An Approach to Concrete Pavement Replacement That Minimizes Disruption of Traffic

R. F. Grimsley and B. G. Morris
Florida Department of Transportation

The Florida Department of Transportation is currently using a method of replacing damaged concrete slabs on the urban Interstate System that results in minimum disruption to traffic flow and maximum safety for maintenance crews. The operation involves using accurate field measurements of damaged slabs to construct forms and pour new slabs in the maintenance yard rather than at the jobsite. These cured slabs are then hauled to the area being repaired and placed on prepared subgrade. Removal of the old slab and setting of the new one are done at night because of the lower traffic volume. As many as four slabs have been replaced during an 8-hour worknight. Slabs are set approximately ½ in. (12 mm) low and are raised to final grade by slab jacking. Joints are then sealed, and the road is ready for traffic. Careful planning and coordination of all crews involved in preparation and installation of slabs are necessary to ensure effectiveness in terms of smooth traffic flow and safety to workmen.

In maintaining today's highways, maintenance engineers are confronted with tremendous traffic volumes. Maintaining production and protecting workmen require that maintenance activities be scheduled when traffic is at its lowest point. Nighttime and weekends are the most opportune times for rerouting or restricting traffic flows.

A recent review of the Interstate System in an urban area in central Florida revealed numerous broken concrete slabs that needed repair or replacement. Until several years ago, slabs at this stage of deterioration were either ignored or leveled with asphaltic concrete. This method was fast and easy but did not prevent further deterioration or present a smooth riding surface to motorists.

A more professional and permanent approach to such maintenance problems involves closing one or more lanes of Interstate roadway to traffic while the deteriorating slabs are removed and replaced with a surface that can bear traffic loads as soon as it is in place.

Today this problem is being solved by precasting roadway slabs in an area remote from the jobsite (Fig. 1). During the hours when traffic volumes are low, the precast slabs are installed with minimum interuption to traffic flow. As many as four broken slabs have been replaced on urban Interstate Systems during the course of an 8-hour worknight. The cost of this method of replacement during 1972 was $35 per square yard.

After a particular slab is located for replacement, it is measured to obtain exact width and length. Interstate slabs are approximately 12 ft (3.66 m) wide by 20 ft (6.10 m) long, but smaller or irregular slabs may be replaced with this method.

Many slabs were cut, skewed, short, or irregular when initially constructed, so a precise measurement is necessary to construct a new slab that will fill the void left by the broken slab. A ¾-in. (19-mm) tolerance is allowed on two ends and one side, but the outside edge of a two-lane facility is adjacent to a paved shoulder and can be fitted snug to the precut shoulder edge. If slabs are replaced in six-lane roadway, a ¾-in. (19-mm) tolerance around the slab is required.

Measurements are given to the casting crews so forms may be set properly for a particular slab. Wooden forms were used for casting slabs for this particular job. However, if this were to be a continuous activity, metal forms would increase production. Slab widths on normal roadway are basically uniform, but lengths were found to vary from 4 to 5 in. (102 to 127 mm). Metal forms are easily adjusted for these varying lengths.

After a bed is prepared for casting a slab, a 6-mil (0.15-mm) Visqueen sheet is placed in the bottom of the form to prevent moisture loss, thus ensuring proper curing. A double mat of reinforcing steel is placed on chairs that are designed to provide necessary clearance for steel placement. These reinforcing bars were Number 5 bars (16 mm); transverse spacing was 6 in. (152 mm) and longitudinal spacing was 15 in. (381 mm). The steel was placed in two layers to compensate for uneven stresses caused by lifting from the bed and placing on an uneven base. This also prevented damage to slab when mud jacking for leveling.

In the casting bed, aluminum tubes were placed vertically in designated locations, making holes through the slab to allow for slab jacking of the slab. Location of these holes is very important, because it is necessary to maintain uniform support under the slab when jacking. Three lines of holes were cast into slabs for this purpose. They were located approximately 18 in. (457 mm) from the ends with 5 ft 8 in. (1.73 m) between holes on the side adjacent to the pavement. The center row was staggered 4 ft 3 in. (1.30 m) from the end with 5 ft 9 in. (1.75 m) between holes. The last row of holes was cast 12 in. (305 mm) from the side with the same distance between holes as the first. Holes usually are spaced a maximum of 6 ft (1.83 m) center to center so that uniform pressure will be exerted on the entire slab.

Six threaded sleeves were placed in the slab to allow lifting from beds and placing in the roadway. These sleeves were located in two rows 3 ft (0.9 m) from the longitudinal side and 5 ft (1.52 m) from the ends with one in the middle of the rows.

Casting required approximately 6 yd^3 (4.6 m^3) of concrete for a slab measuring 8 in. (203 mm) thick by approximately 12 ft (3.6 m) wide and 20 ft (6.1 m) long. Slabs were poured from 3,000-psi (2068-MPa) concrete followed by a vibrating screed and a light broom finish. The slabs were allowed to cure as specified in the department's standard specification.

