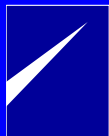


RPUG 2008



Estimate JCP Joint Faulting and Functionality using Profile Data

Presented by
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Transtec Group



THE
TRANSTEC GROUP

University of Michigan



UMTRI
Transportation Research Institute

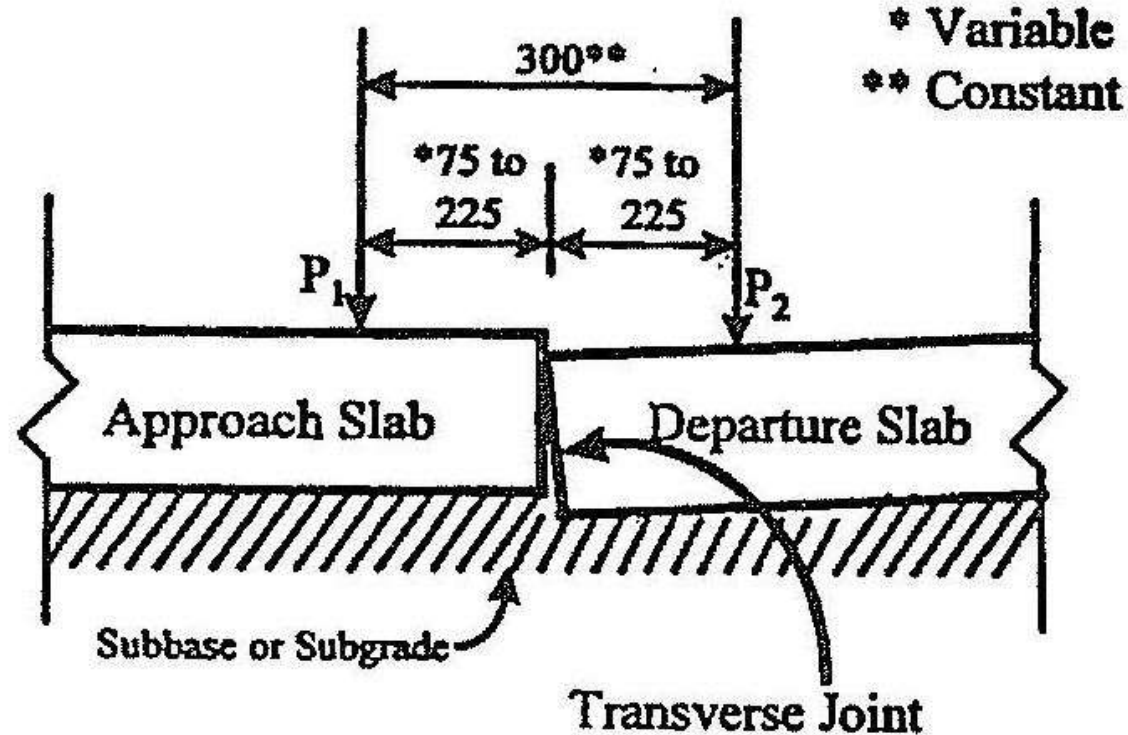
Acknowledgement

- FHWA Sponsorship
- Co-authors:
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Transtec Group
 - David Merritt, P.E., Transtec Group
 - Mark Swanlund, P.E., FHWA

Joint Faulting

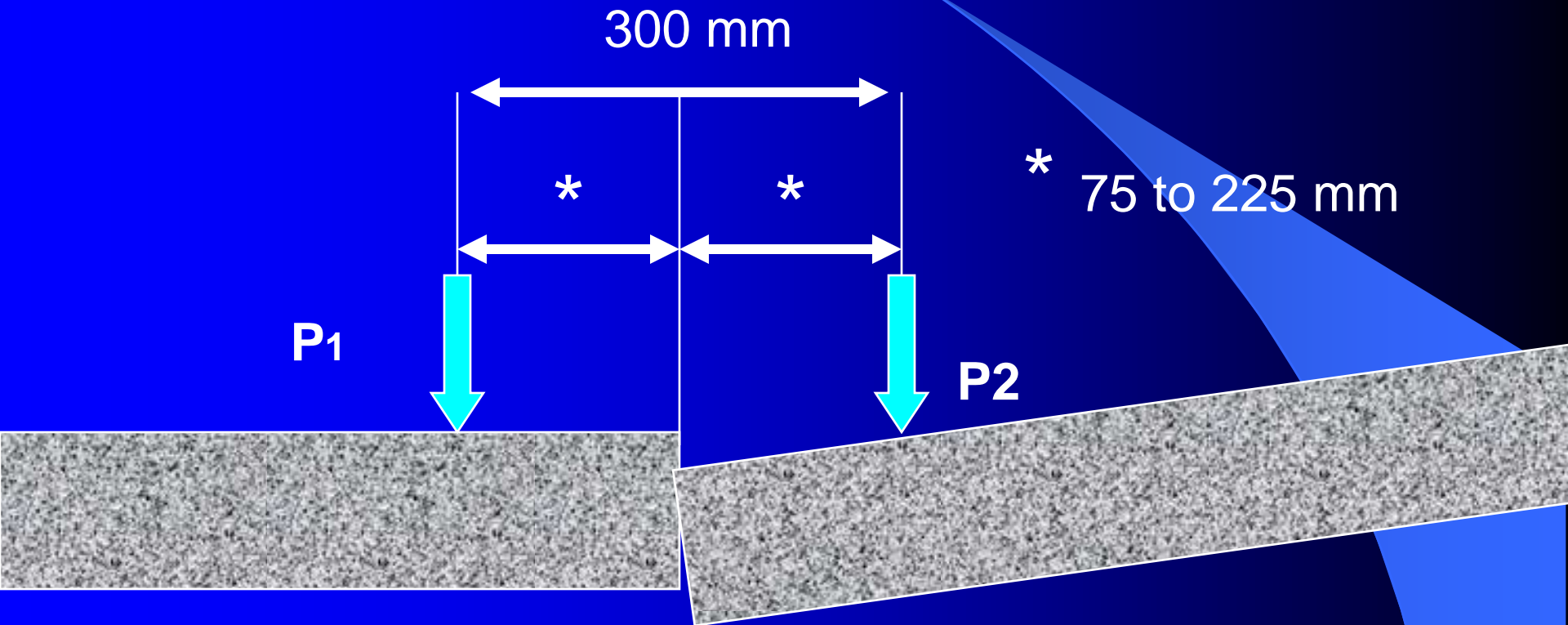
AASHTO
PP 39-00

P_1 and P_2 Points to Measure Relative Elevation



Dimensions in millimeters (mm)

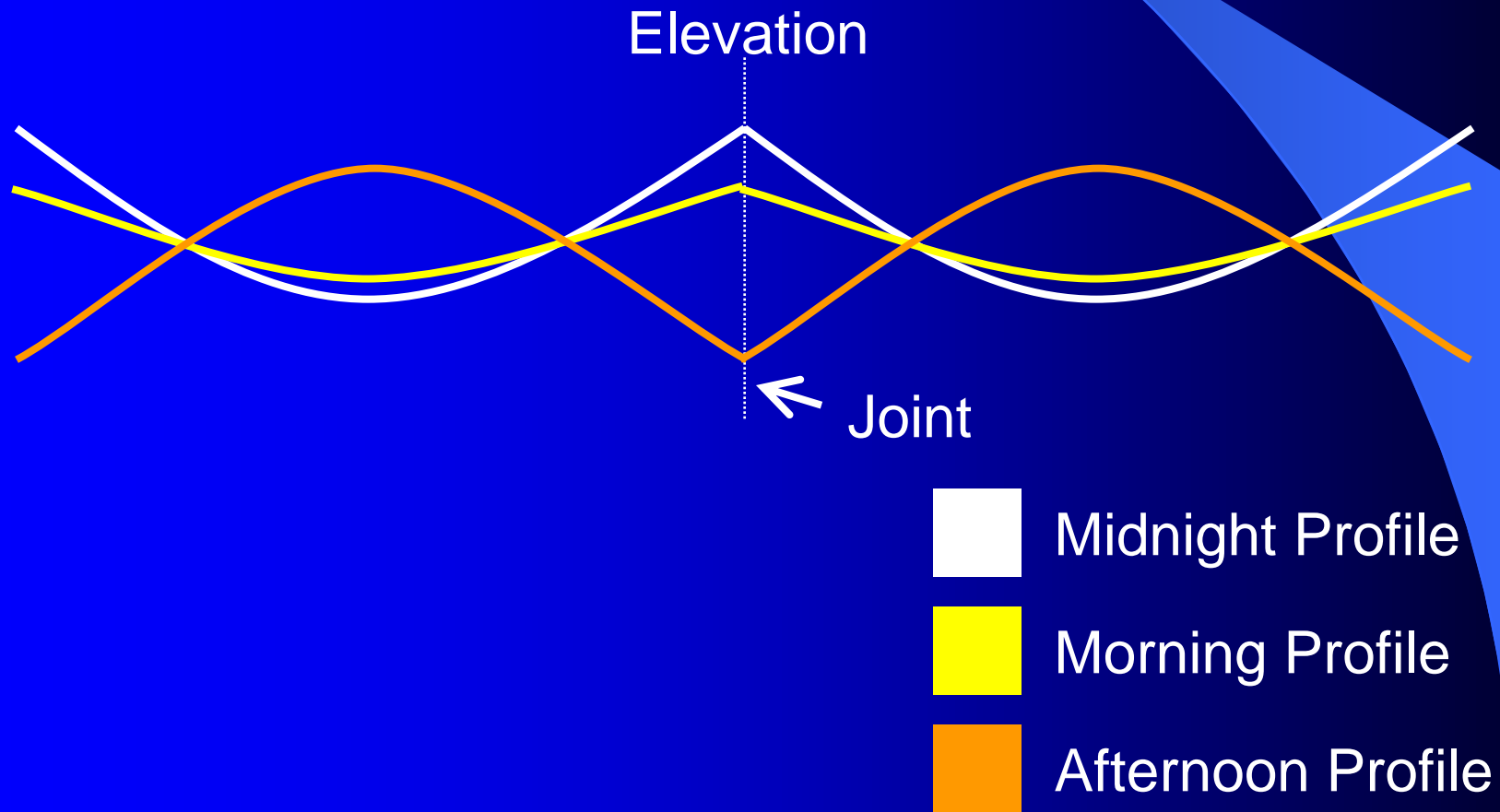
Joint Faulting



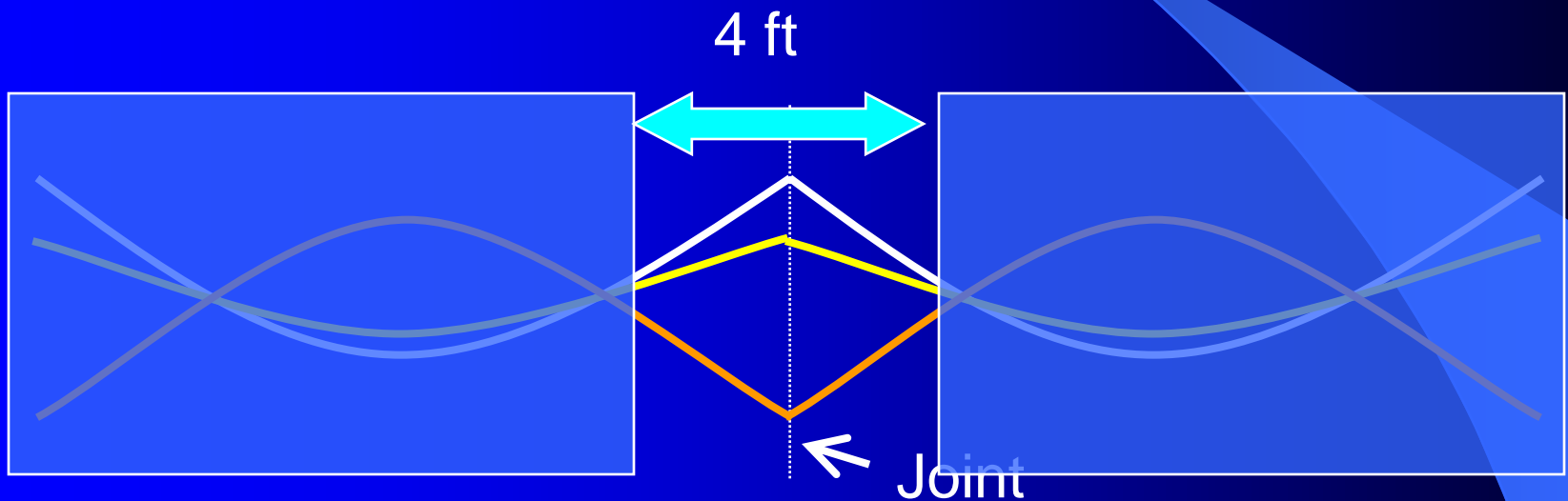
Joint Hinge Functionality

- Define movement of curled slab edges
- Describe the joint as a hinge point allowing both slabs to curl freely or locked-up
- “Working” joints relieve some of the curling stresses
- “Non-working” or “Frozen” joints indicate curling stresses are being built up

