From chapter 10 (pages 275–290) of the *IMCP Manual* (reference information on page 16)

Troubleshooting

Table 10-1. Problems Observed Before the Concrete Has Set

Mixture and Placement Issues

1. Slump is Out of Specification

Potential Cause(s)	Actions to Consider/Avoid	See Page
Change in water content or aggregate grading	Check aggregate moisture contents and absorptions.	44, 47, 183, 206, 207, 211
	Check for segregation in the stockpile.	
	Make sure the batch water is adjusted for aggregate moisture content.	
	Conduct batch plant uniformity tests.	
	Check whether water was added at the site.	
Mix proportions	Check batch equipment for calibration.	207
Admixture dosage	Check delivery ticket for correct admixture dosage.	207
Concrete temperature too high or too low	Adjust the concrete placement temperature.	127
Haul time	Check the batch time on the concrete delivery ticket. Haul times should not be excessive.	209

2. Loss of Workability/Slump Loss/Early Stiffening

Potential Cause(s)	Actions to Consider/Avoid	See Page
Dry coarse aggregates	Make sure the aggregate stockpile is kept consistently at saturated surface-dry (SSD) (use soaker hoses if necessary).	206
Ambient temperature increases	Do not add water.	179, 182, 183, 206, 210, 226
	Chill the mix water or add ice.	
	Sprinkle the aggregate stockpiles.	
	Use a water reducer or retarder.	
	Do not increase the water/cement ratio to a value greater than the maximum approved mix design.	
	Use a mix design that includes slag or fly ash.	
Transport time too long	Reject the load if greater than specified.	183, 209
	Use retarder in the mixture.	
	Use an agitator rather than dump trucks.	
Mix proportions have changed	Check/monitor the moisture contents of the aggregate stockpiles.	206, 207, 246
	Check the batch weigh scales.	
	Verify that aggregate gradations are correct.	

(continued on the following page)

Mixture and Placement Issues, continued

2. Loss of Workability/Slump Loss/Early Stiffening, continued

Potential Cause(s)	Actions to Consider/Avoid	See Page
False setting (temporary)	Check for changes in cementitious materials.	58, 209, 211
	Reduce Class C fly ash replacement.	
	Change the type of water reducer.	
	Try restoring plasticity with additional mixing.	
	Contact the cement supplier.	
Incompatibility	Check for changes in the cementitious materials.	97, 246, 247
	Reduce Class C fly ash replacement.	
	Change chemical admixtures.	
	Change the batching sequence.	
	Cool the mixture.	
Variation in air content	Check the air content/air entrainer dosage.	56

3. Mixture is Sticky

Potential Cause(s)	Actions to Consider/Avoid	See Page
Sand too fine	Change the sand grading.	44, 109
Mix too sandy	Check the sand and combined aggregate grading.	180
Cementitious materials	Check the cementitious materials contents. (Mixtures containing GGBF slag and fly ash appear sticky but finish well and respond well to vibration energy.)	31, 109, 179, 214
	Lower the vibration energy to avoid segregation.	
	Adjust the mix proportioning.	
Using wood float on air-entrained concrete	Use magnesium or aluminum floats.	

4. Mixture Segregates

Potential Cause(s)	Actions to Consider/Avoid	See Page
Inconsistent concrete material—batching, mixing, placing	Check aggregate gradation; poorly graded mixtures may tend to segregate.	176, 206, 207, 208, 213, 215, 246
	Verify batching/mixing procedures so that the mixture is adequately mixed.	
	Check aggregate stockpile, storage, and loading procedures to prevent aggregate segregation.	
	Place concrete as close to final position as possible to minimize secondary handling.	
	Perform uniformity testing on batch plant, if necessary, use agitator trucks for transport.	
	Reduce the vibration energy if consolidation efforts cause segregation. (Vibration at 5,000–8,000 vpm is sufficient for most well-graded mixtures.)	

5. Excessive Fresh Concrete Temperature

Potential Cause(s)	Actions to Consider/Avoid	See Page
Hot ingredients	Do not add water.	128, 226, 247
	Follow hot-weather concreting practice as appropriate.	
	Chill the mix water or use ice.	
	Shade and sprinkle the aggregate stockpiles.	

(continued on the following page)

Mixture and Placement Issues, continued

5. Excessive Fresh Concrete Temperature, continued

Potential Cause(s)	Actions to Consider/Avoid	See Page
Long haul times	Adjust the hauling operation to minimize haul times.	209
	Adjust paving time to off-peak traffic time if hauling through public traffic.	
Hot weather	Follow hot-weather concreting practice as appropriate.	129, 226, 247
	Chill the mix water; sprinkle the aggregate stockpiles.	
	Pave at night or start paving in afternoon.	

