Pavement Systems: Constructing, Maintaining and Inspecting

SMCWPPP

Annual C.3 Stormwater Workshop

City of San Mateo

June 14, 2016

Peter Schultze-Allen, EOA

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Presentation Overview

- Construction
- Maintenance
- Inspection

Slides courtesy of:

David Smith	- ICPI
Russell Snyder	- CalAPA
Mike Marhenke	- Calstone
Paul Hathaway	- Pacific Interlock Pavingstone
David Liguori	- Bay Area Pervious Concrete

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Construction

Pre-construction Meeting

Participants:

- Owner's rep, GC, pavement installer, suppliers, testing lab(s)

Meeting Checklist:

- Walk through site with builder/contractor/subcontractor
- Review erosion & sediment control plan and SWPPP
- Determine time of pavement installation in construction sequence
- Identify material stockpile locations
- Protect finished surface from contamination
- Locate elevation & size of underdrains
- Discuss need and delivery location for supplemental maintenance pavers

Sediment Management

No

- Stabilization of soil in area draining into pavement
- Min. 20 ft (6 m) wide vegetative strips recommended

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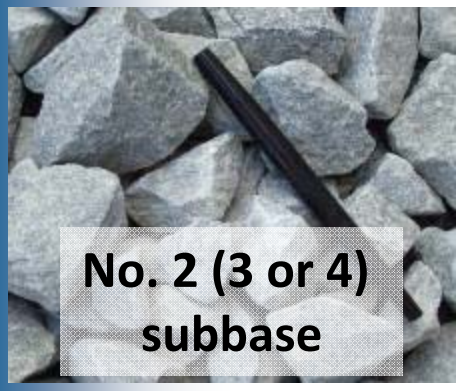
Verify Materials Delivered to the Site

Aggregates

- Sieve analyses for subbase, base, bedding, and jointing aggregates conforms to specifications
- Decide consistent sampling & testing for delivered materials
- NO SAND for bedding or joints

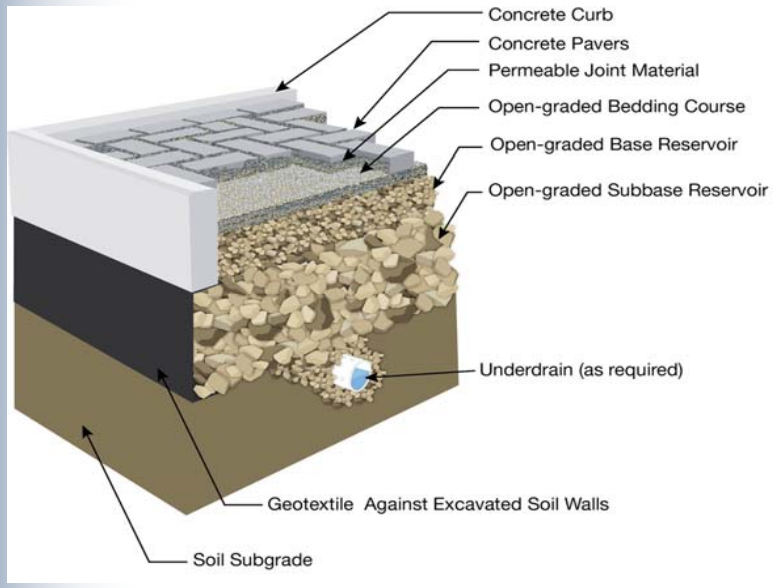
Other materials meet specs

- Pavers
- Edge restraints
- Geotextile/Geomembrane



Underdrains

- **Ensure size, perforations, locations, slope & outfalls meet specs & drawings**
- **Verify elevation of overflow pipes**



Permeable Interlocking Concrete Pavers (PICP) and Permeable Pavers (water flows through paver)

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Mechanical Paver Installation

Same inspection acceptance criteria as manual installation

For larger commercial projects

Efficiency factors:

- **Configuration/width**
- **Site access/flow of materials**
- **Crew experience**
- **Paver laying pattern**
- **Must be in bid**

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Pervious Concrete (poured in place)

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Porous Asphalt (poured in place)

Porous Asphalt

CalAPA

Porous asphalt parking lot under construction in West Sacramento 2014

Porous Asphalt

Top surface (left) and subgrade.

Porous Asphalt

City of Elk Grove porous pavements demonstration fountain 2012.

Inspection at Completion of Construction

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Test Infiltration Rate

- **Test surface for infiltration rate per specifications using ASTM C1781 – establish base rate**
- **Minimum 100 in./hr (254 cm/hr) recommended**


1
2
ASTM C1781
3
4

Other Inspection Items

- Check the depth of the underdrain outlet
- Check the joint aggregate type and size
- Clean pavers/pavement surface
- Use the Inspection Checklist from ICPI
- Look for broken pavers, uneven surfaces

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Maintenance

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Pavement Condition and Maintenance

Hydrologic Conditions

- Surface infiltration rate and drainage outfalls

Structural Conditions

- Depression
- Rutting
- Faulting
- Damaged Pavers
- Edge Restraint Damage
- Excessive Joint Width
- Joint Filler Loss
- Horizontal Creep