Joint Hinge Functionality

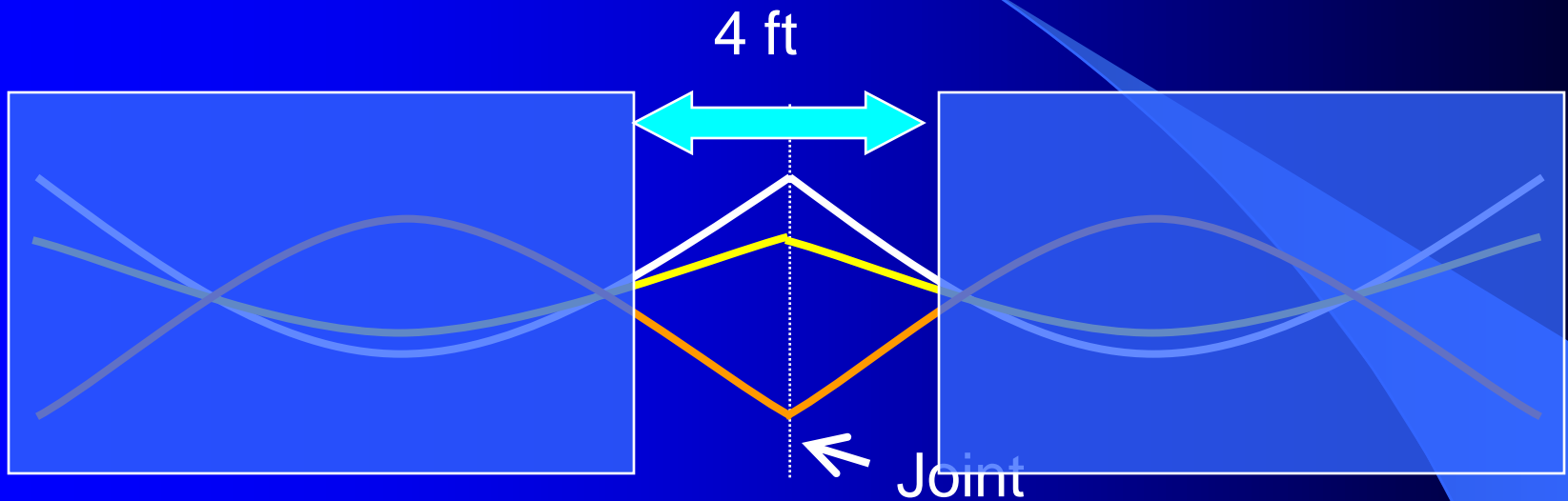


Joint Hinge Functionality

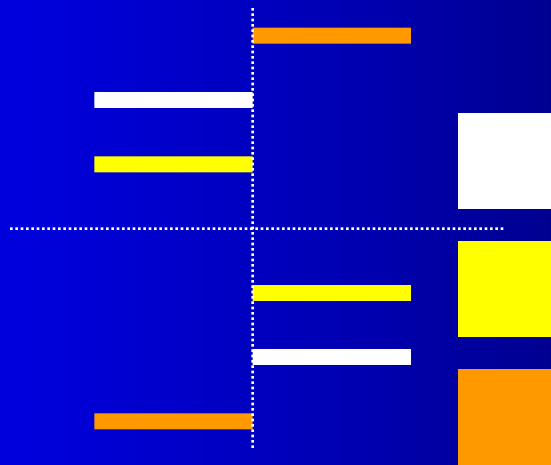


- Midnight Profile
- Morning Profile
- Afternoon Profile

Joint Hinge Functionality



Slope



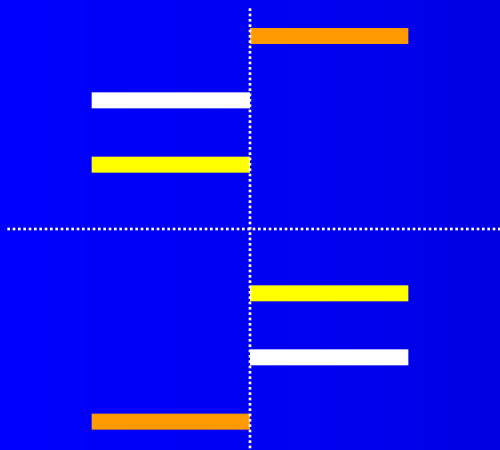
Midnight Profile

Morning Profile

Afternoon Profile

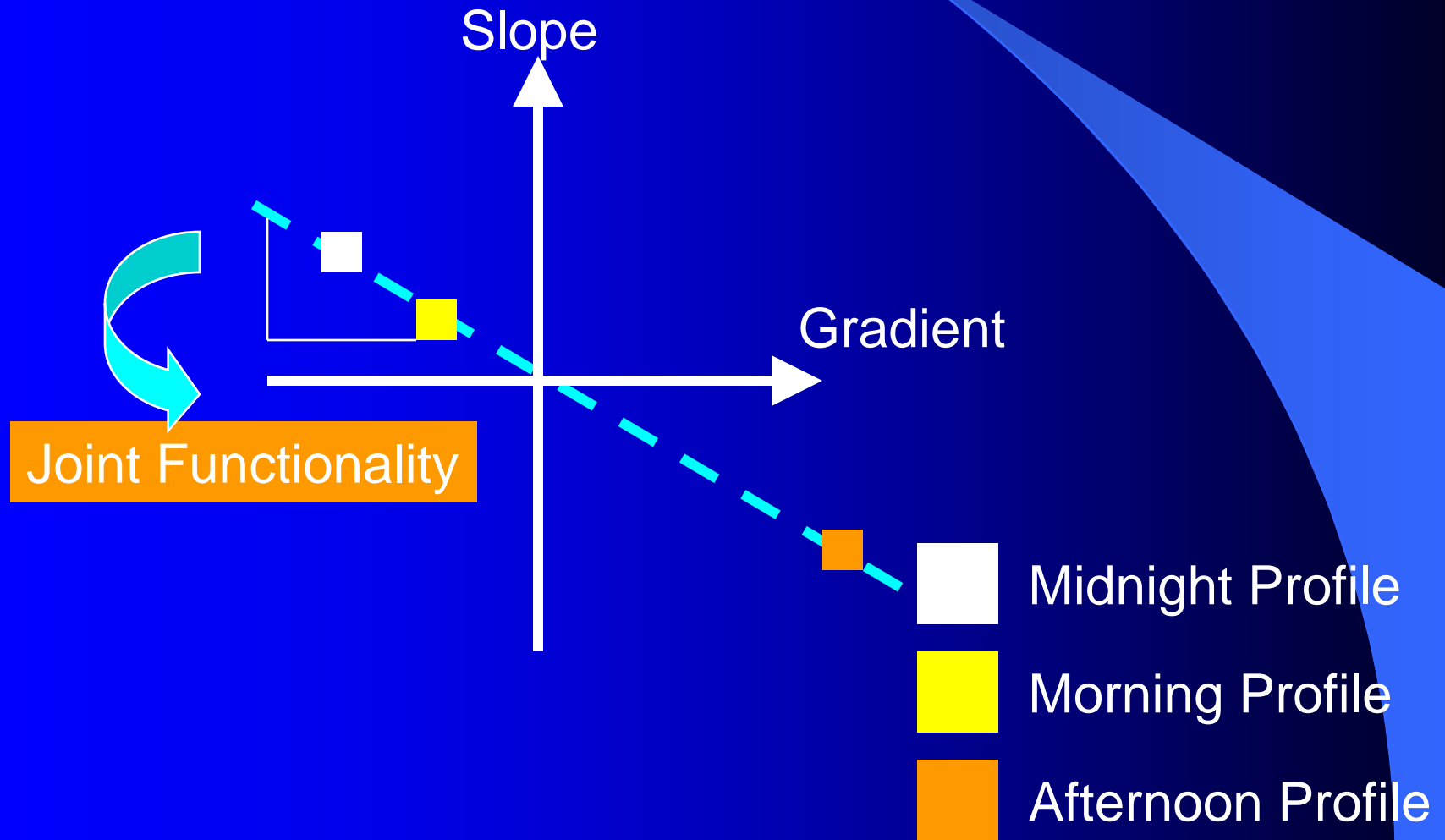
Joint Hinge Functionality

Slope

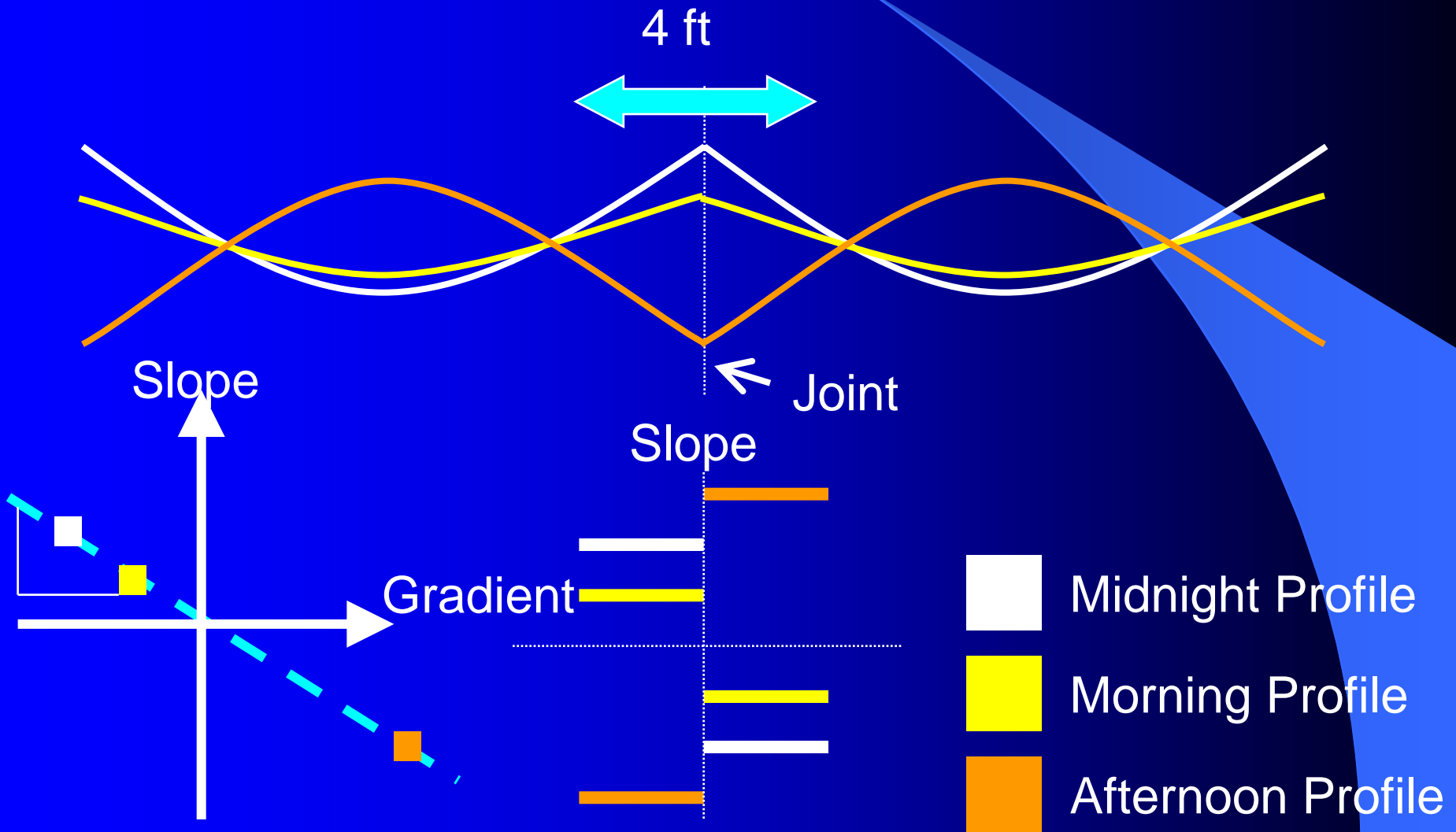


- Midnight Profile ($-1^{\circ}/\text{in}$ Gradient)
- Morning Profile ($-0.5^{\circ}/\text{in}$ Gradient)
- Afternoon Profile ($+2^{\circ}/\text{in}$ Gradient)

