Stronger, Faster

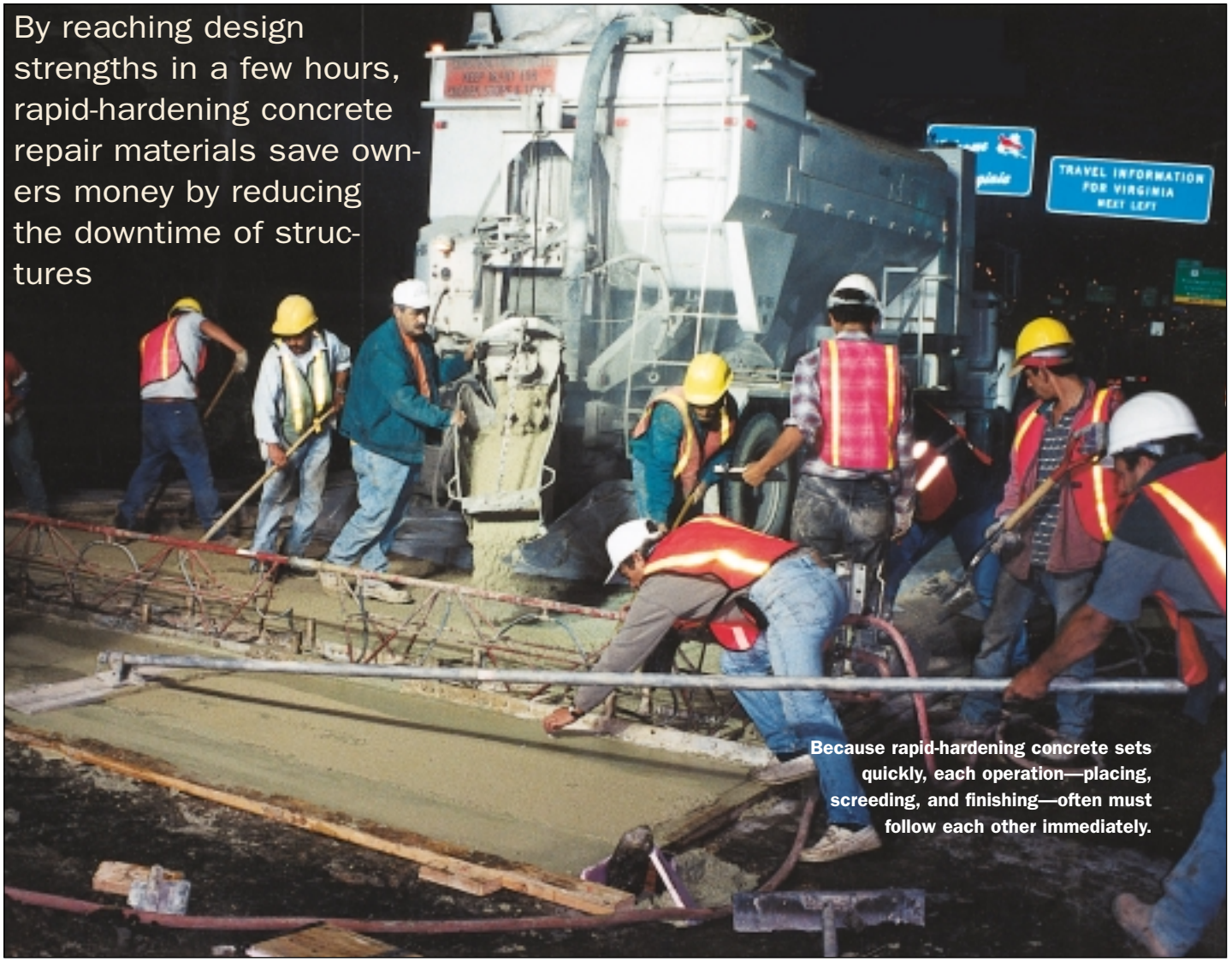
By Martin S. McGovern

When determining the true cost of a concrete repair project, owners must consider the financial impact of shutting down a structure to perform the work. What is the cost of traffic delays caused by shutting down a lane of highway? How much revenue is lost when a section of a manufacturing facility must be closed? These hidden costs often can exceed the actual price of the repair.

The money saved by reducing the downtime of in-service structures has created a big market for concrete repair materials that gain strength quickly. An owner often is willing to pay a substantial premium for a product that allows a structure to be returned to service in a few hours instead of a few days.

