraction joints or construction joints. For expansion joints the width of the sealant reservoir must be at least as wide as the width of the compressible joint filler board. The edges of the joint are chamfered in order to prevent spalling and to provide space for expansion of the joint sealant.

PROTECTION OF THE CONCRETE

-Protection against drying out.

• A curing compound is usually used to protect road concrete against drying out . This coating is sprayed on the concrete top surface and on the vertical surfaces immediately after the paving train has passed and, if applicable, after the concrete surface has been boomed.

-Protection against rain.

• Concreting is stopped if it rains. Furthermore, the necessary measures have to be taken to prevent that the concrete surface is washed out by rain. This applies both to freshly spread concrete that has not been compacted yet and to smoothed concrete. Plastic sheets or mobile shelters are suitable means of protection.

-Protection against frost.

• When concrete is placed in cold weather the pavement surface has to be effectively protected against frost in such a way that the temperature at the surface of the concrete does not drop below + I °C for 72 hours after placement. This protection can consist of, for example, non-woven geotextile or polystyrene foam non-woven geotextile or polystyrene foam plates with ballast.

SPECIAL MEASURES

- Workability period:

• It must always be ensured that the concrete is processed as quickly as possible, certainly within 2 hours after batching including the surface treatment and the protection measures. In hot, dry weather an even

• Furthermore, all necessary measures shall be taken to keep the water content of the concrete as constant as possible from the time of batching until completion of the placement.

-Paving interruptions:

• Whenever the supply of concrete is interrupted, the driver of the paving machine shall immediately take the necessary measures to lower the speed of the paving train and to ensure that the machine stops as little as possible.

• Upon a long-lasting defect of the paving equipment, the supply of fresh concrete has to be stopped immediately and an attempt must be made to complete the current paving phase.

-Special weather conditions

- Concrete paving in cold weather

• When placing concrete in cold weather the setting and hardening time of the concrete increases due to the slower hydration of the cement.

Concrete pavement can only be laid if the air temperature measured at 8 o 'clock in the morning at 1.5 m above ground under thermometer shelter, has reached at least + I°C and if, during the night, the temperature has not dropped below - 3°C.

If circumstances so justify or require, the concrete placement can be continued at low temperatures provided additional precautions are taken to prevent frost damage, e.g.

● addition to the concrete mix of a setting accelerator such as dissolved calcium chloride (except for reinforced concrete), at a rate of no more than 2 mass-% of the cement;

● improved protection of the pavement during the first days, by placing an insulating material on the surface.

.

Concrete paving in hot and/or dry weather:

Hot and/or dry weather can have two adverse effects: faster drying out of the concrete, which is accompanied by shrinkage deformation) (cracks forming due to plastic shrinkage);

- thermal deformations as a result of the concrete mass heating up.

At air temperatures above 25°C, or at a relative humidity below 50 %, special measures have to be taken to protect the fresh concrete against drying out and being warmed up by the sun:

- apply additional curing compound to the fresh concrete;
- moisten the concrete as soon as it has hardened sufficiently.

Other measures, having the same purpose, can also be considered,

- sprinkling the foundation just before the concrete is deposited;
- adding a setting retarder to the concrete mix
- shifting the working hours.

OPENING TO TRAFFIC

Usually, a concrete pavement is only opened to traffic 7 days after the concrete has been laid

The success of a project requires:

a thorough study of the project and very good specifications;

a quotation that takes into account all the difficulties that will occur during the work;

a careful execution by skilled personnel that respect the code of good practice;

a correct and accurate control, before, during and after the execution of the work.

In conclusion we should take those point sirosly that we mention it in previous pages in this research and build a customized standard of Kurdistan concreting system and preparing the type of concrete to our roads to decrease waste and increase of our work level and quality of our roads.

Thanks