Joint Hinge Functionality



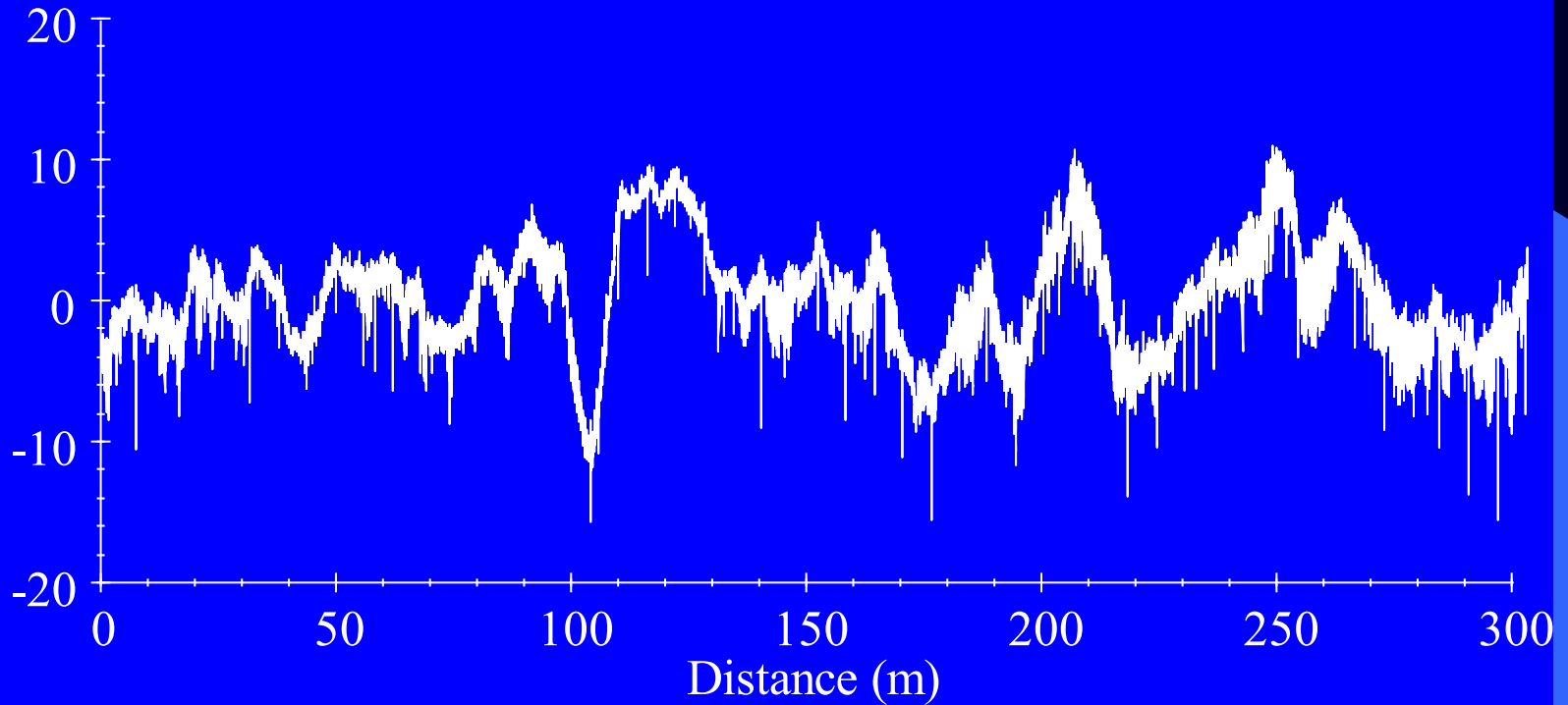
Joint Hinge Functionality



Raw Profile

IA_023A

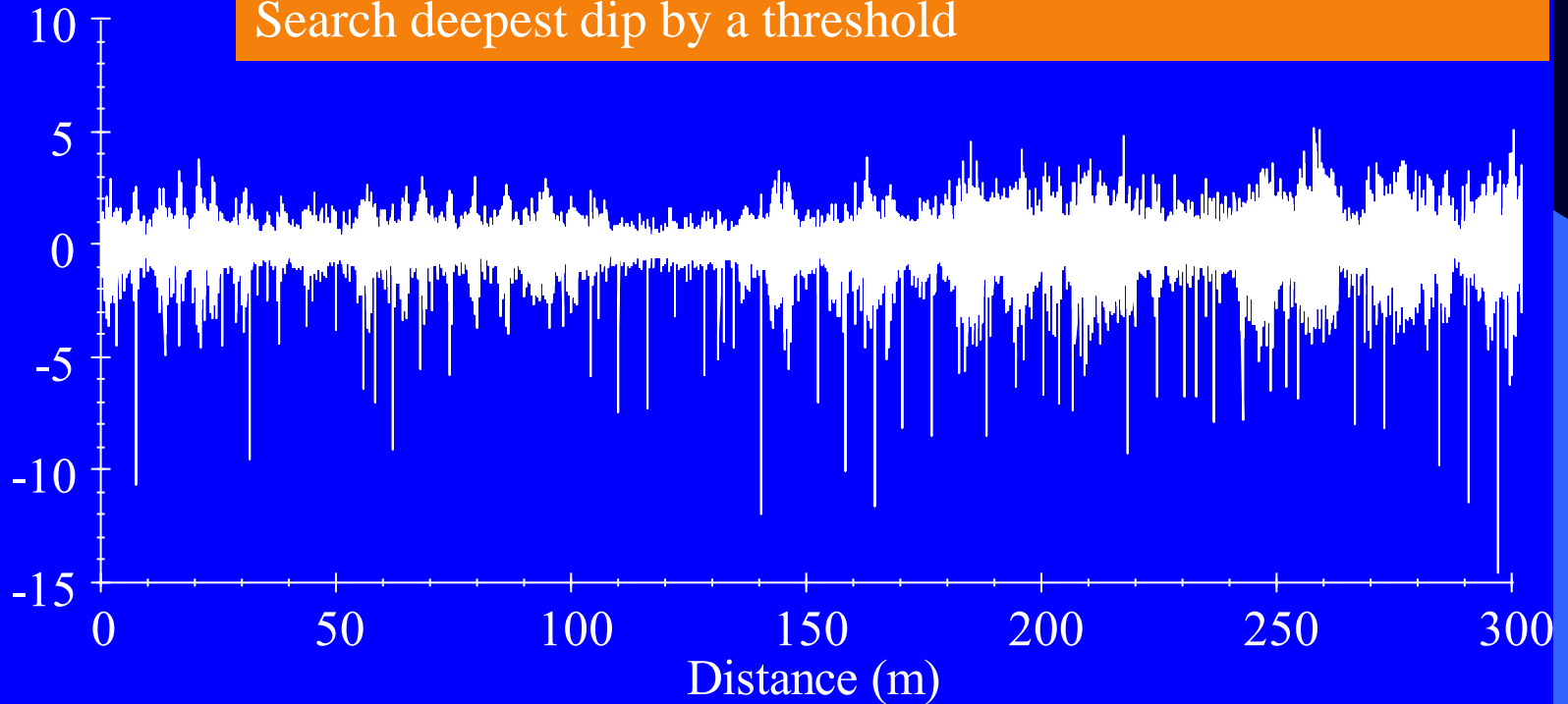
Left Elevation (mm)



Spike Profile

Filter with moving average anti-smoothing
Normalize by RMS
Search deepest dip by a threshold

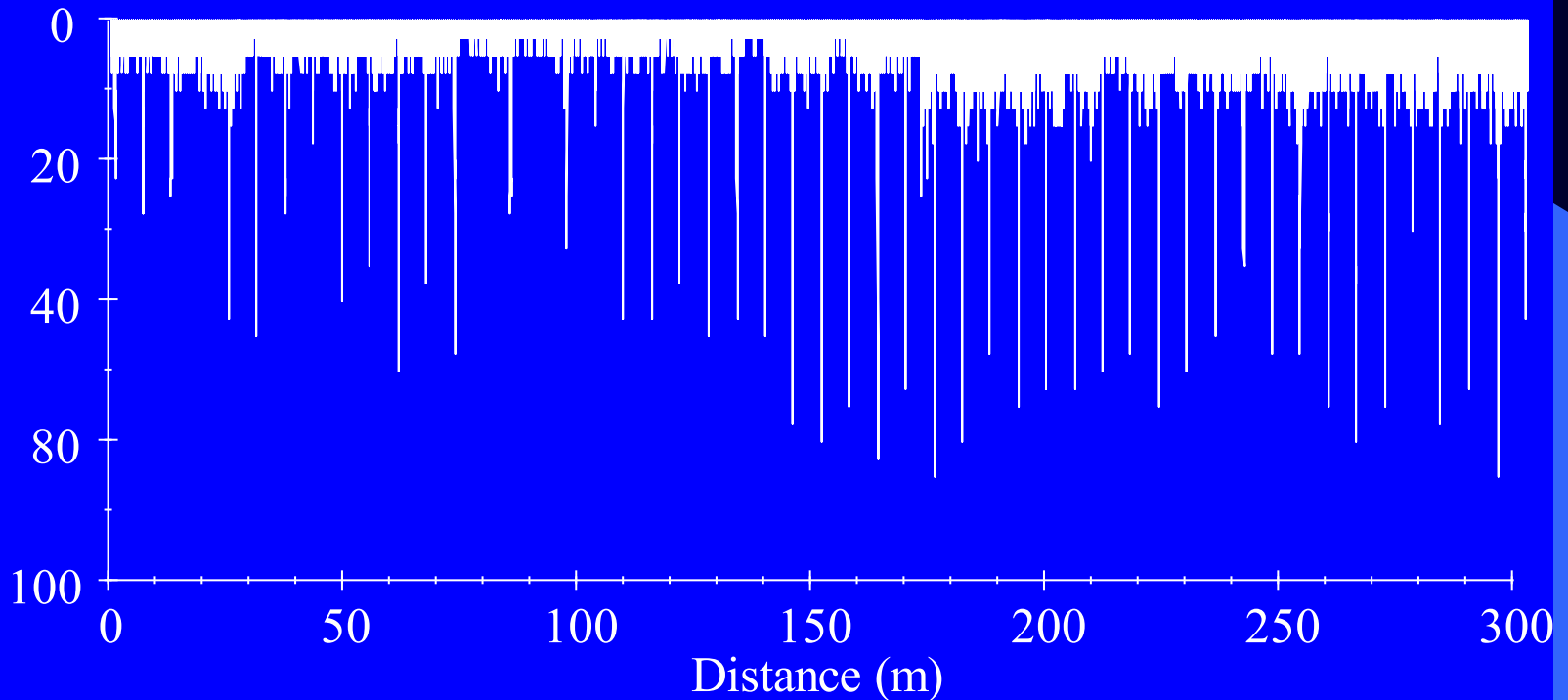
"Spike" Profile



Spike Incidence

Assemble the dip count across the data set

Spike Incidence (percent)

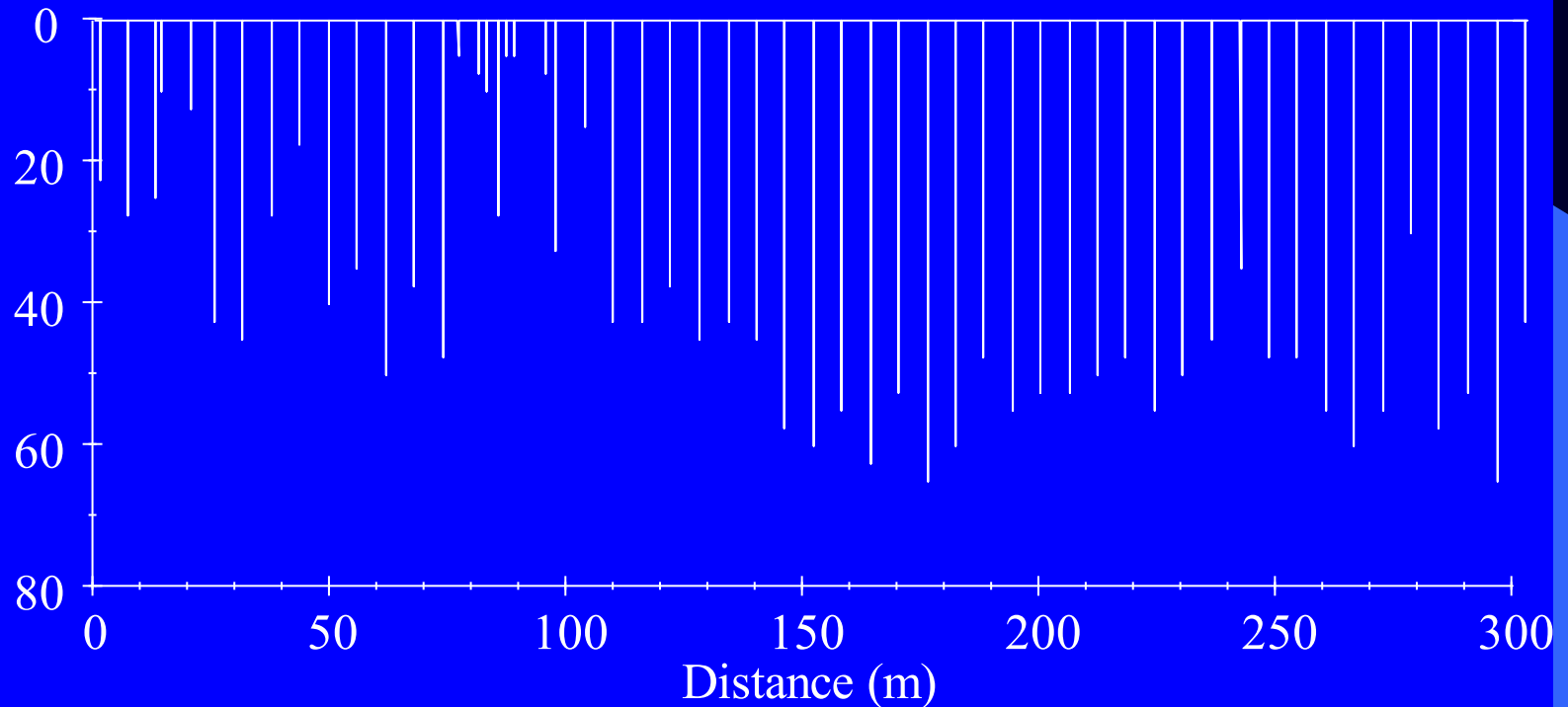


Weeded Spike Incidence

Weed/clear false hits

Extract the joint locations

Weeded Spike Incidence (percent)



Computation Steps

1. Load a profile and joint location information
2. Crop segments of the profile on either side of each joint within the section.
3. De-trend and de-mean the cropped profile.
4. Mask the profile within the joint window.