Most engineers and contractors prefer to use conventional portland-cement concrete as the repair material because it's readily available, well understood, and economical. But a typical air-entrained concrete mix containing Type I portland cement and a water-cement ratio of 0.40 takes 3 days to reach a compressive strength of 2000 psi when cured at 70° F (Ref. 1). When pushed to the limit, portland-cement concrete con-

By reaching design strengths in a few hours, rapid-hardening concrete repair materials save owners money by reducing the downtime of structures



Because rapid-hardening concrete sets quickly, each operation—placing, screeding, and finishing—often must follow each other immediately.

CTS CEMENT MANUFACTURING CO.

A Guide to Prepackaged, Rapid-Hardening Concrete

Manufacturer	Product	Working life (min)*	Compressive strength (psi) 1-hr	3-hr	1-day	28-day
American Concrete Systems (Edoco) circle 3	Structural Repair Concrete Highway Patch II	25(i) 20(i)		2500 6330	5000 9380	8000 10,450
American Stone-Mix circle 4	IFSCEM 110 Magna 110[2]	25(i) 10-15	2000 2000	 5000	4000	7000 8000
W.R. Bonsal circle 5	Rapid Patch-VR	20(i)		3000	6000	7000
Burke by Edoco circle 6	Fast Patch 928 D.O.T. Patch	10[1] 10	2700[6] 3190	 4440	6170[6] 6280	7890[6] 9690
ChemRex circle 7	Sonneborn Road Patch Thoro Road Patch II ThoRoc 10-60 ThoRoc 10-61	10-15 10-15(i) 16(i) 40	3000[4] 2000	4800 2450[3] 4000 3000	7100 4580 7000	9800 6320 8500 9000
Conproco circle 8	Express Set	5-10	2000	3150	4400	6200
Conspec Mktg. & Mfg. circle 9	Pave Patch Special Patch LPL Patch	15-25(f) 15-25(f) 30-40(i)		2000[7] 1200[7] 1500[7]	 3600	7200 7000 7200
CTS Cement circle 10	Cement All D.O.T. Repair Mix Mortar Mix	25 10-20 29(i)	 2000[4] 2000[4]	5730 5000 3470	6620 7500 4740	8500 10,500 7600
Dayton Superior circle 11	HD-60 Day-Chem Perma Patch	15 15	2500 2000	3500 3000	6145 5000	7990 10,000
Euclid circle 12	Euco-Speed Euco-Speed MP[2]	18(f) 8-12(i)[1]		1400 5000	5000 6000	7000 7500
Five Star Products circle 13	Structural Concrete Highway Patch	20(i) 15(i)	 2500[5]	2500	5000 5500	8000 6500
Fox Industries circle 14	FX-928	15(i)	2800		6000	8000
L & M circle 15	Durapatch Hiway	14(i)		2500[3]	5000	8100
Mapei circle 16	Quickcem Top 102 Quickcem Top 202	30 30		1520 1175	5130 3520	5920 6980
Master Builders circle 17	Emaco T415 Emaco T430 Set 45[2]	14-21(i) 75(i) 10-15(i)[1]	 2000	2400[3] 980 5000	6300 4500 6000	10,000 10,990 8500
Metalcrete circle 18	Speedpave Speedpave MP[2]	16(f) 13(f)[1]		1500 4600	4000 7600	7500 9500
Sika circle 19	Roadway Patch	15-25		1500[3]	4000	8000
STO circle 20	Trowel Grade Mortar (acc) Flowable Mortar (acc)	30 30		1500 1500	3000 3000	6000 6000
Symons circle 21	D.O.T. Patch Fast Set 5 Fast Set 20 Fast Set 40	15 5(i) 21(i) 42(i)	1050 	3500 1000 675 580	4100 4100 5900 3300	10,120 8560 9230 6350
Tamms circle 22	Speedcrete 2028 Speedcrete Greenline	20-35(i) 6-15(i)	2600 2000	5000	7000 3160	9000 6380
Target Products circle 23	Traffic Patch	25(i)	2150[4]	2800	3970	10,000

[1]Products with extended setting times are available for hot-weather applications.
[2]Magnesium-phosphate based
[3]Strength @ 2 hours
[4]Strength 1 hour after setting
[5]Strength @ 90 minutes
[6]Cured at 40° F
[7]Strength 3 hours after setting
*@ 70° F: (i) denotes initial set time; (f) denotes final set time

taining Type III cement and accelerating admixtures can reach 2000 psi in 4 to 6 hours (Ref. 2).

