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Building Contoured Pavements With Precast Concrete Pavement Slabs

***International Conference on
Concrete Pavements***

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The Fort Miller Co., Inc.



Prevailing Approach To Precast Pavement Panel Design

- Concentrate on structural aspects of precast panels
 - Load transfer devices
 - Panel reinforcement (mild steel or pre-stress)
 - Bedding techniques
- Use single-plane (flat panels) in all cases
- Grind top surface to make it smooth

Reality

- Flat panels work in a majority of locations
 - Even in “mildly-contoured” locations
- Some “more severely contoured” locations preclude the use of flat panels
 - The purpose of this paper – to show and demonstrate how “significantly-contoured” some pavement surfaces really are

The Advantages of Using Flat (Single-Plane) Panels

- Forming is simple
- May be manufactured on long-line beds and prestressed
- May be used in “slightly contoured” locations
 - Tops may be ground smooth (within limits)
- Geometric design is simple
 - Potentially fewer mark numbers – more standard sizes

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Frustrating Aspect – You Can't Visually Perceive "Significantly-Contoured Surfaces"

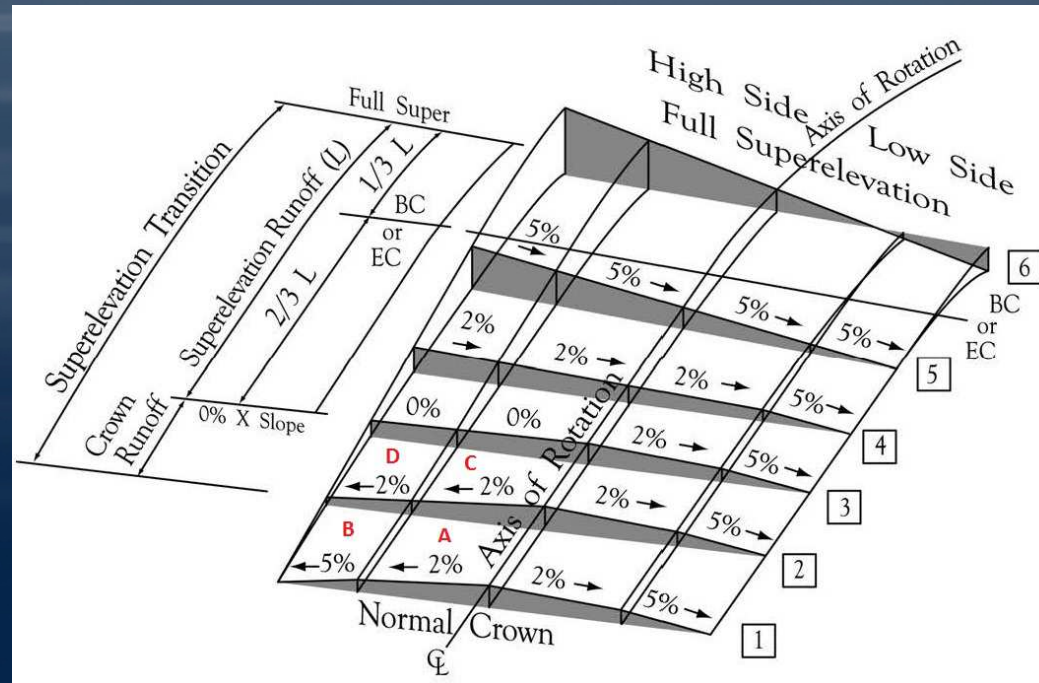


I-15, Ontario, CA



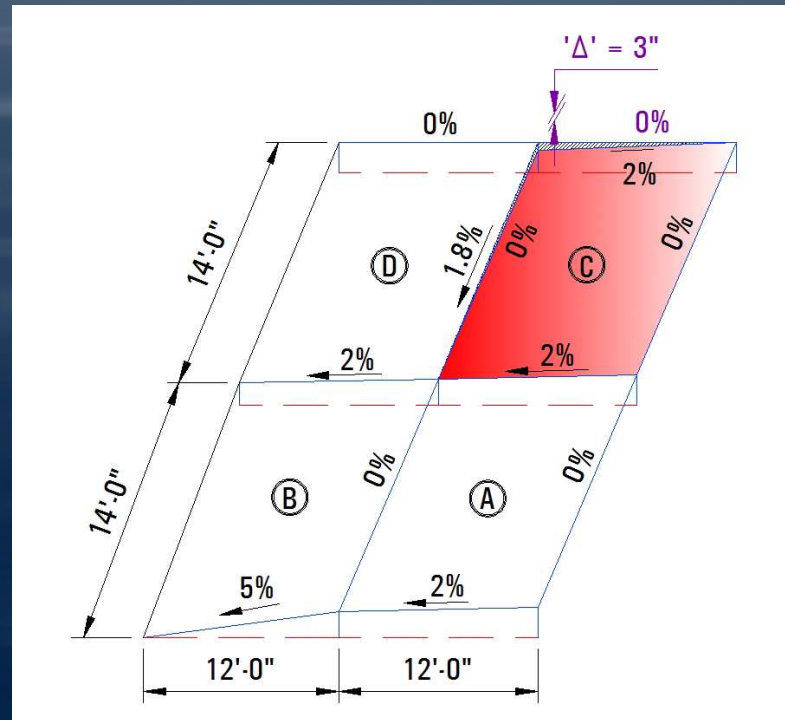
Ramp 9-A to Broadway
Tarrytown, NY

Interstate Super Elevation Transitions



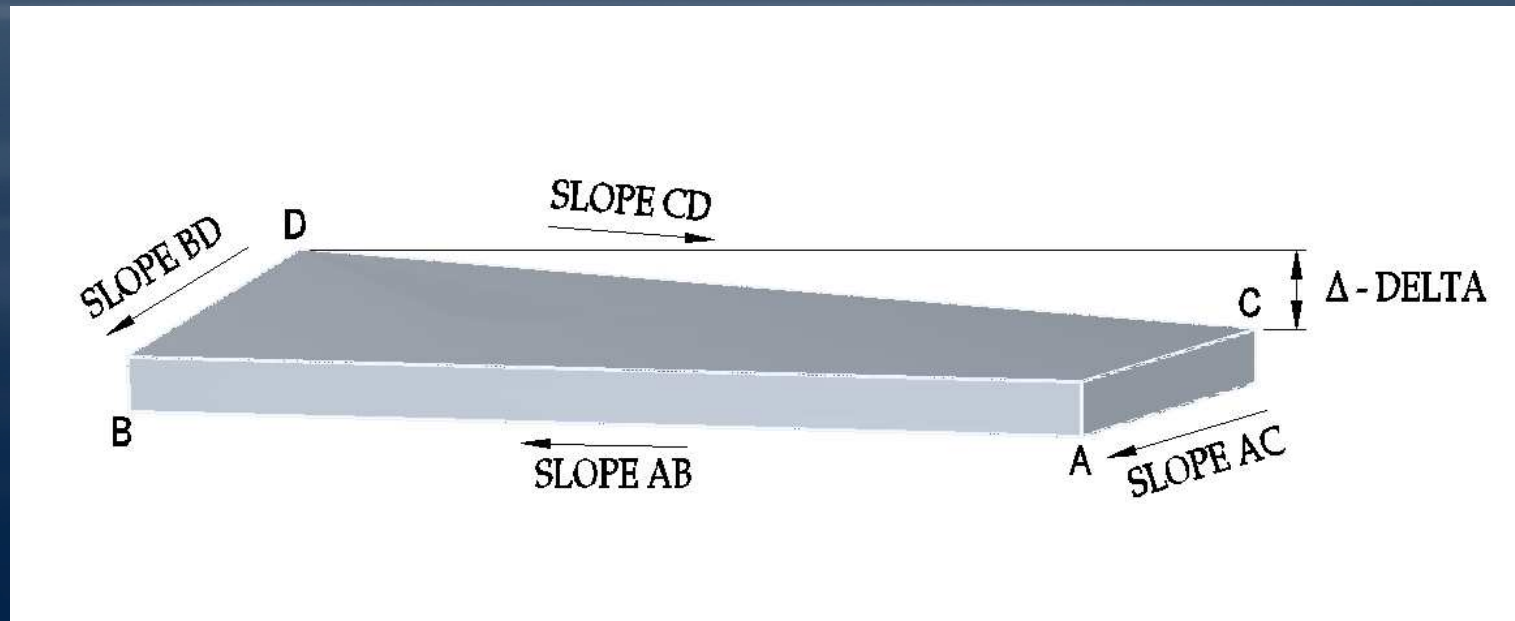
Elements of a Super Elevation Transition
(CALTRANS highway Design Manual)