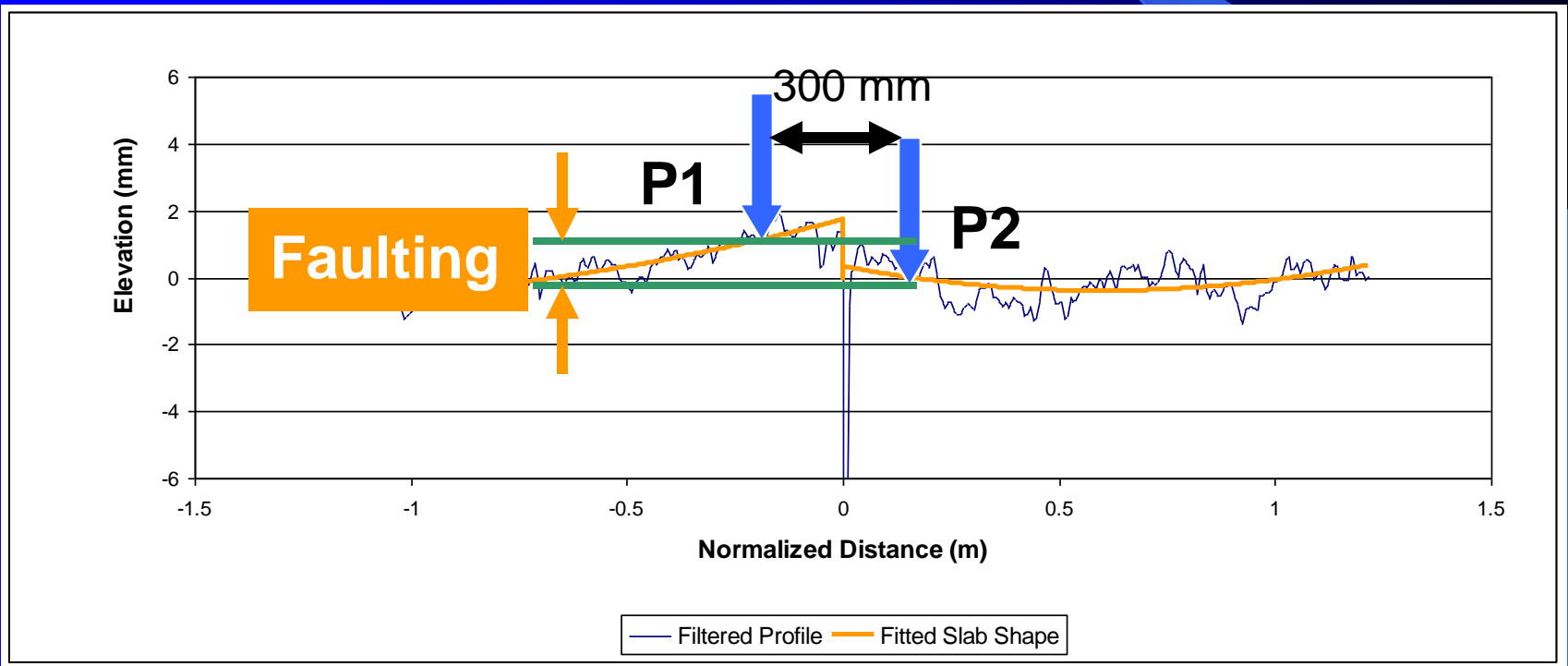
Computation Steps

5. Perform curve fitting for the remaining profile for the approach slab edge and leave slab edge.
6. Estimate linear slopes for the fitted shapes for both the approach and leave sides.
7. Estimate the faulting based on the AASHTO PP 39-00 specification.

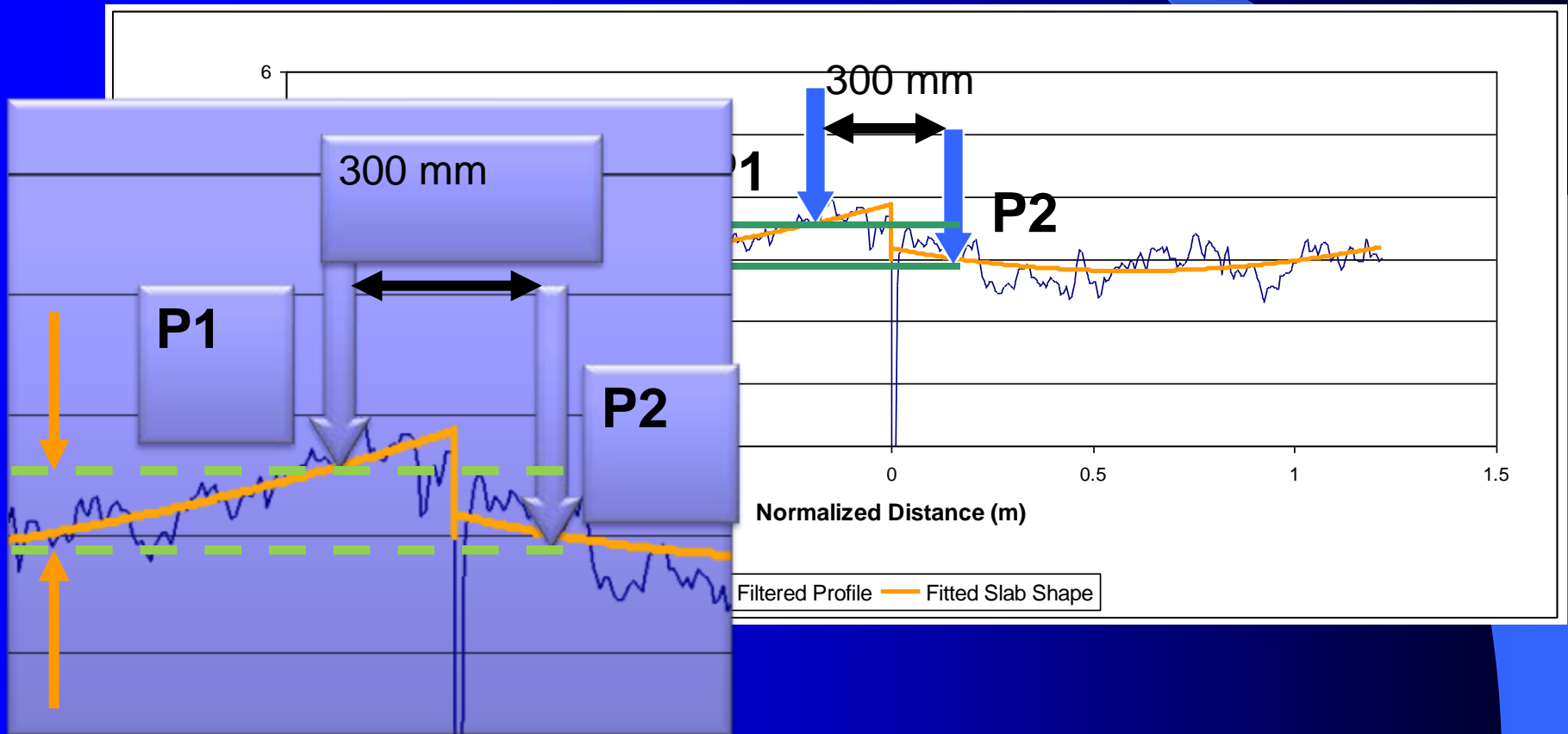
Computation Steps

8. Repeat Steps 1 to 7 for all profile runs, including all diurnal runs from all seasons.
9. Compute joint functionality from all diurnal runs during each season for a given site.

Joint Faulting

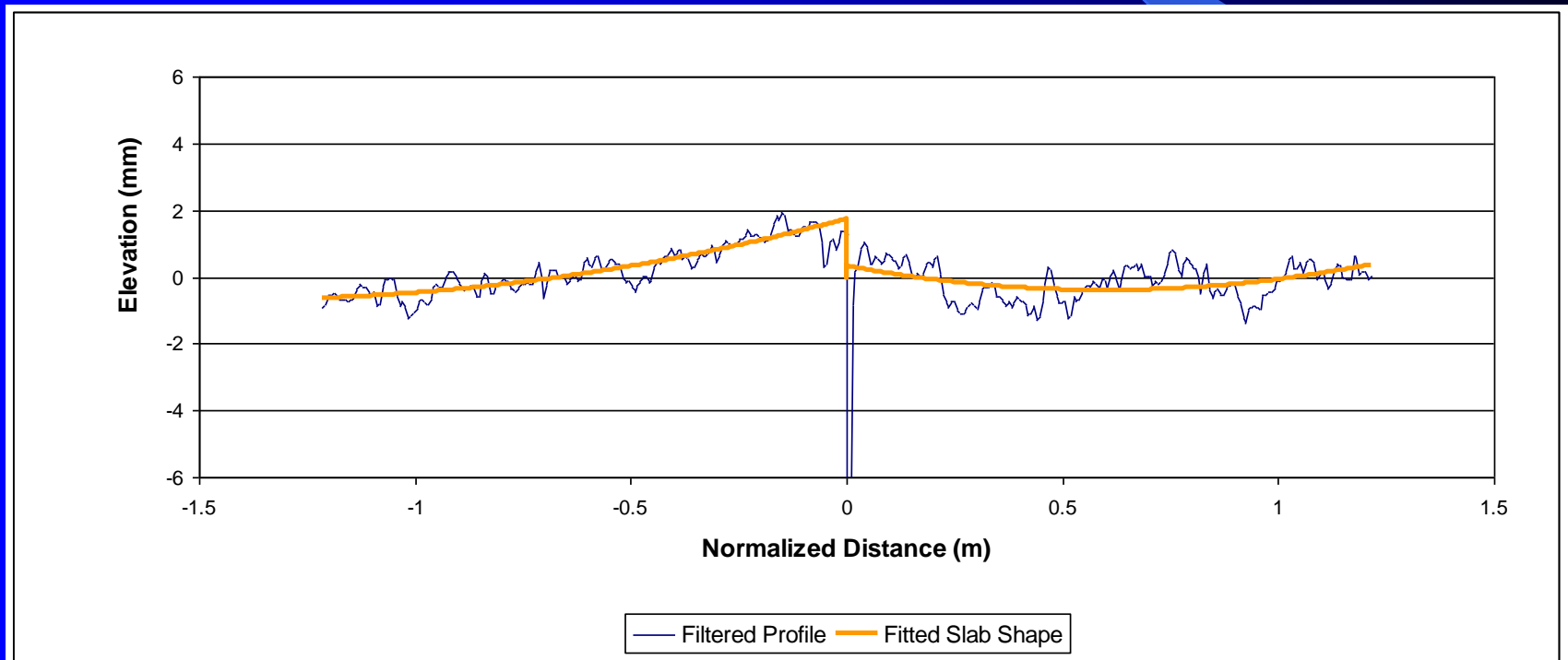


Joint Faulting



Joint Edge Geometry

CA_008Em, joint no. 12 (+D.+D.P)