6. Air Content is Too Low or Too High

Potential Cause(s)	Actions to Consider/Avoid	See Page
Temperature changes	The air-entraining admixture dosage may need to be adjusted during hot/cold weather.	186
Materials have changed	Check for uniformity of materials.	
Mix proportions have changed	Altering other admixture dosages may impact the effectiveness of the air-entraining admixture.	176, 180, 246
	Check slump; it is easier to entrain air with increasing concrete workability.	
	Check/monitor the moisture contents of the aggregate stockpiles.	
	Check the batch weigh scales.	
	Verify that aggregate gradations are correct.	
	Verify sand quantity.	
Short or inadequate mixing	Check the charging sequence.	209
	Increase mixing time.	
	Check if the blades of the mixer are missing or dirty.	

7. Variable Air Content/Spacing Factor

Potential Cause(s)	Actions to Consider/Avoid	See Page
Incorrect or incompatible admixture types	Change types or brands of admixtures.	186, 248
	Try to work within one manufacturer's family of admixtures if air-entraining agent is being combined with other admixtures.	
Admixture dosage	Check the batching equipment for calibration and settings.	207, 248
	Change the sequence of batching.	
Mix proportions have varied or changed	Check/monitor the moisture contents of the aggregate stockpiles.	176, 183, 206, 248
	Check the batch weigh scales.	
	Verify that aggregate gradations are correct.	
Cementitious materials	Check for changes in cementitious materials, particularly the loss-on-ignition (LOI) content of fly ash.	34
Poor plant configuration	Introduce aggregates together on the plant's belt feed (requires a multiple weigh hopper).	207
Poor aggregate grading	Use a more well-graded coarse and fine aggregate mixture.	176
	Check variation in the amount of materials retained on the #30 through #100 sieves.	
Temperature changes	Air-entraining admixture dosage may need to be adjusted during hot/cold weather.	56, 133, 247
	Altering other admixture dosages may impact the effectiveness of the air-entraining admixture; air-entraining admixtures work more efficiently with increasing workability.	
Variable mixing	Ensure that each batch is handled consistently in the plant.	207

Mixture and Placement Issues, continued

8. Mix Sets Early

Potential Cause(s)	Actions to Consider/Avoid	See Page
Cementitious materials	Check for changes in the cementitious materials; differing sources or changes in properties of a given material may result in incompatibility; changes in proportions may also affect setting times.	99
Admixture dosage	Check the dosage of chemical admixtures, particularly accelerators.	56, 99, 183, 207, 246
	Check the batching equipment.	
Hot weather	Adjust the mix proportions.	31, 99, 185, 186, 226, 246
	Use mix designs that include GGBF slag or fly ash.	
	Use a retarder.	
	Reduce haul time if possible.	
	Reduce the placement temperature of the concrete.	
	In hot weather, use a hot weather mix design.	
	Cool the concrete ingredients.	

9. Delayed Set

Potential Cause(s)	Actions to Consider/Avoid	See Page
Excessive retarder dosage	Verify the proper batch proportions.	56, 183, 207, 246
	Check the batching equipment.	
	Reduce the dosage of the retarder.	
Excessive water reducer dosage	Verify the proper batch proportions.	56, 183, 207
	Reduce the dosage of the water reducer.	
Retarder not dispersed well	Improve mixing to disperse the retarder.	209
Supplementary cementitious materials interference	Reduce GGBF slag content; GGBF slag in excess of 25 percent can cause a dramatic increase in set time.	31
	Eliminate/reduce fly ash content in the mix.	
Cold placement temperature	Follow cold-weather concreting practices if appropriate.	228
Organic contamination	Verify the proper batch proportions.	39, 52, 207
	Check for contamination of water and aggregates.	

Mixture and Placement Issues, continued

10. Supplier Breakdown, Demand Change, Raw Material Changes

Potential Cause(s)	Actions to Consider/Avoid	See Page
Cement	Refer to backup lab mixes if conditions were anticipated.	28, 171, 211
	Switch sources, batch new mix designs, and develop new laboratory strength gain and maturity information. (This action may require a project delay. To avoid unacceptable delays, a contractual agreement should be arranged prior to paving, which allows for unforeseen material supply changes, burden of delay costs, and risk of paving during batch revision testing. If paving activity is continued during testing, compare early-age strengths (1- and 3-day) and maturity data to confirm that the new mix will perform adequately.)	
Supplementary cementitious materials	See cement supply change.	31
	Switch sources and compare early-age strengths (1- and 3-day) and maturity data to confirm that the mix will perform adequately.	
Aggregates	See cement supply change.	39
	Switch sources and compare early-age strengths (1- and 3-day) and maturity data to confirm that the mix will perform adequately.	
Chemical admixtures	See cement supply change.	55
	Switch admixture sources and compare early-age strengths (1- and 3-day) and maturity data to confirm that the mix will perform adequately.	