Close-Up View of Panels A, B, C, D



Flat Panel "C" Would Be 3 Inches Out-of-Plane

What's Needed For Panel "C"



Warped Panel – Differing Slopes on Opposite Sides

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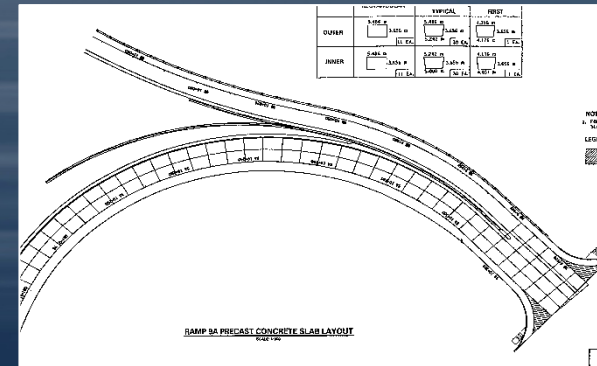
Horizontally-Curved Roadways on Grades



Chicago, Illinois



Brooklyn, NY

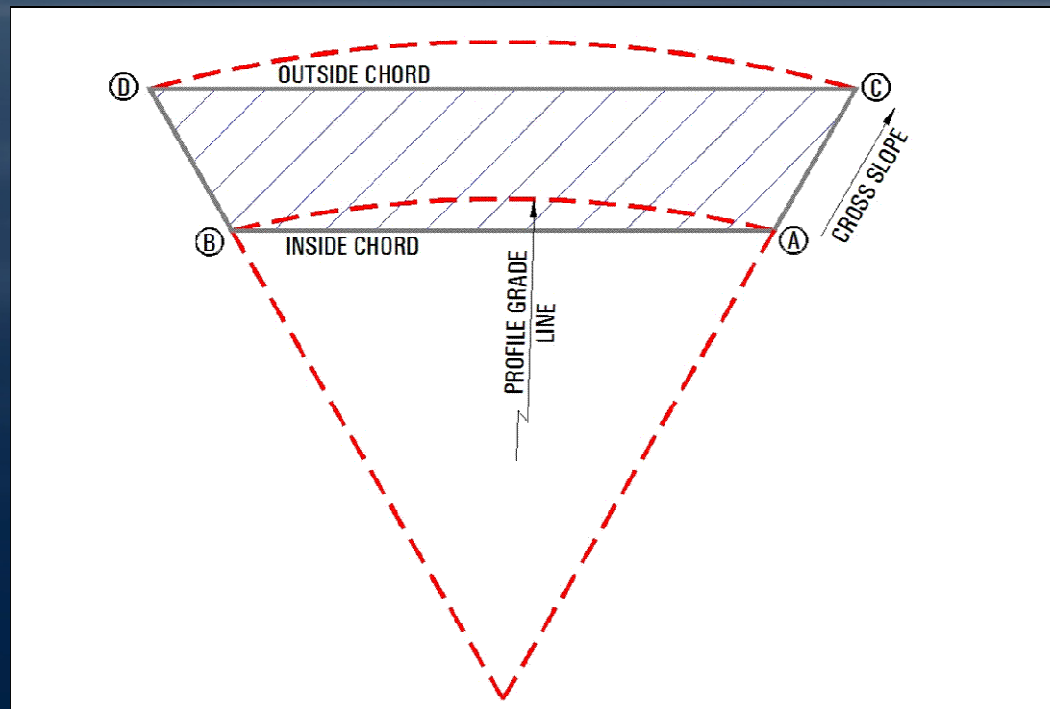


Plan View



Tarrytown, NY

Exaggerated Plan View



Plan View

- Difference in elevation A-B = difference in elev. C-D
- Same difference over two chords of unequal length
- Slope A-B not equal to slope C-D
- Panel is warped