Slabs were hauled to the approximate job location and stored near an entrance ramp in the area where they were to be installed (Fig. 2). Because the slabs were overwidth for movement on the highway at night, they were transported during daylight hours. Each slab weighs approximately 12 tons (10.8 Mg), so only two were hauled on each transport.

Traffic control installations were handled by a separate unit that preceded the slab installation by several hours. These crews were briefed on the lane closure plan before beginning the operation. In this briefing, they were reminded of proper procedures to follow and their impact on safety. Units consisted of a pickup truck with a roof-mounted sequential arrow light. It entered the Interstate System and raised the roof light as the work area was approached. When it stopped at the work site, the truck's sequential light directed the traffic to the left lane, while another truck and crew set up necessary trailer-mounted sequential lights and A-frame barricades for further traffic control. A sign crew installed detour signs that are turned away from traffic when not in use.

We used the Manual on Uniform Traffic Control Devices for Streets and Highways to

Figure 1.

Figure 2.

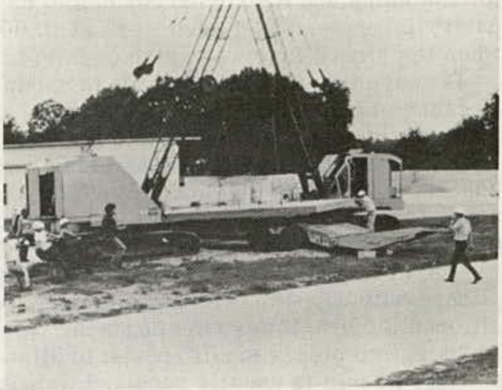

Figure 3.

Figure 4.

Figure 5.

determine the proper detour for the work location. It usually takes a couple of hours for the signs and detour barricades to be erected according to this manual. In this particular case, we started work at 10:00 p.m. and finished at approximately 6:00 a.m., when the closed lane was again open to traffic.

Because the work site was in an urban area, the width of roadbed was restricted. Because of its location in a fill section, all operations were coordinated and planned to allow equipment to pass and to offer maximum safety for men and traveling public.

Joints surrounding the broken slab were sawed with a 24-in. (610-mm) diamond concrete saw blade that cut through the dowel bars and the concrete slab. When slabs are removed, it is important to saw through the joint, or adjacent slabs will be broken or damaged when the slabs to be replaced are broken.

The next operation was to break up the damaged concrete slab. This was accomplished with a ½-ton (450-kg) mobile dragline and a headache ball. The operator positioned the dragline so the headache ball could be dropped on the designated slab and break it into pieces small enough to allow easy removal from the work area. Approximately 45 min is usually required to break a slab into pieces small enough to be loaded into dump trucks by a gradall (Fig. 3). Extreme care in dropping the headache ball is required to prevent damage to adjacent slabs.

After the broken slabs were hauled away, the subgrade was compacted by adding material and releveling. A plate compactor was used to compact the subgrade because the area was too small for other types of compaction equipment. Density under the slabs is important to ensure that no further settlement of the subgrade takes place when a new slab is installed. All slabs were installed approximately ½ in. (12 mm) below final grade. The slabs then were raised to final grade by slabjacking. This ensures uniform support under the new slabs.

The next operation consisted of placing the slabs in the prepared location (Fig. 4). A crane was used to lift the slab from the transport onto the roadway base. Heavy equipment such as the crane should be kept off newly placed slabs until the final grade is established.

Slabjacking is accomplished through holes arranged in the slab when poured. The area under the slab at each pumping point is blown out sufficiently to allow grout to be pumped into this void. The grout forms a lubricant under the slab, causing the slab to float on the subgrade. After all holes have been pumped and the slab is floating on the subgrade, the holes are pumped with a heavier grout to raise the slab (Fig. 5). After three to five piston strokes of the pump in each hole, the slab is normally raised to grade or the operation is repeated.

After the slab has been raised to the proper grade, a pressed fiberboard is placed in the joint. This serves as a filler and a bond breaker. The joint sealer used is a rubberized asphalt sealant that is heated in an oil kettle bath according to the manufacturer's recommendation. The sealer is poured ¼ in. (6 mm) below the top of the slab to prevent damage by traffic. The seal is allowed to cool and the equipment is removed from the jobsite.

The traffic control crew removes the barricades and signs and opens the land to traffic.

In conclusion, precast slabs for maintenance is one method of repairing broken slabs in a heavily traveled urban highway. This method of replacement offers the engineer the quickest and safest approach. The public is least inconvenienced by this method, because the work is accomplished during low-volume hours.

An activity such as this requires a coordinated effort by all involved crews. Each phase has to be planned to ensure maximum efficiency.