Edge and Surface Issues

11. Fiber Balls Appear in Mixture

Potential Cause(s)	Actions to Consider/Avoid	See Page
Fibers not thoroughly dispersed in mix	If added in bags, check the timing of addition and subsequent mixing.	62
	Some mixes do not break down bags as easily as others (i.e., smaller sized rounded coarse aggregate mixes); check compatibility.	
	Use a blower for synthetic fibers or a belt placer for steel fibers instead of bags.	

Edge and Surface Issues, continued

12. Concrete Surface Does Not Close Behind Paving Machine

Potential Cause(s)	Actions to Consider/Avoid	See Page
Insufficient volume contained in the grout box	Place more material in front of the paver; consider using a spreader.	209
The concrete is stiffening in the grout box	Check for premature concrete stiffening (admixture compatibility). (See no. 2: Loss of workability/slump loss/early stiffening.)	97
The fine/coarse aggregate volume or paste volume is too low	Check mixture proportions, particularly aggregate gradations.	171, 176
	Check the uniformity of aggregate materials/supplies.	
The finishing pan angle needs adjustment	Adjust the pan angle.	
The paver speed is too high or vibrators need to be adjusted	Slow the paver.	215, 248
	Lower the vibrator frequencies or use vibrators with greater force.	
	Adjust the location of the vibrators; raise them closer to the surface.	
	Place more material in front of the paver; consider using a spreader.	
	Change the vibrator angle.	

13. Concrete Tears Through Paving Machine

Potential Cause(s)	Actions to Consider/Avoid	See Page
Excessive concrete slump loss	Check for slump loss and mixture or weather changes.	109
	See no. 2: Loss of workability/slump loss/early stiffening.	
Insufficient concrete slump	Check the mixture proportions.	171
Angular fine aggregate (manufactured sand)	Replace a portion of the manufactured sand with natural sand.	39
Paver speed too high	Slow the paver.	
Coarse aggregate is segregated	Check the stockpile.	109, 206
Coarse aggregate is gap-graded	Check the combined aggregate grading.	109, 176
	Blend the aggregate with intermediate aggregates to achieve a uniform combined grading.	

14. Paving Leaves Vibrator Trails

Potential Cause(s)	Actions to Consider/Avoid	See Page
Vibrator frequency too low	Check if the seals on the vibrators are leaking.	248
Vibrator frequency too high	Lower the vibrator frequency.	248
Paver speed too slow	Increase the paver speed.	212
Non-workable concrete mix	Review concrete workability field test data.	109
	See no. 2: Loss of workability/slump loss/early stiffening.	
Over-sanded mixes	Increase the coarse aggregate.	176, 180
Poor combined aggregate grading	Check the combined aggregate grading.	176

Edge and Surface Issues, continued

15. Slab Edge Slump

Potential Cause(s)	Actions to Consider/Avoid	See Page
Poor and/or nonuniform concrete—gap-graded aggregate, high water/cement ratio, etc.	Verify the mix design and batching procedures.	176, 246
	Check the aggregate grading—use a well-graded combined aggregate gradation.	
Inadequate operation of equipment	Check the construction procedures.	212
	Adjust the outside vibrator frequency.	
	Adjust the side form batter.	
Improper equipment setup	Adjust the overbuild.	212
	Check the track speed (same on both sides).	
	Check the pan profile.	

16. Honeycombed Slab Surface or Edges

Potential Cause(s)	Actions to Consider/Avoid	See Page
Hot weather may induce premature stiffening	Follow hot-weather concreting practices if appropriate.	226
	See no. 2: Loss of workability/slump loss/early stiffening.	
Inadequate vibration	Check that all vibrators are working properly, at the right frequency and amplitude; the paver speed should not be too high.	248
	Add an additional vibrator near the slipformed edge.	
Poor workability	Check for changes in the aggregate grading.	176

17. Plastic Shrinkage Cracks (figures 5-30, 5-31, 10-1)

Potential Cause(s)	Actions to Consider/Avoid	See Page
High evaporation rate (excessive loss of moisture from surface of fresh concrete; i.e., evaporation rate > bleed rate)	Apply the curing compound as soon as possible to protect the concrete from loss of moisture.	158, 176, 191, 206, 224, 226
	Use additional curing measures: fogging, evaporation retarder, windbreaks, shading, plastic sheets, or wet coverings.	
	Make sure the absorptive aggregates are kept moist; a dry concrete mixture from concrete aggregates that are not saturated tends to surface dry at mixing. This is problematic if not accounted for.	
	Use a well-graded combined aggregate (gap gradation requires more paste and causes more shrinkage).	
	Refer to hot-weather concreting practices if appropriate.	
	Pave at night.	
	Chill the mixing water.	
	Dampen the subgrade.	
	Avoid paving on hot, windy days.	
	Consider adding fibers to the mix.	
Delayed setting time	Check the time of set.	114