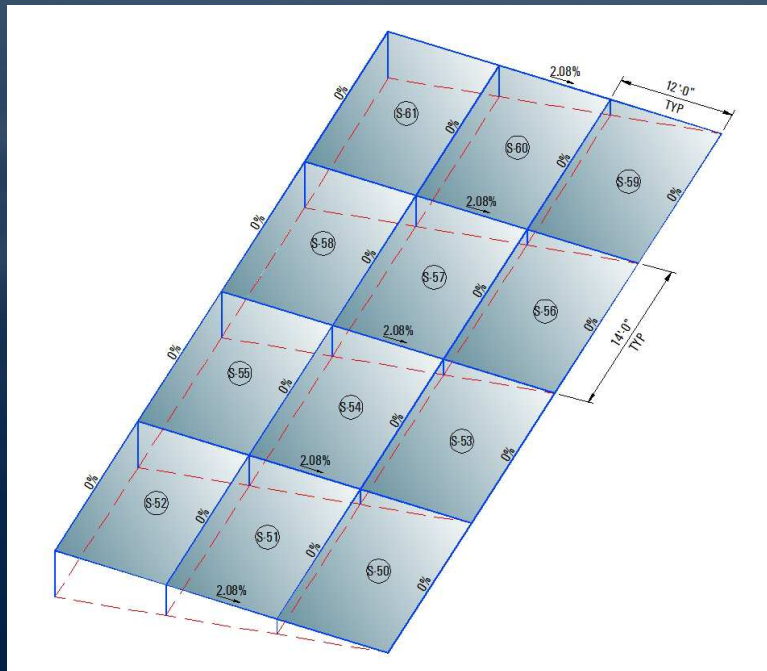
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Warped Surfaces On I-15, Ontario, CA

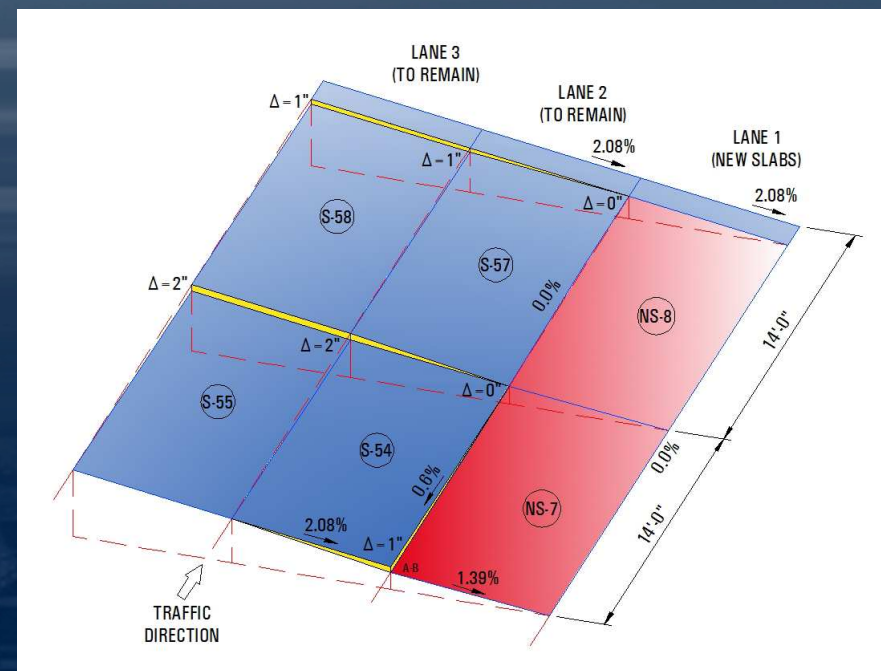


730 Panels – 25% Warped (some as much as 2 Inches)
Visually Imperceptible

As Built vs. Present Condition



As Built (40 Years Ago)