If faster strength gain is required, it can be provided by the products listed in the table. Calcium-aluminate cements, magnesium phosphate, or other proprietary cement formulations enable many of these rapid-hardening products to reach design strengths in less than 4 hours. The products listed are prepackaged mortars that usually come in 50-pound bags. For larger jobs, contractors can arrange bulk purchases with some manufacturers. Some manufacturers also offer rapid-hardening cement to which contractors add both fine and coarse aggregates.

The table includes only those products that reach a compressive strength of at least 500 psi in 3 hours and thus meet the compressive strength requirement for rapid-hardening concrete as outlined in ASTM C 928. Because rapid-hardening concrete sets quickly, the table also lists values for the working life of the products. The working life is an estimate of the length of time after mixing that the mortar is plastic enough to be consolidated.

Rapid-hardening concrete is an excellent choice for repairs performed in cold weather.

While some manufacturers listed values for working life, others listed values for initial set time, final set time, or both. When both values were listed, we used the initial set time in the table because it is a more accurate estimate of the working life of the mortar.

For patches thicker than 1 inch, most of the mortars can be extended by as much as 60% by adding about 25 to 30 pounds of ⅜-inch pea gravel per 50-pound bag. For thicker repairs, consult the manufacturer about using aggregates larger than ⅜ inch.

Aside from lowering material costs, adding coarse aggregate to the mortars has other benefits. Less water is required, which lowers the shrinkage potential. Also, most rapid-hardening repair materials generate a lot of heat. The coarse aggregate absorbs the heat, reducing the chance of thermal cracking, especially in thick sections.

Most products exhibit good freeze-thaw durability without requiring a separate air-entraining agent. For products requiring additional air, conventional air entrainers can be used.

Mixing

Because some rapid-hardening concrete reaches initial set in as little as 5 minutes, manufacturers recommend mixing times as short as 60 seconds. One way to ensure that this requirement is met is to use a mobile volumetric mixer. Usually truck- or trailer-mounted, volumetric mixers carry all the materials in separate bins. After the materials are batched, a continuous mixer rapidly blends dry ingredients and water using a steel-bladed auger. Mixing time from input to output usually is less than 20 seconds. Volumetric mixers eliminate waste because they mix materials just before placement. This makes them an excellent choice on jobs where concrete placement must be stopped and started often.

On projects requiring a large volume of material that can be discharged quickly, rapid-hardening concrete with longer setting times can be mixed in ready-mix trucks. One way to batch materials is to charge the truck drum with the aggregate and most of the water at the ready-mix plant and add bulk cement or mortar at the jobsite.

Placing and finishing

Plastic rapid-hardening concrete handles much like conventional portland-cement concrete, but rapid-hardening concrete sets faster and begins to stiffen much sooner. Each operation—placing, screeding, and finishing—must follow each other immediately. Most manufacturers strongly warn against retempering their products because additional water can affect both setting time and strength development. Working the product after it begins to stiffen can tear the surface.

Some products contain very fine cement particles, so the concrete doesn't bleed. Workers may be tempted to sprinkle additional water on the surface to make the concrete easier to finish. This should be avoided because additional water weakens the concrete surface.

Rapid-hardening concrete is an excellent choice for repairs performed in cold weather. Some products can set and gain strength at temperatures well below freezing. However, many manufacturers recommend heating the materials before placing them at temperatures below 40° F.

Hot weather causes many rapid-hardening concretes to set very quickly. This not only makes them difficult to place but also can lower ultimate compressive strengths. In these cases, add cold water to the mix. Proprietary retarders are available for some products; others are formulated to have extended setting times.

Curing

Because some products don't bleed, they are susceptible to plastic shrinkage cracking. Therefore, wet cure these products as soon as possible. To determine when to start curing, one manufacturer recommends pressing a finger to the concrete. If you can't see a fingerprint, start curing the concrete.

If wet curing is impractical, most manufacturers recommend applying a curing compound to their products. But some products should be air-cured and some products should not be wet cured. Check with the manufacturer for proper curing methods. ■

References

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