Special Report - Equipment

Smooth Operator!

Engineer JAGVIR GOYAL tells us how the slip-form paver enables fast and accurate construction.

Pavers are an intrinsic part of construction and come in fixed-form and slip-form varieties. Further, these can be divided into full-width and partial-width pavers. As all these pavers have been tried in India, their performance can be well compared. Though super-screed, fixed-form pavers used in Madhya Pradesh and Bangalore have shown fast speed of working, slip-form pavers have proved even faster and better than fixed-form pavers.

Speed and accuracy  
Indeed, slip-form pavers, which com-prise a main frame, concrete receiving hop-per, levelling cylinder, spreader, smoother, levelling sensor, vibrator, level sensors and slope controllers, can discharge concrete from their hoppers, spread it, level it, compact it and finish it smoothly in a single operation. What's more, all these tasks are executed with complete accuracy as electronic controls monitor the thickness, level and slope of the pavement. No side supports are required to support the concrete pavement laid by slip-form pavers - the slump of concrete is watched and the rest is taken care of by the paver itself.  
The numbers say it all. Slip-form pavers can lay pavements at a high rate of 1 km per day. Thus, if working hours are 8 am to 8 pm (12 hours), the speed of the pavers is about 1.5 m per minute under continuous operation. They can handle up to 300 cu m of concrete per hour even if the thickness of the pavement is as little as 30 cm. Pavers produced in India can lay a road width varying from 2 m to 17 m in a single pass. Indian slip-form pavers are highly versatile and many optional types of equipment can be attached to them. Further, variation in their models makes them suitable for concrete and asphalt roads. Being crawler-mounted, these pavers are highly suitable for larger road width.

The right width  
During expressway construction, it is preferred to use a full-width slip-form paver. However, the batching plant installed should be able to produce the large quantity of concrete demanded by a full-width paver. Also, adequate transportation arrangements must be in place. Generally, the batching plant is able to produce the required quantity but distances for transportation of concrete are large. Under such conditions, it is better to deploy a paver of lesser width.

Mix design  
These days, cement concrete pavements are preferred over asphalt pavements owing to their longer life, lower maintenance requirements and zero permeability. Pavement sections consists of a layer of pavement quality concrete (PQC) over a layer of dry lean concrete (DLC). However, when the section is in filling, subgrade of designed thickness, a drainage layer and a WMM layer need to be laid below the DLC. Generally, M40 PQC is designed for pavements. Coarse aggregate is preferred to be of 25 mm maximum size instead of the usual 40 mm in both DLC and PQC.

Minimum cement content  
While using a slip-form paver for expressway construction, effort should be made to optimise cement content of concrete instead of specifying high minimum cement content. High cement content may result in cracks in pavements as a higher heat of hydration is released. Minimum cement content for M40 concrete is 350 kg per cu m. However, keeping in view the excellent quality and grades of cement available these days, required strength is achievable with less content of cement. The minimum cement content can then be reviewed on a case-to-case basis by keeping durability and abrasion resistance requirements in view.

Temperature of concrete  
In most cases, for pavements it is specified that temperature of concrete being laid should not exceed 35° C. To maintain this requi-rement, chilled water should be used to produce concrete at the RMC plant or batching plant. Temperature of concrete produced should be around 22° to 25° C so that by the time the concrete is laid in position, its temperature doesn't exceed 35° C. It is always better to make these observations on site as wea-ther and ambient temperature play an important part.

Slump control  
It is very important to control slump of concrete while using slip-form pavers. Slump should neither be more nor less. Higher than designed slump will not allow the pavement to stay intact and it will tend to spread at the ends while less slump will obstruct the working of the paver. During the use of slip-forms to build structures, the slump of concrete at concrete production point and con-crete placement point is worked out and specified. The same procedure is applicable to slip-form pavers too. These two slumps should be worked out by working backwards. First, the slump at placement point that is suitable to the slip-form paver should be decided. Next, the time taken in transportation of concrete and likely loss of slump during this period should be noted. Accordingly, the slump required at concrete production point can be worked out.

Placement of DLC and PQC  
Both DLC and PQC should be laid by using the slip-form paver. PQC placed in the receiving hopper of the paver is poured before the levelling cylinder. The spreader spreads it to the required thickness and the paver vibrator compacts it fully. As the leveller levels PQC to the required level, the smoother, another part of the paver, finishes the pavement smoothly. In some projects, separate pavers are used to lay DLC and PQC. However, preference should be given to the use of a single paver to lay both DLC and PQC. This will result in time and cost savings. It has been noted that in some projects, contract conditions ask for deploy-ment of separate pavers for DLC and PQC - to meet this requirement, the contracting agency arranges separate pavers for the two concretes. During construction of pave-ments, emphasis should be on getting the pavement laid in lesser time and meeting quality standards rather than insisting on deploying a specified number of pavers.  
A membrane is laid over DLC before laying the PQC layer over it. This 100 to 125 micron-thick layer must be checked to ensure that it is free of any holes, folds or crumples before laying of PQC.

Curing of concrete  
Once the pavement has been laid and finished, the concrete is sponged to remove any surface water. Then, the texturing-cum-curing machine does its work. Texturing of concrete pavements is essential to avoid skidding of vehicles on the surface. Along with texturing, a curing compound is applied on the concrete surface at a rate of about 350 ml per sq m. The texturing-cum-curing machine is also a part of the slip-form paver train. On completion of the operation, the pavement has to be covered with Hessian cloth and water sprinkled over it for the next 14 days.

Systems for accuracy  
Automatic controllers are provided on slip-form pavers to control the longitudinal level and the transversal slope of roads. Electronic level sensors are mounted for longitudinal level checking and these continue to check the material thickness with respect to a fixed datum. Transversal slope controllers are mounted on the cross beams and they send signals as and when there is a change in slope. In addition to these electronic controllers, manual controls are kept on standby. Nowadays, microwave technology and laser systems are being inducted in road construction equipment control.

The Indian scene  
SF 2700 and SF 3000, the slip-form pavers produced by Power Pavers Inc, are much faster in the construction of pave-ments than fixed-form pavers. Gomaco's slip-form pavers can lay pavements up to 15-m width - automatic dowel bar inserter is also available. The mid-sized S850 slip-form paver of Guntert & Zimmerman (G&Z) can lay pavements of 3.5 m to 9 m width. It is equipped with an oscillating correcting beam and a finishing pan, thus avoiding a separator smoother to finish the concrete. This paver also has the facility of compact dowel bar insertion (CBDI). G&Z has devised a complete package including mix design consultation, choosing of aggregates and suggested cost-saving techniques for buyers. Ancon International's concrete slip-form paving equipment put to use in India has also shown satisfactory results.  
While NHAI, MES, IRCON and most highway construction departments have realised the necessity of slip-form pavers for construction of expressways and highways, the contracting system needs to be reviewed and full faith needs to be reposed in Indian construction agencies who are clinching major projects abroad. Years ago, when the Mumbai-Pune Expressway was constructed, its total length was divided among four or five agencies for fear that one agency may get stuck. This precaution resulted in a higher-than-necessary cost to the government. But those were perhaps first-time fears. Now, any major project in India can be handled by our own constru-ction companies single-handedly as major construction giants have started adding slip-form pavers to their equipment.