Present Condition

Contoured Intersection Pavement

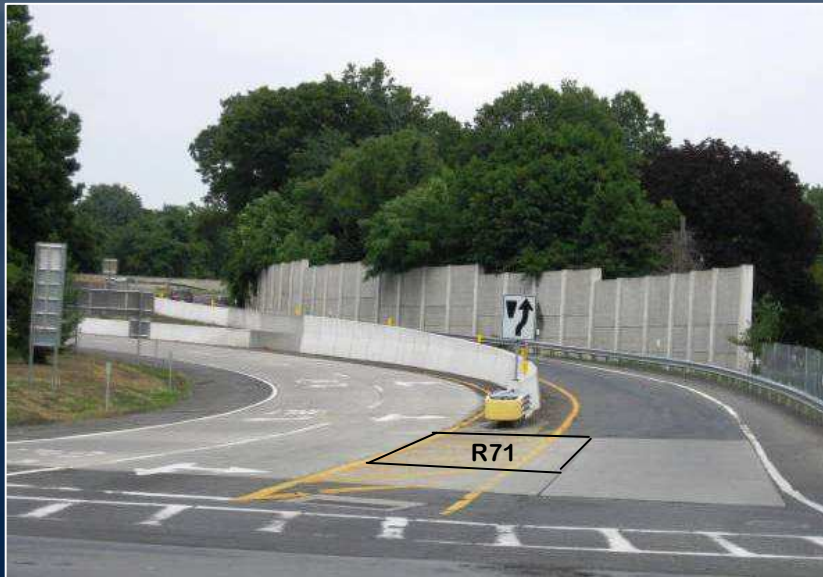


- You can't see warps
- 180 precast panels, 12' wide x 16' long
- 34% (61) warped panels
- Warps varied from $\frac{1}{4}$ " to 2- $\frac{5}{8}$ "

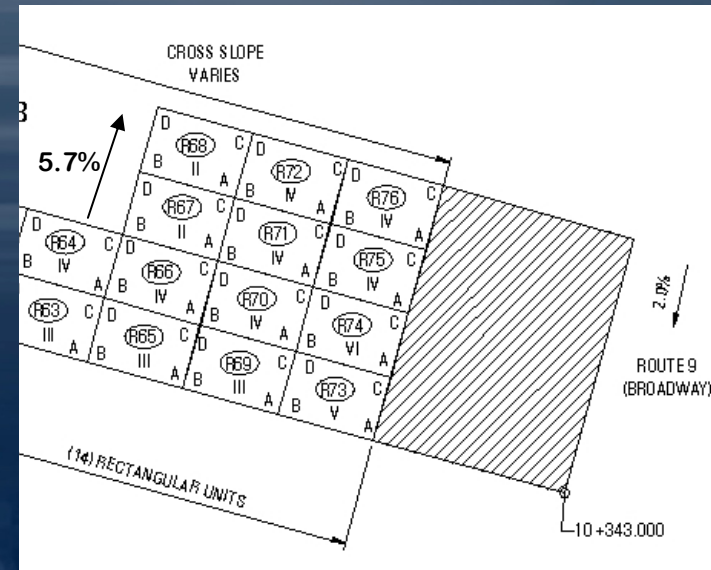
Rt. 7 Cross Town Arterial,
Rotterdam, NY