Classification of Joint Edge Geometry

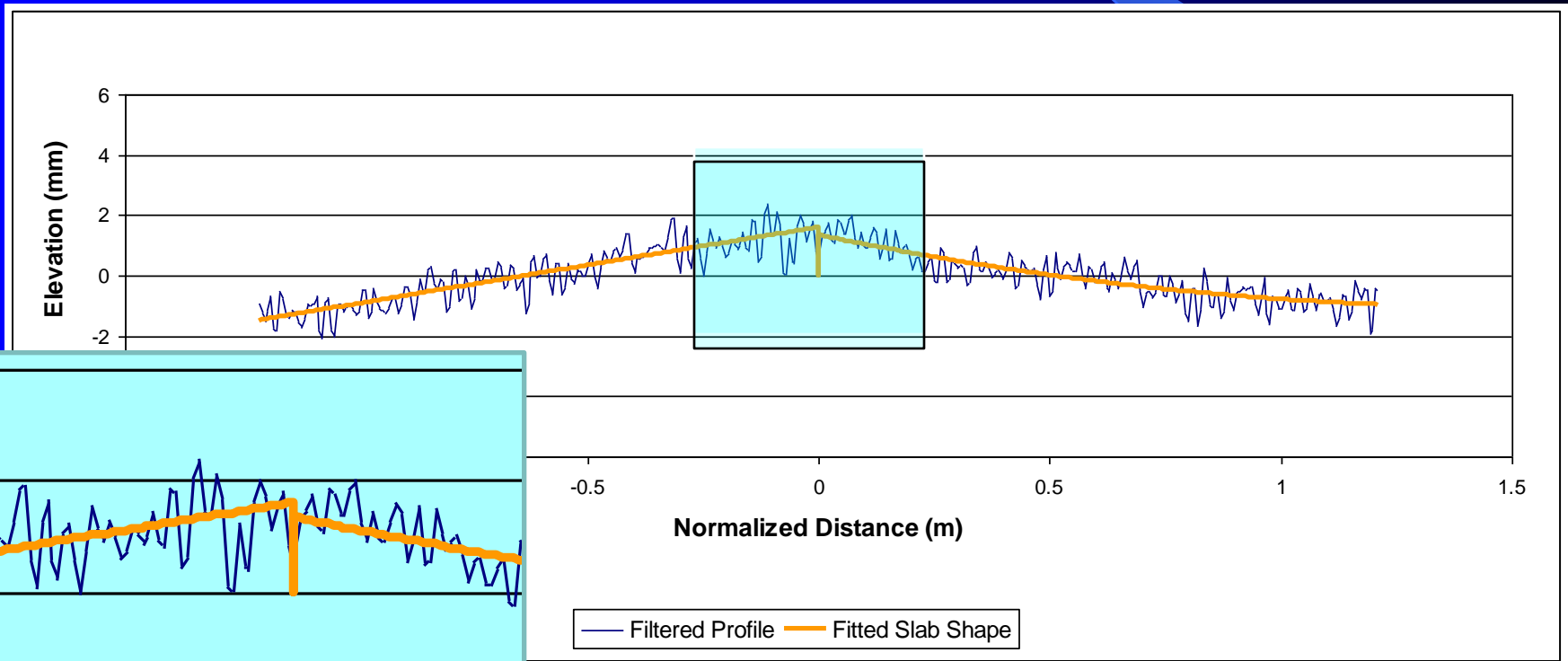
- Fitted linear slopes for both approach and leave slab edges:
 - (+) for positive slope and
 - (-) for negative slope with the direction toward the joint.
- Deformed shapes for both approach and leave slab edges:
 - (S) for straight line,
 - (U) for concave upward, and
 - (D) for concave downward.

Classification of Joint Edge Geometry

- Joint Faulting:
 - (0) for no faulting,
 - (P) for positive faulting (i.e., step down in the direction of traffic),
 - (N) for negative faulting (i.e., step up in the direction of traffic).

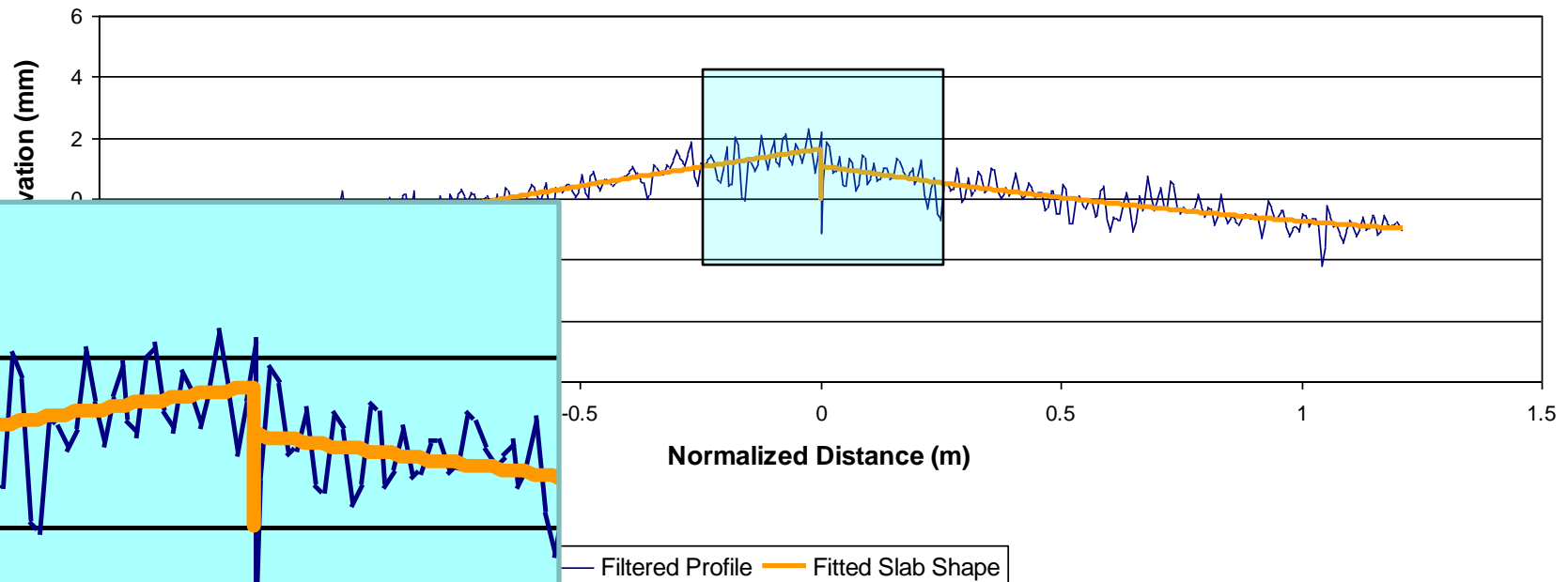
Joint Edge Geometry

AZ001A1, joint no. 18 (+S.+S.0)



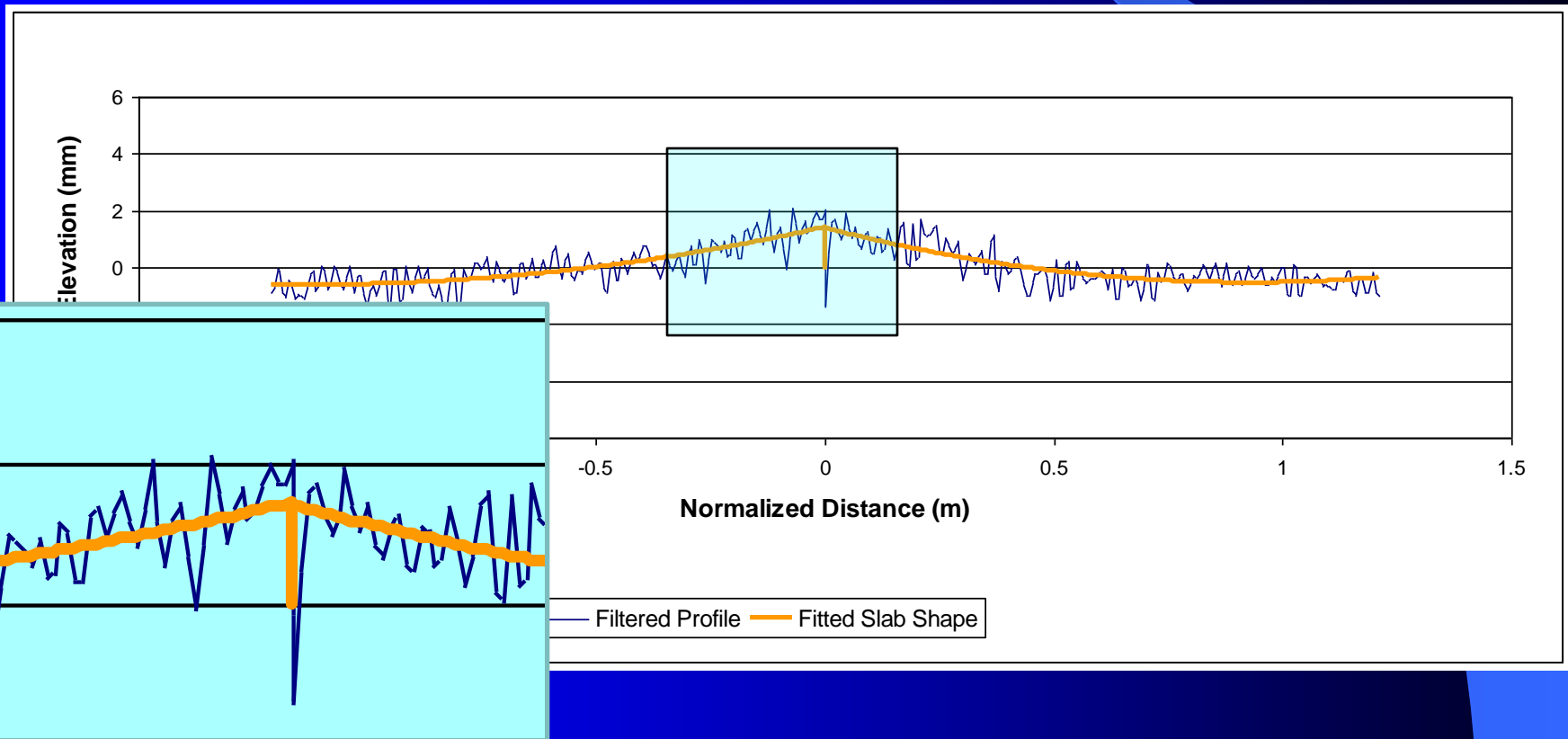
Joint Edge Geometry

AZ001A1, joint no. 21 (+S.+S.P)



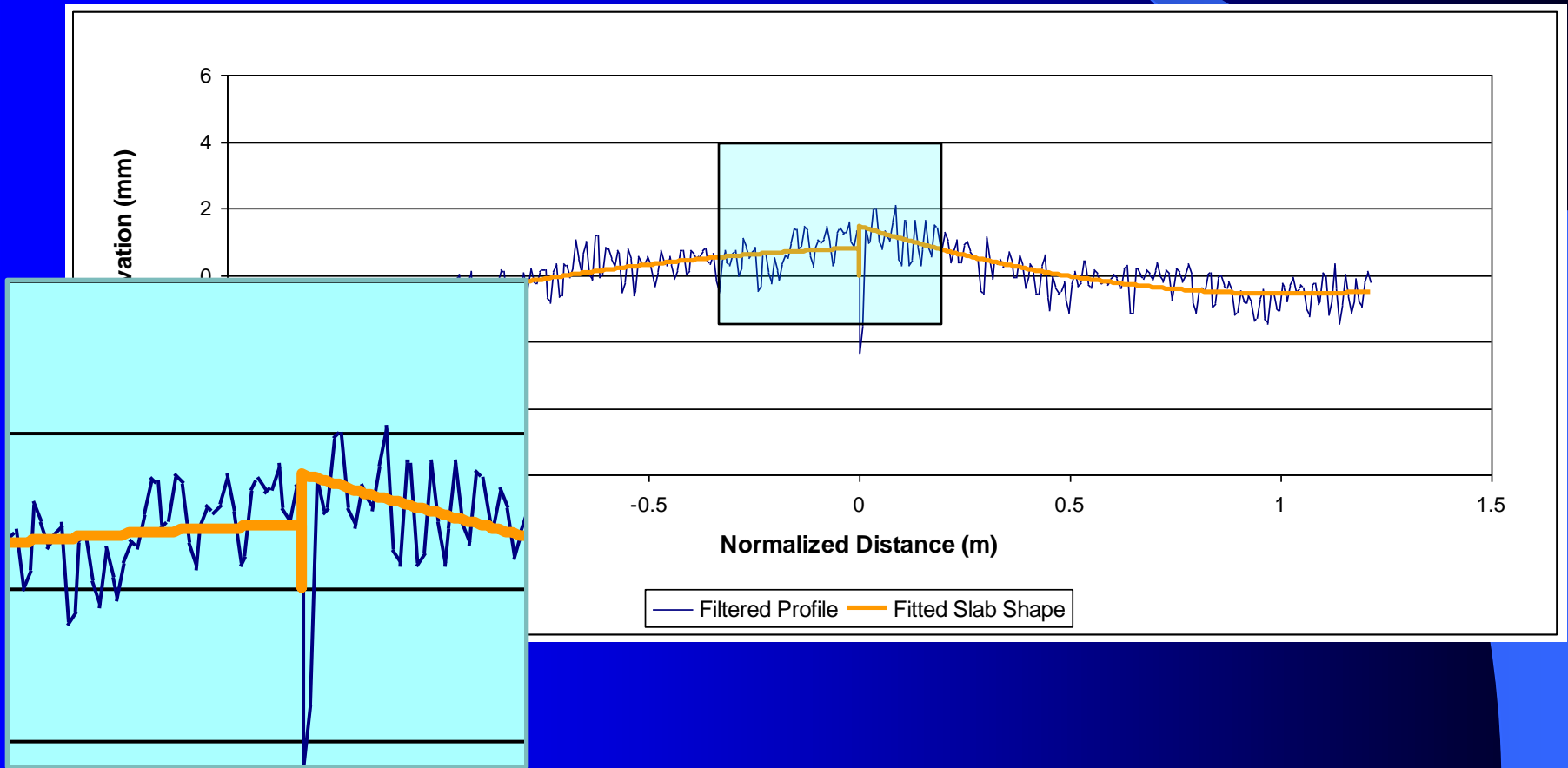
Joint Edge Geometry

AZ001A1, joint no. 25 (+U.+U.0)