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Hydrologic: Inspecting Surface Clogging

Inspect 1 to 2 times annually preferably after a storm

Inspect and document:

- **General site features and distresses with photographs, etc.**
- **Obvious sources and locations of sediment (usually at entrances)**
- **Changes in adjacent land use that might contribute sediment**
- **Vegetation around perimeter for cover and soil stability**

Hydrologic: Inspecting Surface Clogging

Inspecting and Documenting…

- **Surface openings for buildup of sediment in joints**
- **Ponds over 10% of the area remaining longer than 1 hour after a rainstorm:**

measure permeability of the surface using:

ASTM C1781 *Standard Test Method for Surface Infiltration Rate of Permeable Pavement Systems*

Ponding & settlement at entrance - common hydrologic & structural distress location

Hydrologic: Sweeper Effectiveness

Mechanical Sweeper
Least effective

Most effective

Regenerative air vacuum sweeper - for routine maintenance

- **Use 1-2 times/year**

True vacuum sweeper

- **Very powerful**
- **For restorative maintenance - Restores highly clogged surfaces**

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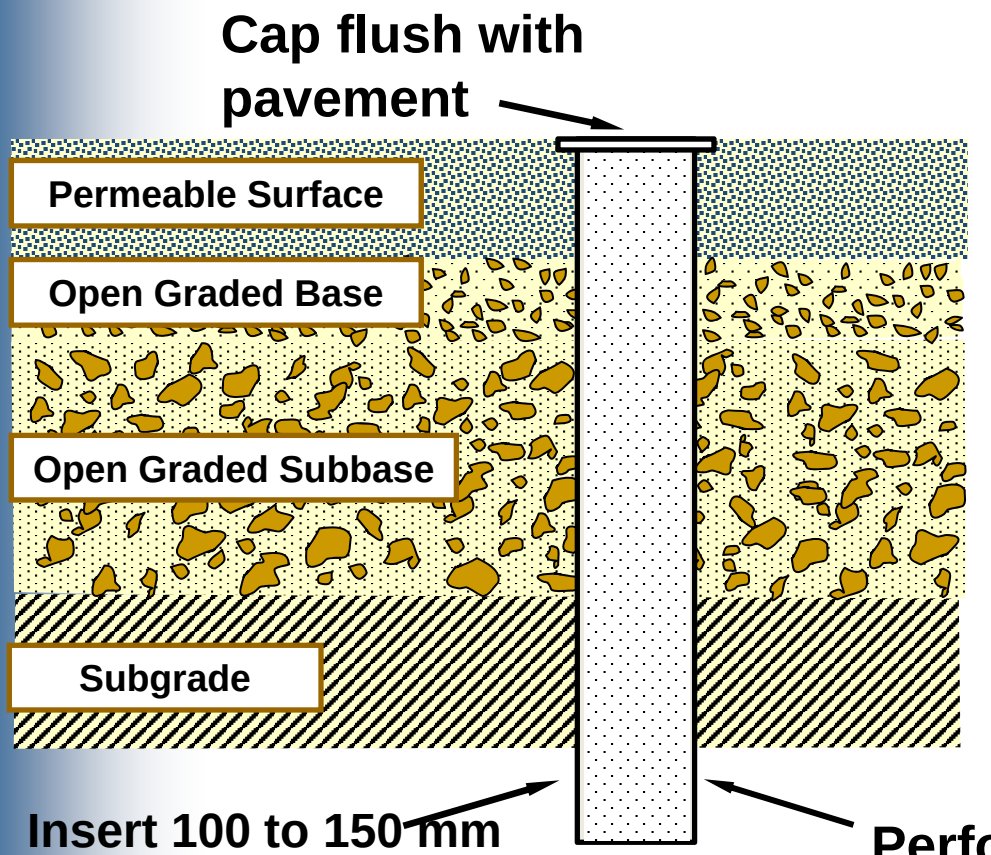
Hydrologic: Subsurface Observation Well



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Structural: Depression

- Settlement of underlying subgrade or granular base

- Most common over utility cuts, catch basins and adjacent to other roadway types

Low severity depression

Medium severity depression

High severity depression

- **Areas exhibiting medium and high severity depressions exceeding 0.5 in. should be repaired**

Structural: Rutting

- A surface depression in the wheel path

- Typically caused by settlement of the underlying subgrade or reservoir base under vehicle loading

Low severity rutting

Medium severity rutting

High severity rutting

- **Medium and high severity rutting (rut depth > 0.6 in.) should be repaired**

Structural: Faulting

- Elevation of small areas of surface that differs or rotated to that of adjacent pavers (a.k.a. lipping)

- Caused by settlement of bedding, poor installation/compaction

Low severity faulting

Medium severity faulting

High severity faulting

- **Areas exhibiting medium and high severity faulting (maximum difference in height exceeding 0.25 in.) should be repaired to ensure smooth ride quality**

Structural: Damaged Pavers

- Typically caused by load related damage, i.e., inadequate support resulting in shear damage, lack of jointing stone, substandard materials, or cutting away more than 2/3 of paver.