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Ramp Termini

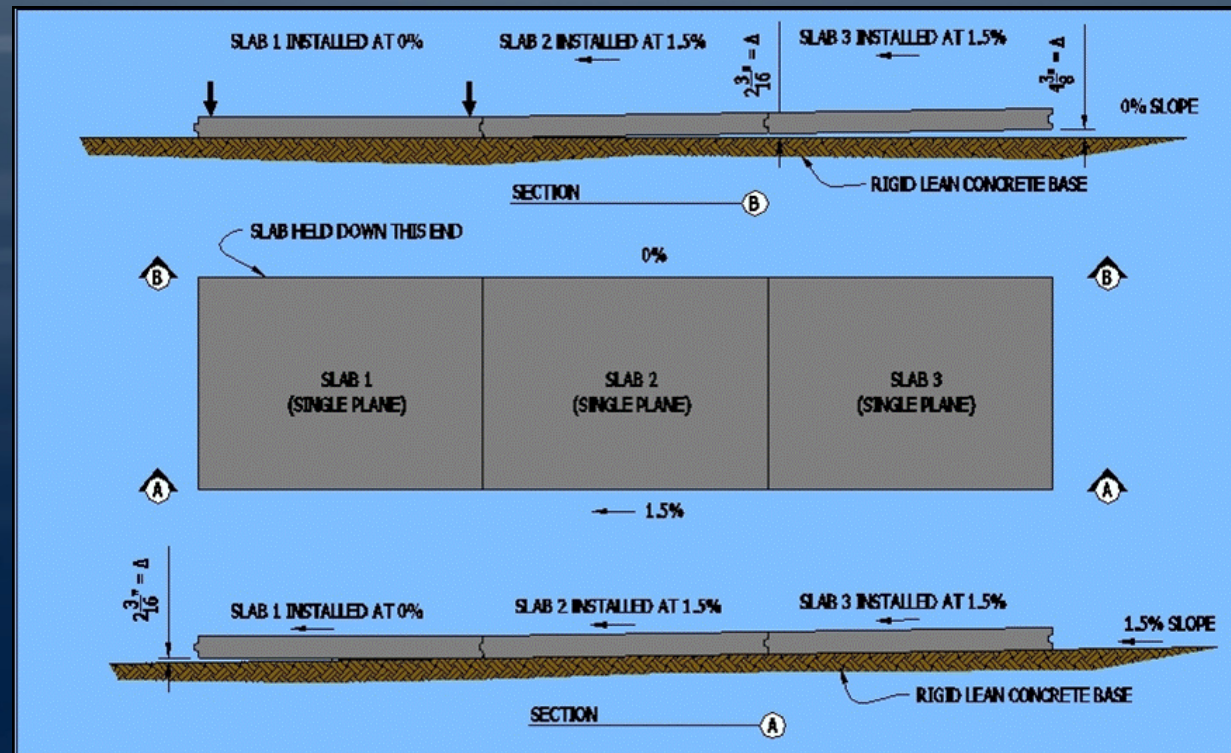


Ramp 9A – 9B,
Tarrytown, NY



Plan View - Panel
R71 Warped 2.25"

Surface Planarity May Affect Joint Design of Single-Plane PPCP Panels



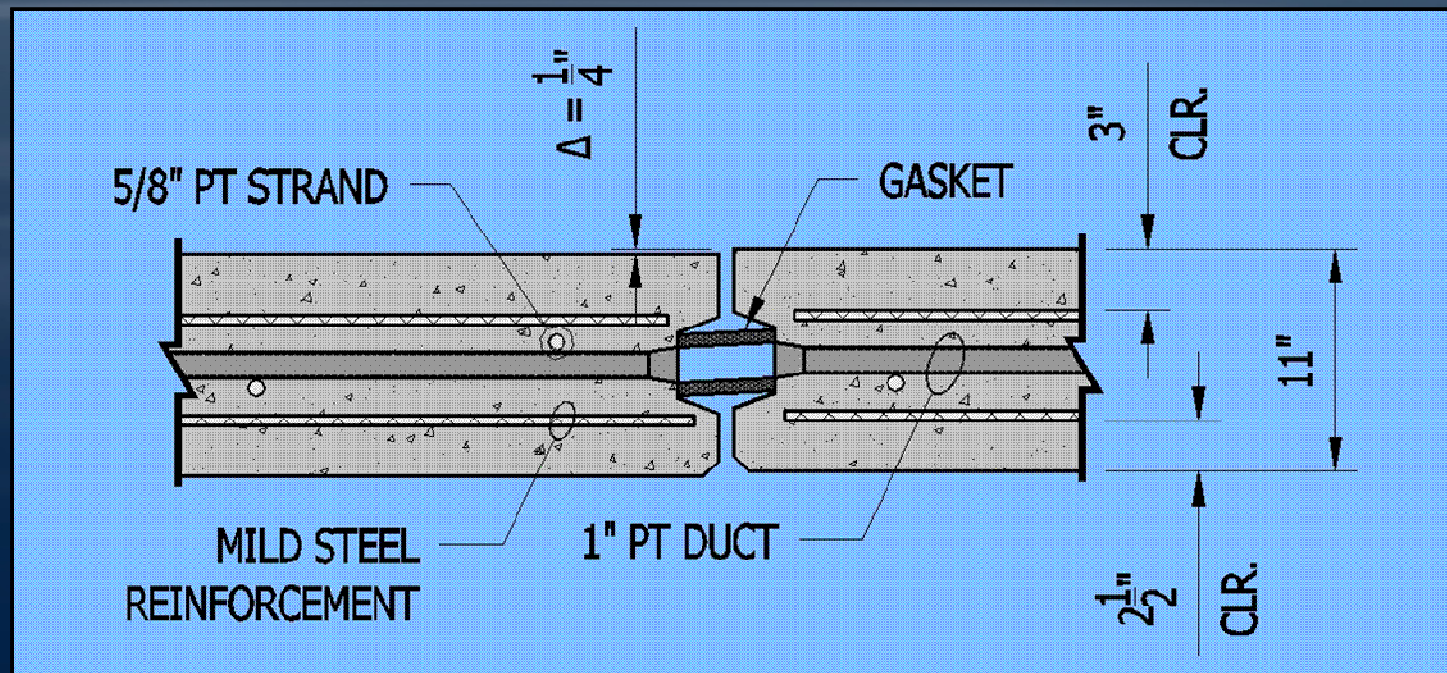
Tongue & Groove 12' x 12' PPCP Panels Placed on Super-Elevated Subgrade Surface