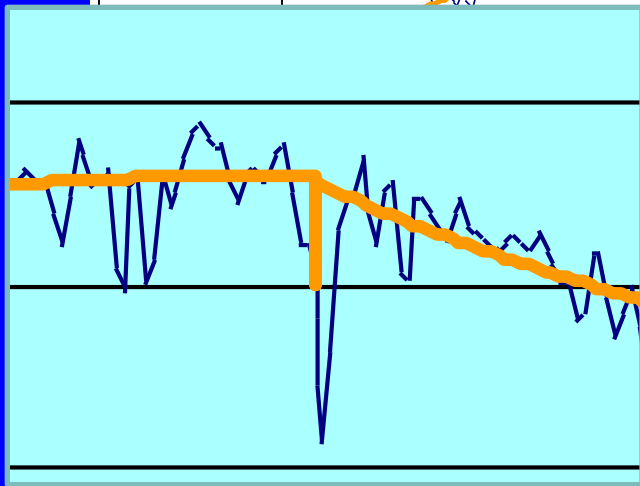
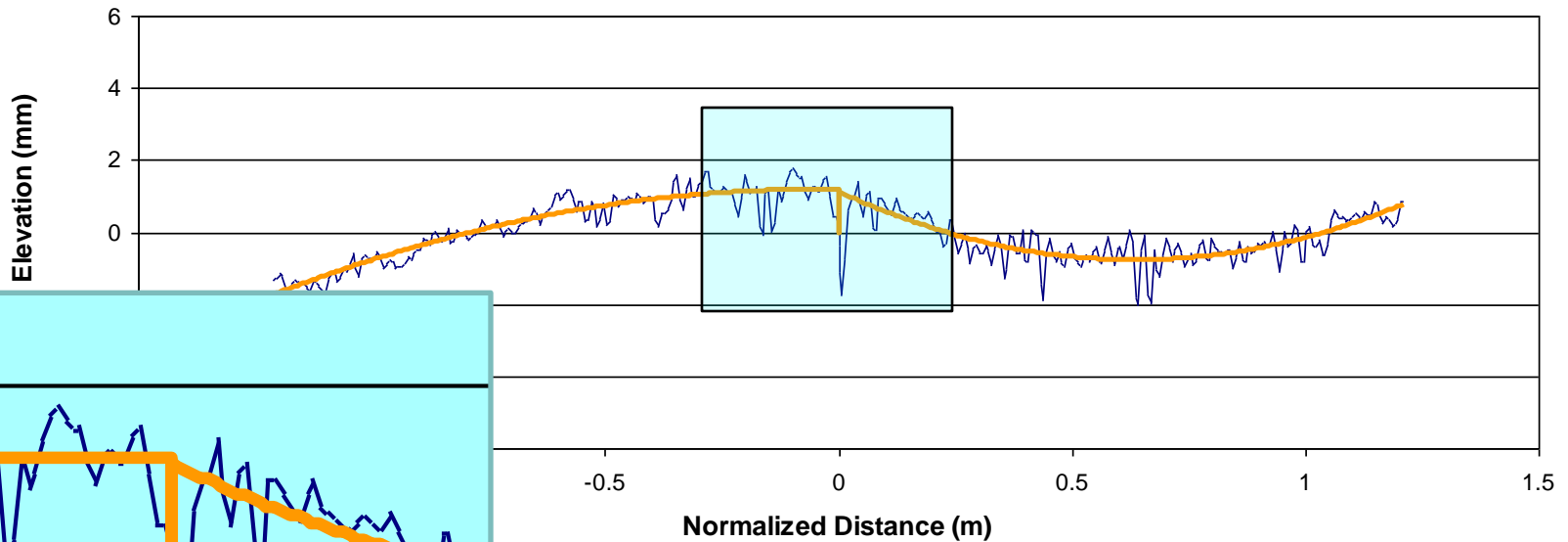
Joint Edge Geometry

AZ001A1, joint no. 26 (+S.+U.N)



Joint Edge Geometry

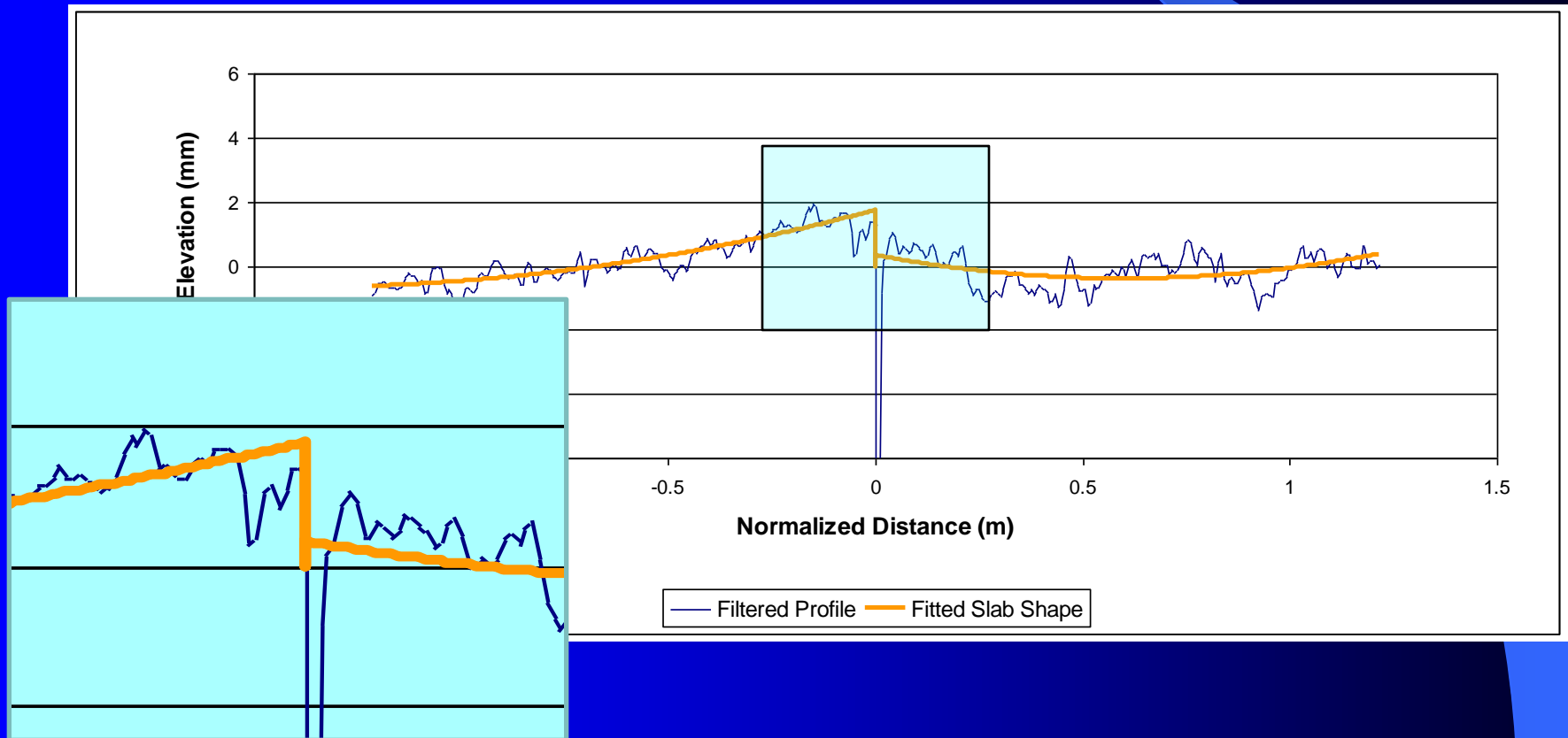
AZ001A1, joint no. 9 (+D.+U.0)



— Filtered Profile — Fitted Slab Shape

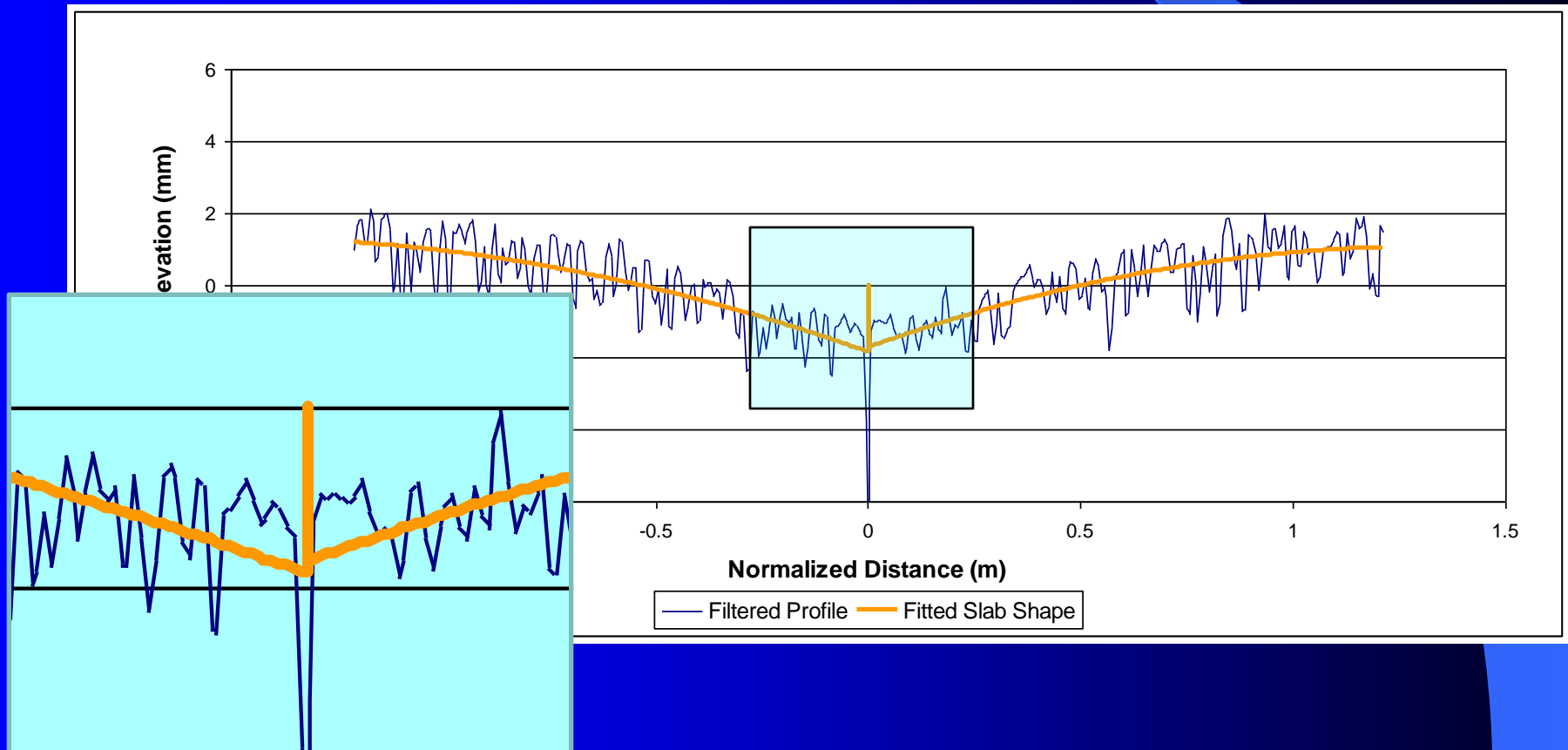
Joint Edge Geometry

CA_008Em, joint no. 12 (+D.+D.P)



