IRMCA Pervious Concrete - *Key Points*:

MOISTURE LOSS DURING OR AFTER PLACEMENT MUST BE HELD TO A BARE MINIMUM.
It is *HIGHLY RECOMMENDED* to take all measures possible to eliminate moisture loss.
Rapid unloading, placement, and finishing are needed to minimize evaporation

"OFF THE SHELF" MIX DESIGN (1 CUYD):

Portland Cement:

- ✓ 400 to 520 lbs. including Pozzolans (500 cementitious is a good start)
  Note: successful placement has been done with total cementitious as low as 400 lbs.

Water:

- ✓ .28 to .40 water/cement ratio
- ✓ .32 works well
- ✓ .28 (usually requires use of slag) - *watch moisture loss even more closely due to low W/C ratio!!!!*
- ✓ Local aggregates will determine further adjustments in cement content. (We usually adjust in 20# increments.)

Supplementary Cementitious:

- ✓ Fly Ash amounts above 50 - 60 lbs/CuYd seem to make mix sticky.
- ✓ Slag produces a brighter finished product
- ✓ Fly-Ash works well.
- ✓ Extend curing time when using these, especially in cold temperatures
- ✓ Mixes with Slag and Ash work well, and are very "Green"

Aggregate:

- ✓ 3/8" max. rock or gravel with 'good gradation', and min of 9% passing #4 sieve.
- ✓ One cubic yard of coarse aggregate. Measure the Dry Rodded Unit Weight of One Cubic Foot & multiply by 27.
  - Approx 2500 – 2850lbs, (Depending on Spec. Gravity & gradation)
  - Get a gradation sieve analysis done to help evaluate which local material is best suited for pervious. "Enough" voids and at least 9% passing the #4 sieve.
- ✓ Generally, a smaller aggregate makes stronger and more attractive mix.
- ✓ Crushed limestone requires more effort to compact, & leaves a more open surface.
- ✓ Rounded gravels require less effort to compact.

Sand:

- ✓ Minimum of 150 to 200 lbs of 'Sand' (material passing the #4 sieve) within the coarse aggregate gradation.
- ✓ 'Sand' is defined as material passing the #4 sieve.

- ✓ Your local pea-gravel may already have enough 'Sand' naturally. If not, add enough material to have a total amount below the #4 sieve equal to 150 – 200 lbs. (Adding such a low amount of sand can make batching slow and inaccurate.) Per Iowa State University studies, this amount of material passing the #4 sieve, provides more strength, and freeze/thaw durability. We've seen a big improvement in unloading and in appearance, with just a slight reduction in porosity (We still have more than required)
- ✓ Be careful of having too much material below the #4, as porosity and compression may suffer.

Air Entrainment:

- ✓ We have not used A/E in our placements in Indiana, and have seen no F/T damage in 6 years.
- ✓ Some authorities recommend using A/E, but admit that they cannot find any bubbles under a microscope, or prove it is there.
- ✓ The use of Fly Ash provides more protection to freeze thaw damage in ASTM C-666 testing than does the use of Air Entrainment. (ISU data).

Admixtures:

*******We do NOT recommend making Pervious Concrete without Hydration Stabilizing Admixture!*******

- ✓ 5-8 oz midrange water reducer/Cwt of total cementitious.
- ✓ 7+ oz. Hydration Stabilizing Admixture (HSA)/Cwt of total cementitious at 60 degrees ambient air temperature. Increase dosage as temps increase, or when hot water is used.
  HSA: Delvo(Degussa), Recover(Grace), WashOut(Euclid), Stop Set(Axim)
- ✓ Don't lower dosage of HSA if hot water is used in cold weather.
- ✓ ***Cold weather – Test, and increase dosage of HSA when using HOT WATER!!***
  Use more with higher temps or longer hauls. We have used as much as 18oz./Cwt when ambient air temperatures are in the 80's and 90's. Strength gain for form removal may take longer at these dosages.
- ✓ Add HSA with the initial mix water. If you don't have HAS in your computerized admixture system, we recommend dumping the proper dosage of HSA into buckets for driver to dispense into truck prior to pulling under the plant.

Fiber:

- ✓ ½ to 1&1/2 lb of ¾" Monofilament Fibers added to empty drum prior to batching.
- ✓ **Do not add dissolvable bags to load**, they will not dissolve completely, and fibers will ball, marring the slab surface.

TRUCKS:

- ✓ Trucks with dual cylinders on chutes unload better than those with single cylinders
- ✓ Trucks that unload slip-form curb mixes will unload pervious concrete well.
- ✓ Trucks with Clean fins are a must for proper mixing.

- ✓ Advise drivers to dump ***all*** water from drums before loading.
- ✓ Consider tape over the Slump Meters for pervious projects.
- ✓ Mark water levels on sight tubes after loading; drivers should wash fins with as little as possible after loading.