Observations

- Joints are not match-cast so there may be some room for “adjustment” at joints
- Voids under panels are too significant to tolerate
- One must conclude T&G panels don’t work at this location



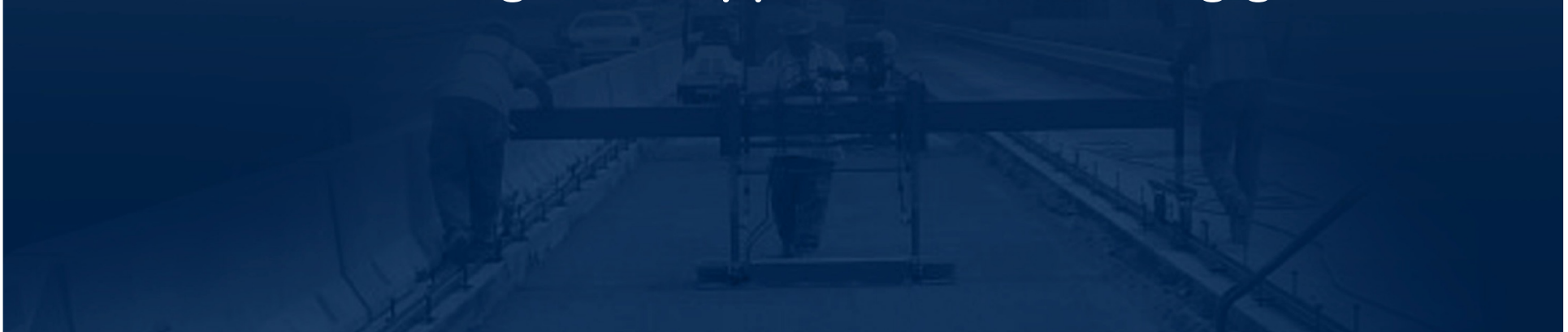
An Alternative Joint Design



**Double Groove Joint Design –
Permits Vertical Mismatch**

Right Answer – Warp Panels if Surface Warp Exceeds Approximately $\frac{1}{4}$ Inch

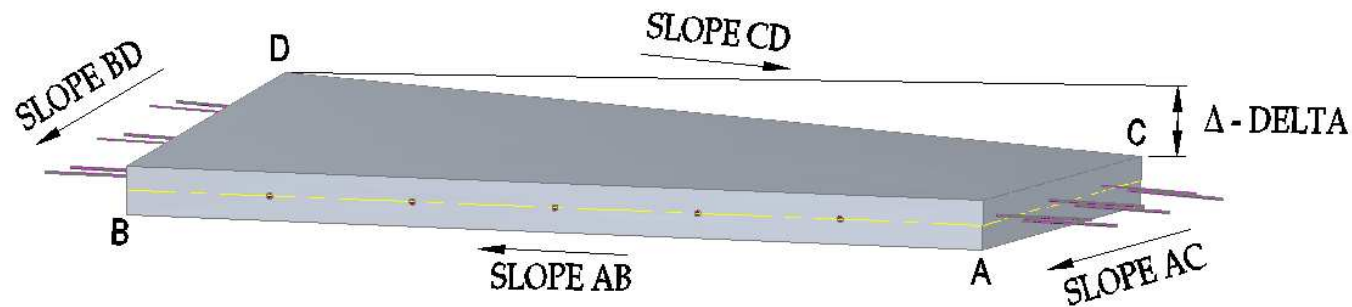
- Minimizes surface grinding
- PPCP panels work better
 - Ducts line up
 - Eccentric pre-stressing loads avoided
 - Original pre-stress is not affected
- Better subgrade support – less bedding grout



Do Precast Panels Flex?