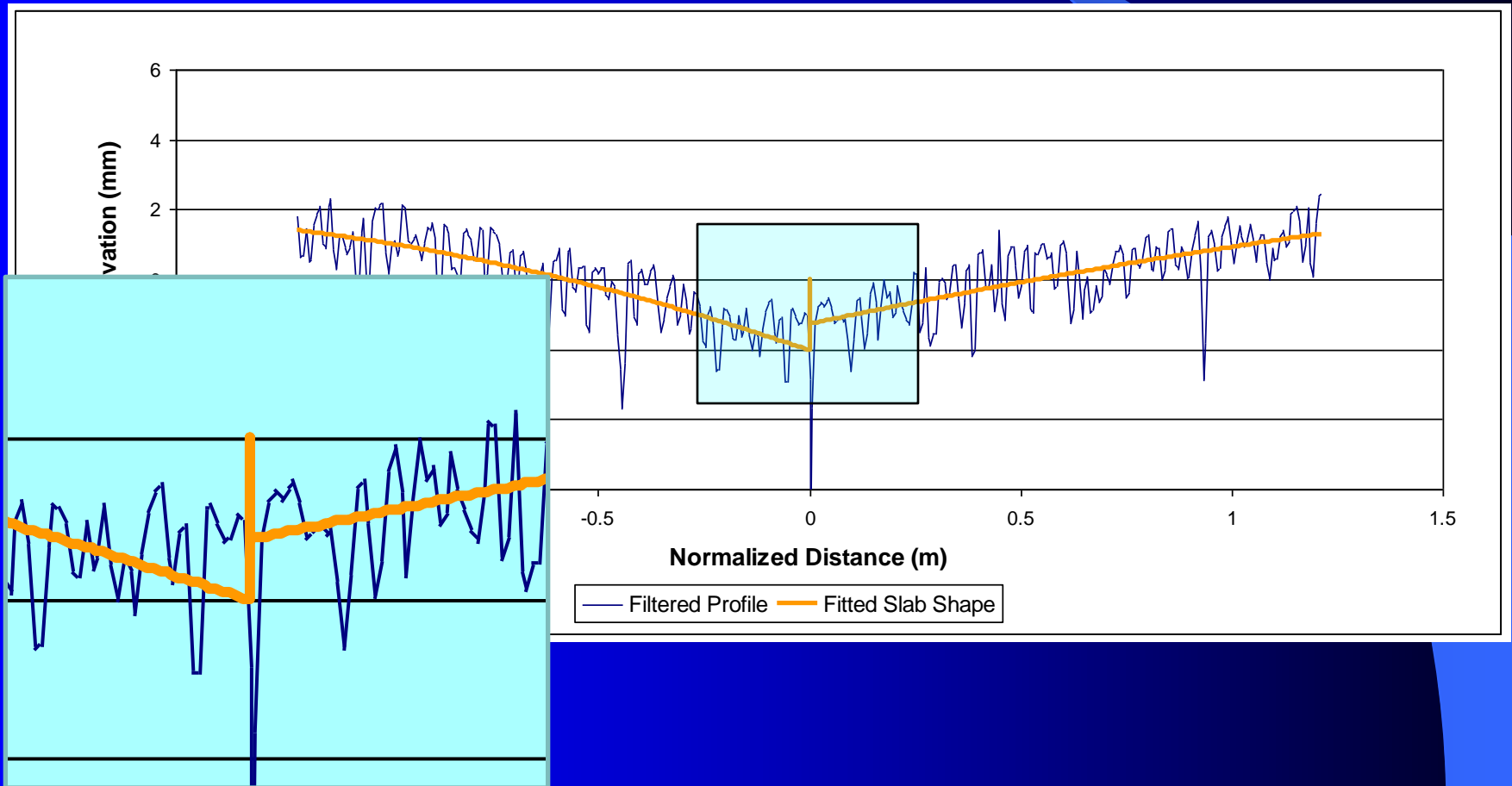
Joint Edge Geometry

MN_046A1, joint no. 1 (-D.-D.0)



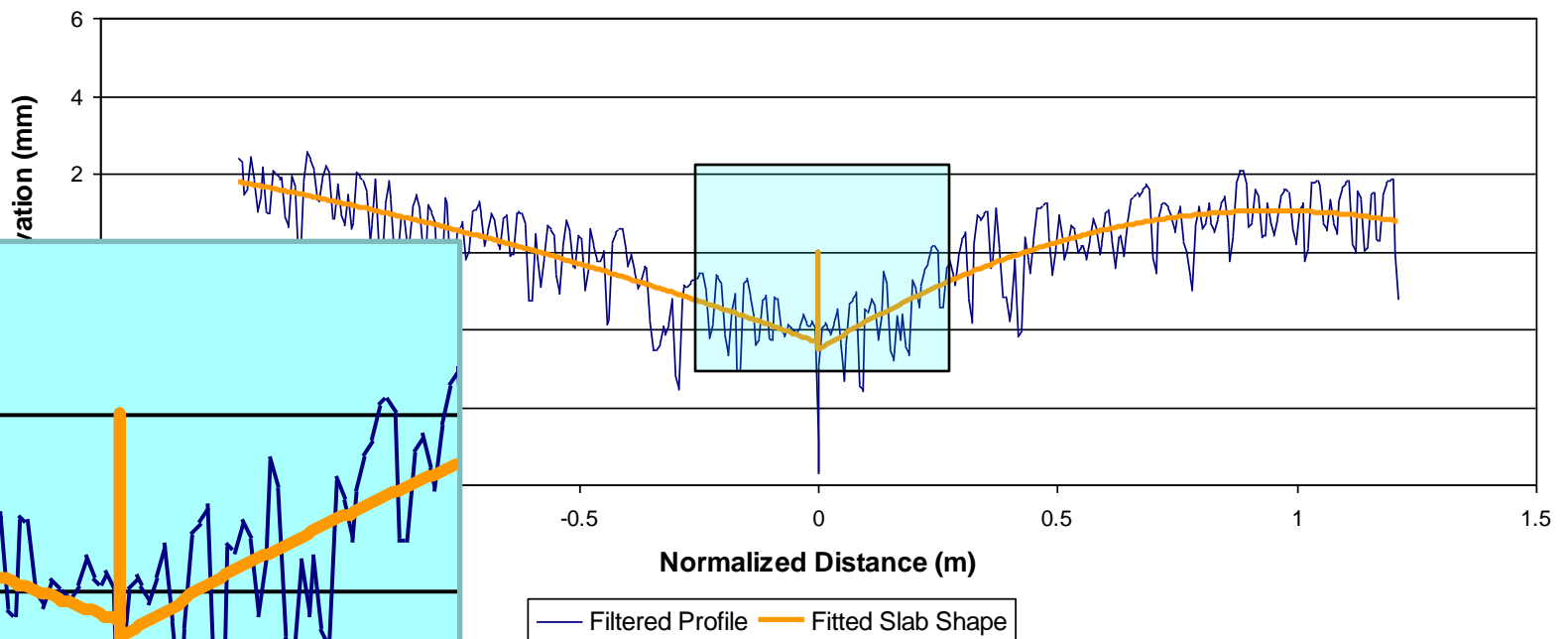
Joint Edge Geometry

MN_046A1, joint No. 3 (-D.-S.N)



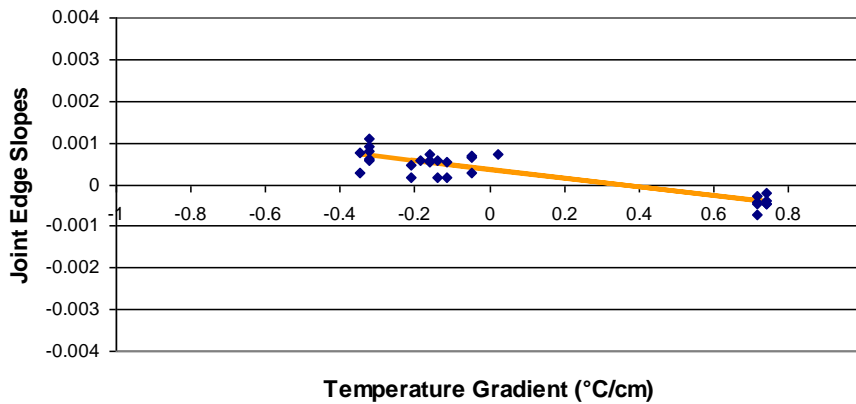
Joint Edge Geometry

MN_046A1, joint no. 4 (-S.-D.0)