BATCHING: **Note: It is better to error on the dry side, when *Batching* pervious concrete.**

- ✓ Load first truck early to allow moisture testing & adjustments
- ✓ Batch ½ of first load of pervious each day
- ✓ Have QC technician test for moisture, and adjust the 2nd ½ of 1st truck
- ✓ Re-test and adjust subsequent loads accordingly.
- ✓ Monitor coarse aggregate for moisture changes, it is much more critical than with normal concrete.
- ✓ Advise drivers to wash down with as little water as possible, and then have QC test at the plant after 70-100 revolutions.
- ✓ Communication between truck on the job and plant is critical to allow proper adjustment of water content at the plant.
- ✓ Communication truck to truck can lead to discussions of slump meter readings, and mistakes. Suggestion → cover the slump meters in the cab.
- ✓ Advise drivers not to add water unless instructed by QC at plant, or by QC or Contractor on the site. Document all water on tickets!
  - → **TELL DRIVER TO IGNORE SLUMP METER!!!**
  - → Drivers are not to discuss how much water each added to their load, as the field will be adjusting with both Hydration Stabilizer and water. Each truck may not have the same amount to start with.
  - → One half gallon per yard, or Four gallons per truck is enough to make the load too wet!

JUDGING WATER CONTENT:

- ✓ Look for oily or metallic sheen on paste.
  (Polarized lenses will filter out sheen, take them off when placing)
- ✓ No sheen = Too dry. Add water at ½ gallon per yard increments and remix material in truck
- ✓ Sheen present = good
- ✓ Grab a handful with a dry hand, squeeze it & release with hand perpendicular to ground, (as if shaking hands)
  - If a scattering of aggregate and paste is stuck to your hand, its good to go!
  - If no aggregate is stuck to your hand, it is still too dry. Add water as above.
  - If your hand has a mass of paste stuck to fingers, the mix is too wet. You may be able to "Dry Up" a load that is a little too wet by putting the truck in full charge to create friction. If the mix is way too wet, you may be able to "Dry Up" with a Viscosity Modifying Admixture (VMA) ½ to 1 gal per yard,

or Microsilica/Silica Fume, but MIX WELL, moving concrete up & down Drum to get full incorporation. Please test the use of VMA, Silica, etc.. in a trial if you want to have this as an option.

- ✓ **TELL DRIVER TO IGNORE SLUMP METER!!!**
- ✓ The Contractor ***will re-test on site and adjust*** as necessary using the above method.
- ✓ Pervious concrete will usually not come down more than just a flop-over chute, and one additional chute.
- ✓ Plan placements with one chute maximum reach and the trucks must drive down between, or straddling, the forms.
- ✓ You can also use a conveyor, to place the material.
- ✓ Pervious may be buggied, but take steps to avoid segregation. And paste 'drain-down'.
- ✓ Pervious concrete is not pumpable.

PLACE AND FINISH PERVIOUS CONCRETE THAT SHINES

Note: It is better to error on the WET side, when ***Placing*** pervious concrete.

- ✓ *PLACE A LITTLE WET* – When a low cementitious content mix is used, it is better to error on the side of a little wet, than a little dry, when ***placing*** pervious concrete.
- ✓ Mixes with a high cementitious content have a tendency self-seal when placed too wet, so folks often err on the dry side.
- ✓ Pervious concrete placed without any sheen will not allow the paste to glue the aggregates together. We look for a 'bridge of paste between the aggregates. If there is not a 'bridge', then the aggregates are not well glued together, and strength and durability suffer.
- ✓ If at any time the sheen starts to go away, stop manipulating the material on the ground and cover it.
- ✓ Once the paste loses its viscosity and gets dry, any movement of the material will break the bonds between aggregates, and they will not re-bond when the paste has dried.
- ✓ When the sheen is gone, add water to the material in the truck to regain the workability & sheen, if possible.
- ✓ Any material in the chute, or on the ground that has not been finished, should be removed and discarded.

PLACEMENT:

- ✓ **The time it takes for placement until plastic is applied, should be less than 20 minutes.**
- ✓ **All possible efforts should be taken to eliminate loss of moisture from the material.**
- ✓ **A speedy placement is key in this regard.** ***FASTER PLACEMENT EQUALS LESS MOISTURE LOSS.***
- ✓ **Proper 'Hot Weather Concrete' practices are of utmost importance with Pervious Concrete.**
- ✓ **Moistening of subgrade is mandatory.**
- ✓ **Misting of air above slab will greatly reduce evaporation.**
- ✓ We recommend using a weighted hydraulic roller to place pervious concrete. (Bunyan Roller Screed) This type of roller often allows the contractor, contingent upon on trial placements with a particular mix, to eliminate the use of shims. It also allows the combination of strike-off and compression steps. This results in faster placement, and ***FASTER PLACEMENT EQUALS LESS MOISTURE LOSS.***
- ✓ Whatever method of placement is used, trial placements with a particular mix design, and placement method, are critical to prevent problems in the field. Any change in mix design or placement method can make large differences in how the material looks, as well as other properties that affect the finished product.
- ✓ Variations in aggregate size from the quarry can require different thickness shims be used. You may want to have 5 different thickness shims on hand to deal with this when using a static roller.
- ✓ Place, strike-off material above finish grade using shims, (if using a static roller), OR;
- ✓ Place, & strike-off material with about a 1 ½" – 2" 'head' of concrete in front of the weighted Hydraulic Roller, (if using a Bunyan roller),
- ✓ Fill in open areas, tamp the edges, re-roll to compress and flatten, roll in the joints, spray the soybean sealer & then cover with minimum 6 mil. Plastic for 7 days or longer.
- ✓ Cross rolling of the pervious removes ridges left by the big roller and other surface bumps or loose material and may be done either before the plastic is placed, or afterward. We suggest to cross roll after the plastic is down. It is faster, thus reducing time for evaporation to occur, ***FASTER PLACEMENT EQUALS LESS MOISTURE LOSS,*** and doesn't allow the cross roller to pick up material from the surface.
- ✓ Spray water onto the plastic to help keep it down and to allow the cross-roller to be adjusted without marring the surface.
- ✓ Do not use trowels or bullfloats to finish pervious concrete.

JOINTS AND EDGING

- ✓ **Cutting of Joints should be done with a "pizza cutter" roller.**
- ✓ The joint roller should have a cutting fin like a pizza cutter. This fin should be ½" thick at the roller, have a radius profile on both sides, and taper to a thin edge. The thickness and radius profile creates a joint that has radius edges in the previous, and also densifies the top edges of the pervious joint. Rolling in the joints with a roller makes more durable joints than sawed joints. This also seems to be the fastest way to install joints. ***FASTER PLACEMENT EQUALS LESS MOISTURE LOSS.***
- ✓ Roller cutting of the joint should only be done when the pervious is still shiny. Rolling joints in pervious concrete that looks dry will cause joint raveling.
- ✓ *ANY* manipulation of pervious concrete when mortar is dry will result in a weaker bond, and less durability.
- ✓ If the shine is gone and joints are not yet cut, come back the next day and saw cut the joints. Cutting joints with a saw requires protection of surface from dust. Any dust allowed onto surface should be removed immediately. The dust still has cementitious properties and will make joints unsightly.
- ✓ ***Edging is discouraged*** because it may prolong the placement sequence and delay covering with plastic. Edging of pervious concrete also may destroy the mortar bond between aggregates if done when mortar is even a little dry. It also can delay the application of the plastic, leading to moisture loss from surface.
- ✓ *If* it is performed when the paste is no longer workable, edging may destroy the paste bonds of the aggregate at the edge, leading to raveled edges, and a poor appearance.

CURING

- ✓ We highly recommend that contractors cut and pre-roll their plastic onto a 6 inch PVC pipe.
  - o Cut the plastic wide enough to overlap the edges of the pervious placement, then attach one end to pipe and roll it up.
  - o Tape or glue the overlapping edges so that the plastic is one piece that will cover the entire slab being placed with no openings present that would allow moisture to leak out or air to flow through. Air flowing under the plastic ***WILL*** dry out the surface, and ***WILL*** result in a less durable surface.
  - o ***Secure the plastic*** with button-cap nails, or by nailing shims onto forms to secure plastic.
  - o Use rebar placed across the width of placement to help maintain plastic in place for a minimum of seven days → ***longer if slag or ash is used, and in cold weather.***
- ✓ Plastic must remain in place for a minimum of seven days to allow proper curing.
- ✓ Extend curing time when using slag or fly-ash, or in cold weather.

- ✓ Proper Curing also requires maintaining proper **temperatures** for a minimum of seven days.
- ✓ The Bean* Soybean oil acts as a secondary sealer in case plastic is removed. It also eliminates or vastly reduces the visqueen/plastic marking of the surface. It may also promote the colonization of the microbes that colonize the pervious concrete system and eat the oil & grease from cars.

Note:
Do ***NOT*** use the Bean oil if you are going to STAIN the concrete. It will not allow the stain to penetrate the paste.
If you are going to stain the pervious concrete, use plastic pulled tight, or burlene, to reduce visqueen marking.

The Bean oil, (& microbes), may be ordered on line at: www.c2products.com
Bunyan Roller available at www.bunyanusa.com
Certified Pervious Contractors & Producers list at: www.irmca.com/installers/index.asp