- Under certain support conditions precast panels will flex
 - But not much
 - Certainly not in the order of magnitude demonstrated in this paper
- One can never be sure of actual support conditions in the field so we can't be assured panels will flex as much as we need them to

Challenges with Warping PPCP Panels



- Strands must be warped
- Warping bed must be used
- Self-stressing one-at-a-time beds are likely required

Practicality of Fabricating Non-planar (Warped) Panels

- Survey and design technology readily available
- Forming techniques are readily available
- Installation technology same as that for flat panels
- Fabrication and installation costs only slightly higher
 - Less than 5% higher (for non-prestressed panels)



Plans and Specifications – What to Include

- Maximum allowable surface mismatch
- Maximum amount of profile grinding
- Identification of portions of the project where non-planar surfaces may occur
- How existing pavement surface planarity is to be determined (if that information is not provided on plans)
- Who is responsible for “designing” surface geometry of new panels

Summary

- Flat panels should be used when surface planarity does not exceed approximately $\frac{1}{4}$ " in any given panel
- Since "significantly-contoured" surfaces are difficult to discern with the naked eye, each location should be analyzed for magnitude of warp
- PPCP panels are particularly affected by the incidence of contoured surfaces
- Plans and specifications should clearly point out and specify the planarity of the panels on the project
- Contoured precast pavement has been reduced to practice – owners can specify them with confidence

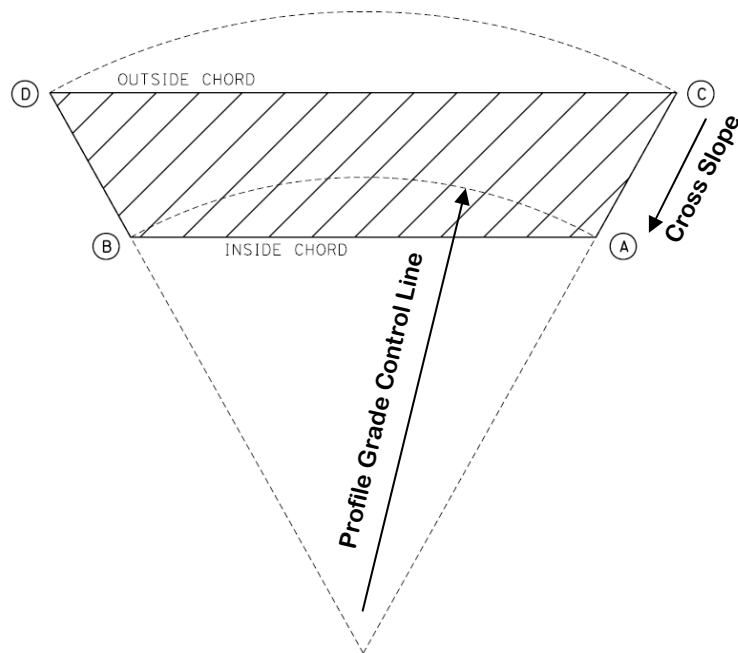
A large, rectangular concrete slab is suspended in the air by several thick cables. The slab is positioned horizontally and appears to be in the process of being moved or installed. The background is a clear blue sky with scattered white clouds. The text "Thank You" is overlaid in a large, bold, yellow font across the center of the image.

Thank You

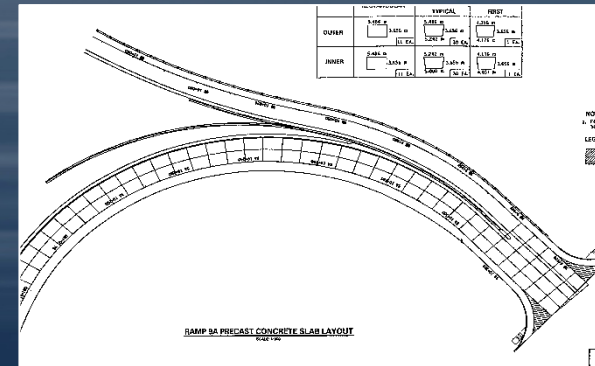
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Small Radius Horizontal Curves on Grades



Same Difference in Elevations Over Different Distances
= Different Slopes = Warped Panels



Plan View Tarrytown, NY



All Slabs Warped & Trapezoidal

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Keys to Success

(Still More to Learn)

Good engineering
Open minds
Real partnering