Table 10-2. Problems Observed in the First Days After Placing

Strength

18. Strength Gain is Slow

Potential Cause(s)	Actions to Consider/Avoid	See Page
Cold temperature during/after placement	Heat the mix water.	31, 59, 121, 182, 224, 228, 233
	Use burlap/insulating blankets for protection from freezing.	
	Use an accelerating admixture.	
	Eliminate/reduce GGBF slag and fly ash content in the mix.	
	Increase the cement content.	
	Use a Type III cement.	
	Utilize early-entry sawing to reduce the potential for random cracking.	
	Monitor the slab temperature with maturity sensors.	
Mix proportions or materials have changed	Check/monitor the moisture contents of the aggregate stockpiles.	176, 206, 207, 211
	Check for uniformity of the cementitious materials.	
	Check the batch weigh scales.	
	Verify that aggregate gradations are correct.	
	Verify that batch weights are consistent with the mix design.	

19. Strength is Too Low

Potential Cause(s)	Actions to Consider/Avoid	See Page
Cementitious materials	Check for changes in the cementitious materials.	211
	Check that the correct materials have been loaded into the cement/fly ash/slag silos.	
Water	Check the water content.	181, 206, 207
	Verify the aggregate moisture contents and batch weights.	
Change in sand grading	Check the sand stockpile to see whether the grading has changed.	176
Contamination with organics	Contamination of one of the ingredients with organics can also effect a sudden change in the required dosage of air-entraining admixture; try to isolate the source.	
Inadequate or variable mixing	Examine the mixer and mixing procedures.	207, 208
	Check for worn mixer blades.	
	Check for mixer overloading.	
	Batch smaller loads.	
	Check the sequencing of batching.	
	Check for mixing time consistency.	
	Conduct batch plant uniformity testing.	
Plant operations	Verify the acceptability of the batching and mixing process.	207, 208
	Check for adequate mixing times.	
	Check if water was added to the truck.	
Testing procedures	Verify proper making, curing, handling, and testing of strength specimens. (Flexural strength specimens are particularly vulnerable to poor handling and testing procedures.)	263
	Verify the machine acceptability testing.	
	Test the cores sampled from the pavement to verify acceptance.	
Air-void clustering	Use a vinsol resin-based air-entraining admixture.	100, 209
	Avoid retempering.	
	Increase the mixing time.	

Cracking

20. Early-Age Cracking (figures 5-32, 5-33, 5-34, 5-35, and 10-1)

Potential Cause(s)	Actions to Consider/Avoid	See Page
Concrete mixture	Check the combined aggregate grading.	31, 39, 55, 88, 97, 148, 176, 228, 235
	Examine the fine aggregates; fine aggregates may be too fine and angularity may cause harsh finishing (i.e., manufactured sands).	
	Reduce the paste content (minimize shrinkage potential).	
	Materials incompatibility may lead to delayed set and/or higher concrete shrinkage; consider mixture component adjustments.	
	Eliminate or reduce the content of fly ash or GGBF slag in cool-weather conditions.	
	Consider using an accelerator in cold weather.	
Sawing	Saw as early as possible but avoid excessive raveling.	231, 233
	Saw in the direction of the wind.	
	Check that the diamond saw blade is appropriate for concrete aggregate hardness, fines, etc.	
	Use early-entry dry sawing.	
	Use HIPERPAV to model stress versus strength gain for conditions to determine the optimum sawing time.	
Curing	Improve/extend curing.	224
	Apply the curing compound at a higher rate.	
	Apply the curing compound sooner.	
	Use blankets between placing and saw-cutting.	
Insufficient joint depth	Check the saws for depth setting.	231, 233
	Check the saw blade for wear (carbide blades).	
	Check that saw operators are not pushing saws too fast, causing them to ride up.	
	Look for base bonding or mortar penetration into the open-graded base-altered effective section; increase the saw depth to create an effective weakened plane.	
	Check the slab thickness.	
Excessive joint spacing	Reduce spacing between the joints.	
	Slabs are too wide in relation to thickness and length; add intermediate joints.	
	Maintain a reasonable length-width ratio.	
Warping (slab curvature due to moisture gradient; the term "curling," however, is commonly used in the industry to cover both moisture- and temperature-related slab distortion)	Check the moisture state of base.	150, 224
	Improve or extend curing.	
	Minimize the shrinkage potential of the concrete mixture.	
	Cover the slab, particularly when night/day temperatures vary widely.	

(continued on the following page)