Low severity damaged pavers

Medium severity damaged pavers

High severity damaged pavers

- **Medium and high severity damaged pavers should be removed and replaced to maintain the pavement structural load capacity**

Structural: Paver Repair

- Remove all cracked pavers and replace with new pavers
- Remove individual pavers with hand removal equipment to prevent damage to surrounding pavers
- Order and store extra pavers on-site for future maintenance

Paver removal equipment

Structural: Edge Restraint Damage

- Edge restraints (typically curbs) provide lateral support

Loss of lateral support due to edge restraint damage can result in movement/rotation of the pavers, loss of jointing and bedding course stone

Low severity loss of edge support

Medium severity loss of edge support

High severity loss of edge restraint

- **All medium and high severity loss of edge restraint should be repaired/replaced**

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Structural: Excessive Joint Width

- Caused by poor initial construction, lack of joint filler, poor edge restraint, adjacent settlement/heave, etc.

Low severity excessive joint width

Medium severity excessive joint width

High severity excessive joint width

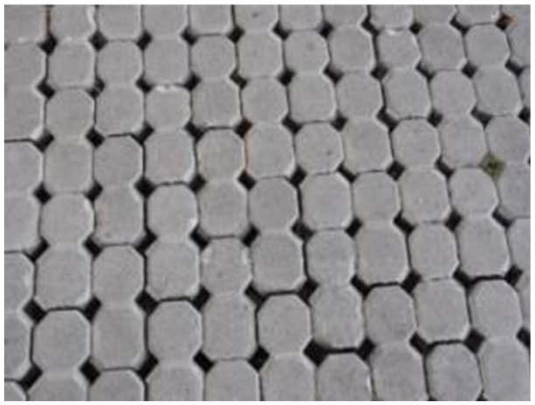
Pavers exhibiting medium and high excessive joint width should be removed and re-set, compacted, jointing stone applied and compacted

Structural: Joint Stone Loss

- Caused by settlement, excessive vacuum force during cleaning, pressure washing, and excessive traffic loads

Low severity joint filler loss

Medium severity joint filler loss



High severity joint filler loss

- **Joint filler should be reinstated in all joints exhibiting medium and high severity loss**

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Structural: Joint Filler Replacement

- **Replenish jointing material 6 months after construction and yearly as needed**

Structural: Horizontal Creep

- **Longitudinal displacement of the pavers caused by wheel loading (turning, braking, accelerating)**

Low severity horizontal creep

Medium severity horizontal creep

High severity horizontal creep

- **Relevel base and Replace**

Suggested Maintenance Practices Hydro-Flo Pavingstones

- Sweep by either brush or vacuum systems. Cleaning intervals depend on traffic type, traffic frequency and environmental factors.
- Annual pressure wash at 1200-1500 psi pressure washer with steam or hot water for better results. Best results with a wet vacuum system in conjunction with pressure washing.
- Use fan tip spray nozzle, at 30 degree angle, 14 to 16 inches from the paver and working at a 45 degree angle from the dominant pattern. Solvents or cleaners are not required or recommended.

Bay Area Pervious Concrete

Most debris, like sand and organic matter are permeable and the system will still function if not cleaned, but at a reduced rate.

Leaf blowers have proven to be highly effective and the only maintenance necessary in many small to medium size applications

Vacuum trucks for larger areas

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Bay Area Pervious Concrete

ASTM C1701
Infiltration Rate

250” /hr min recommended

Run baseline test before pavement goes into service.

Repeat every 6-12 months. Re-evaluate maintenance routine

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Inspection and Monitoring Plan

Distress	Activity	Frequency
Clogging	Vacuum sweep surface to remove sediment.	Annually (unless increase in sediment loading)
Clogged/Damaged Secondary Features	Clean out or repair secondary drainage features.	Annually, after major rain event
Depressions	Repair all paver surface depressions, exceeding 0.5 in.	Annually, repair as needed
Rutting	Repair all paver surface rutting, exceeding 0.6 in.	Annually, repair as needed
Faulting	Repair all paver surface faulting, exceeding 0.25in.	Annually, repair as needed

Inspection and Monitoring Plan, cont.

Distress	Activity	Frequency
Damaged Paver Units	Replace medium to high severity cracked, spalled or chipped paver units.	Annually, repair as needed
Edge Restraint Damage	Repair pavers offset by more than 0.25 in. from adjacent units or curbs, inlets, etc.	Annually, repair as needed
Excessive Joint Width	Repair pavers exhibiting joint width exceeding 0.4 in.	Annually, repair as needed
Joint Filler Loss	Replenish aggregate in joints.	As needed
Horizontal Creep	Repair areas exhibiting horizontal creep exceeding 0.4 in.	Annually, repair as needed
Additional Distresses	Missing pavers shall be replaced. A geotechnical investigation is recommended for pavement heaves.	Annually, repair as needed

SMCWPPP Resources

1. Inspection checklists
2. O&M plans for pervious pavements
3. Guidance for pervious pavements (C3TG)

See the program website for more details:
www.flowstobay.org/privatend
www.flowstobay.org/newdevelopment

The handouts & presentations will be posted on:
www.flowstobay.org/trainings

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