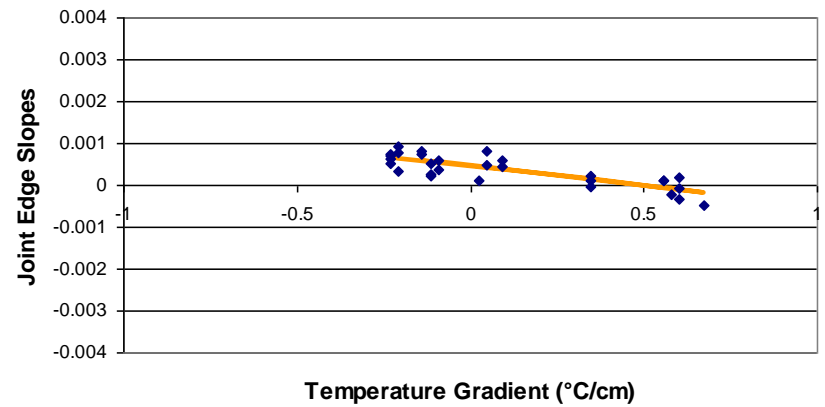


Joint Hinge Functionality

Season 1

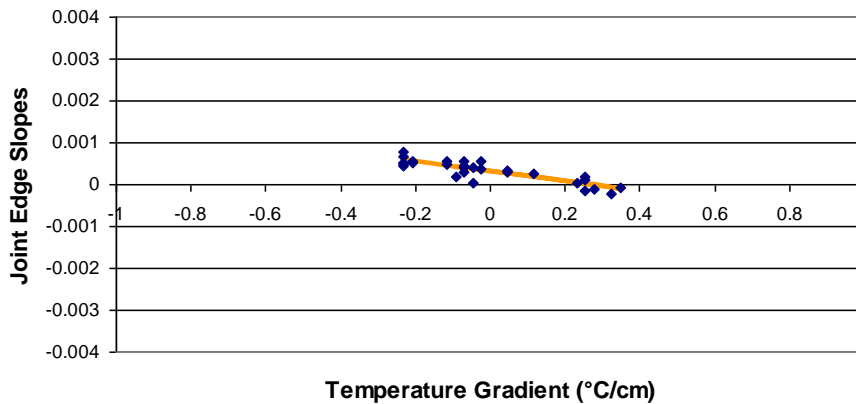


Season 2

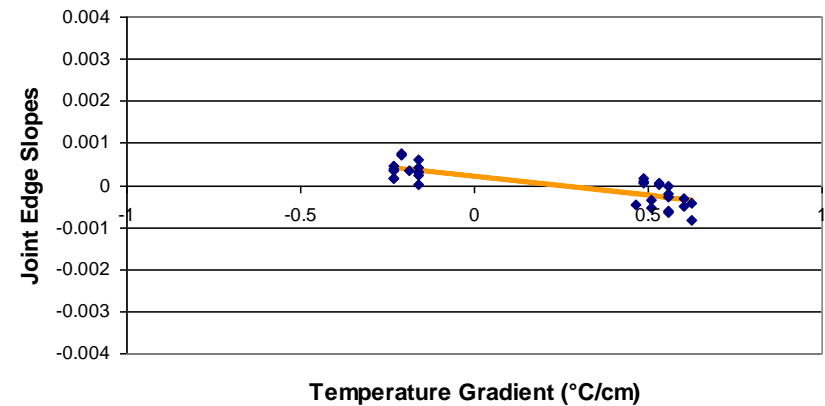


CA_008em, joint no. 1

Season 3

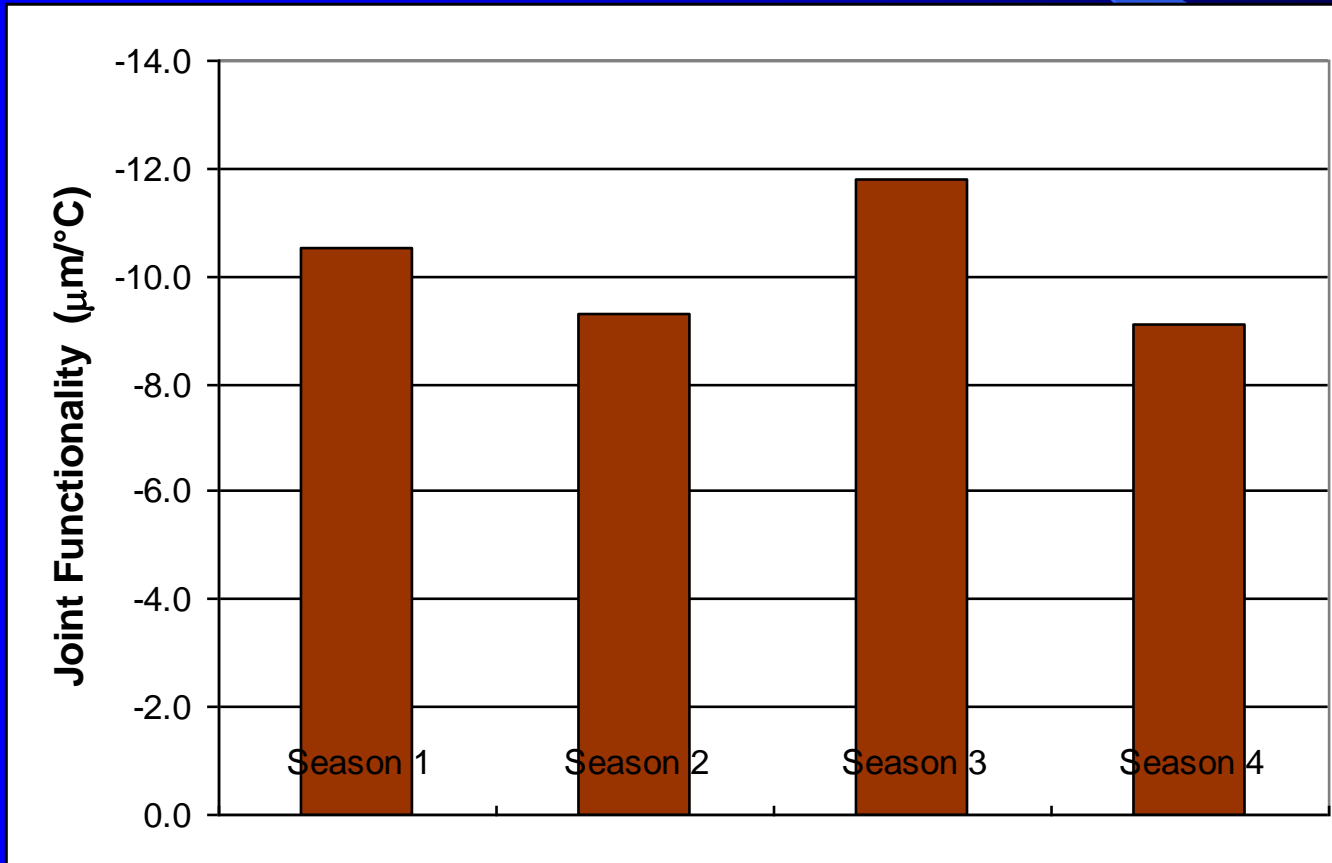


Season 4



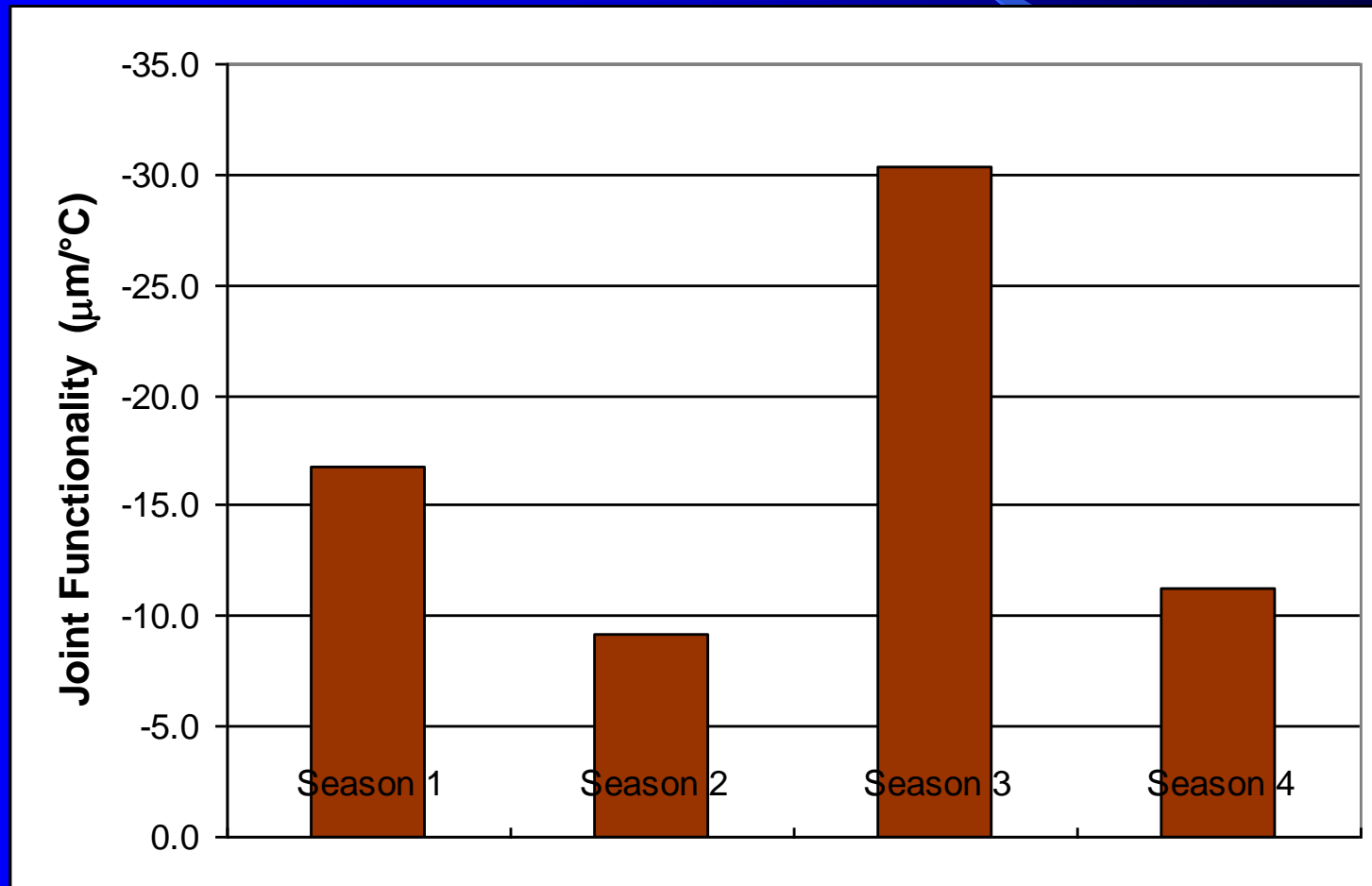
Joint Hinge Functionality

CA_008em, joint no. 1



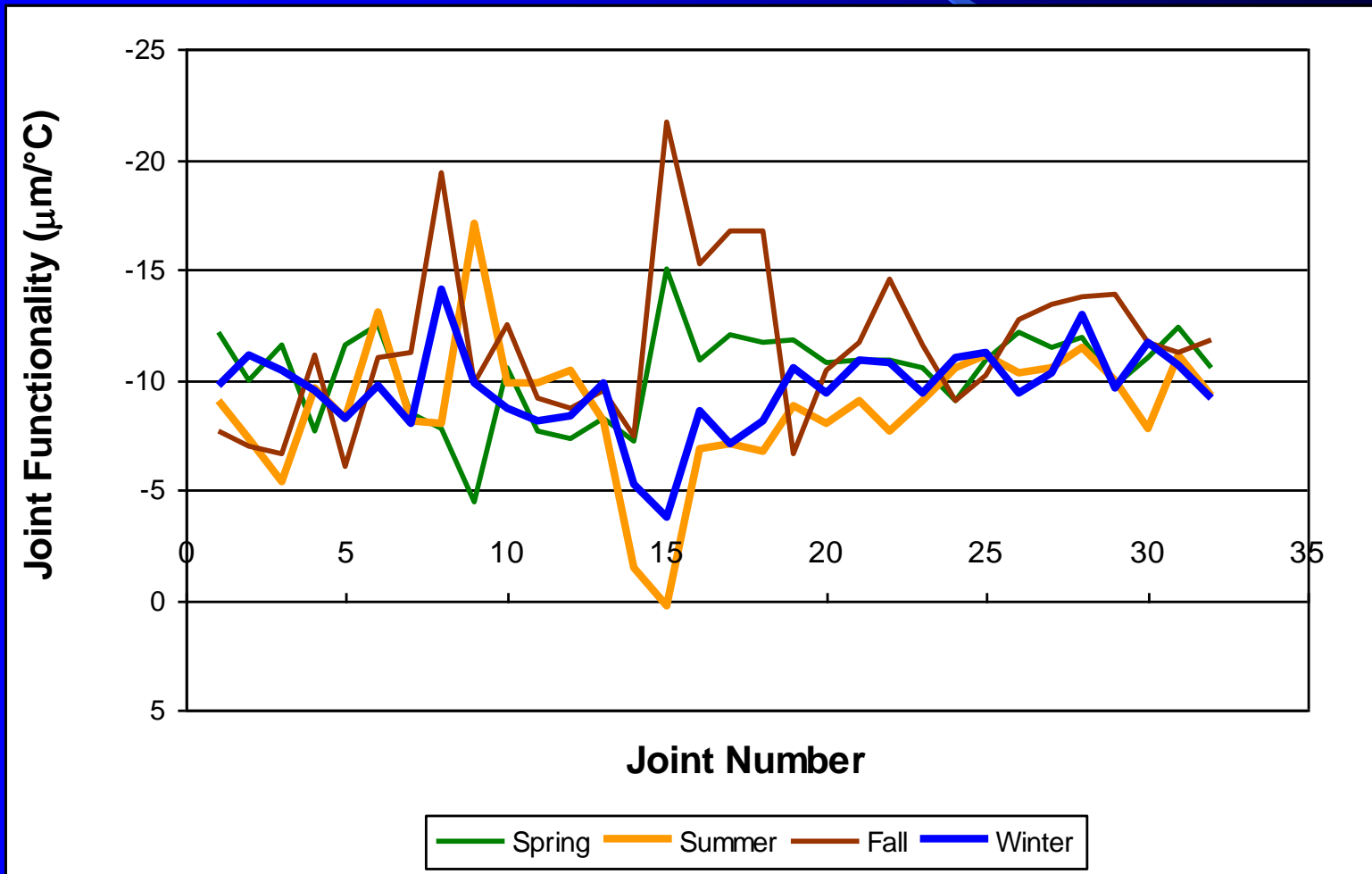
Joint Hinge Functionality

MN_043am, joint no. 17



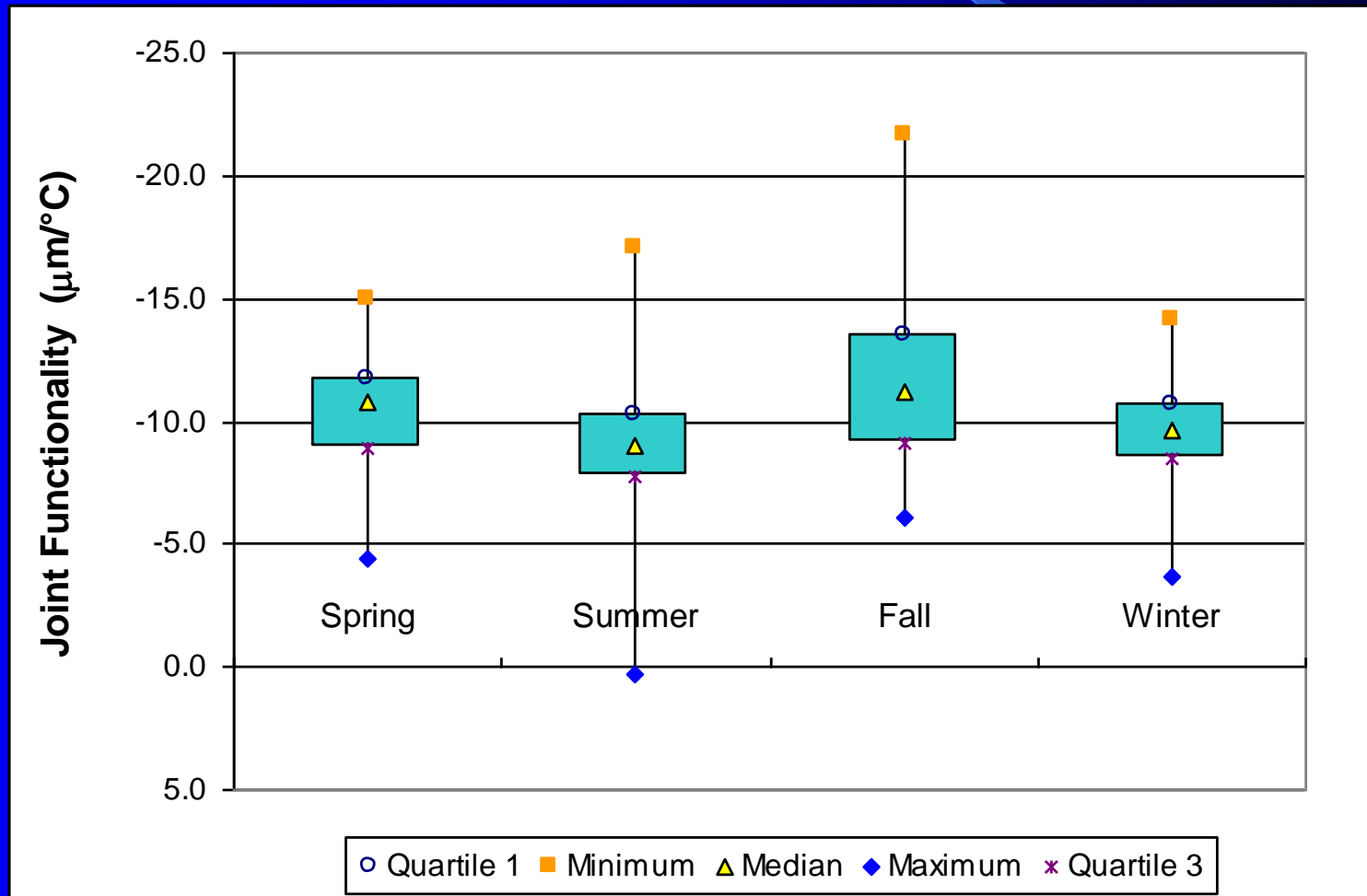
Global Analysis of Joint Functionality

CA_008e, main lane



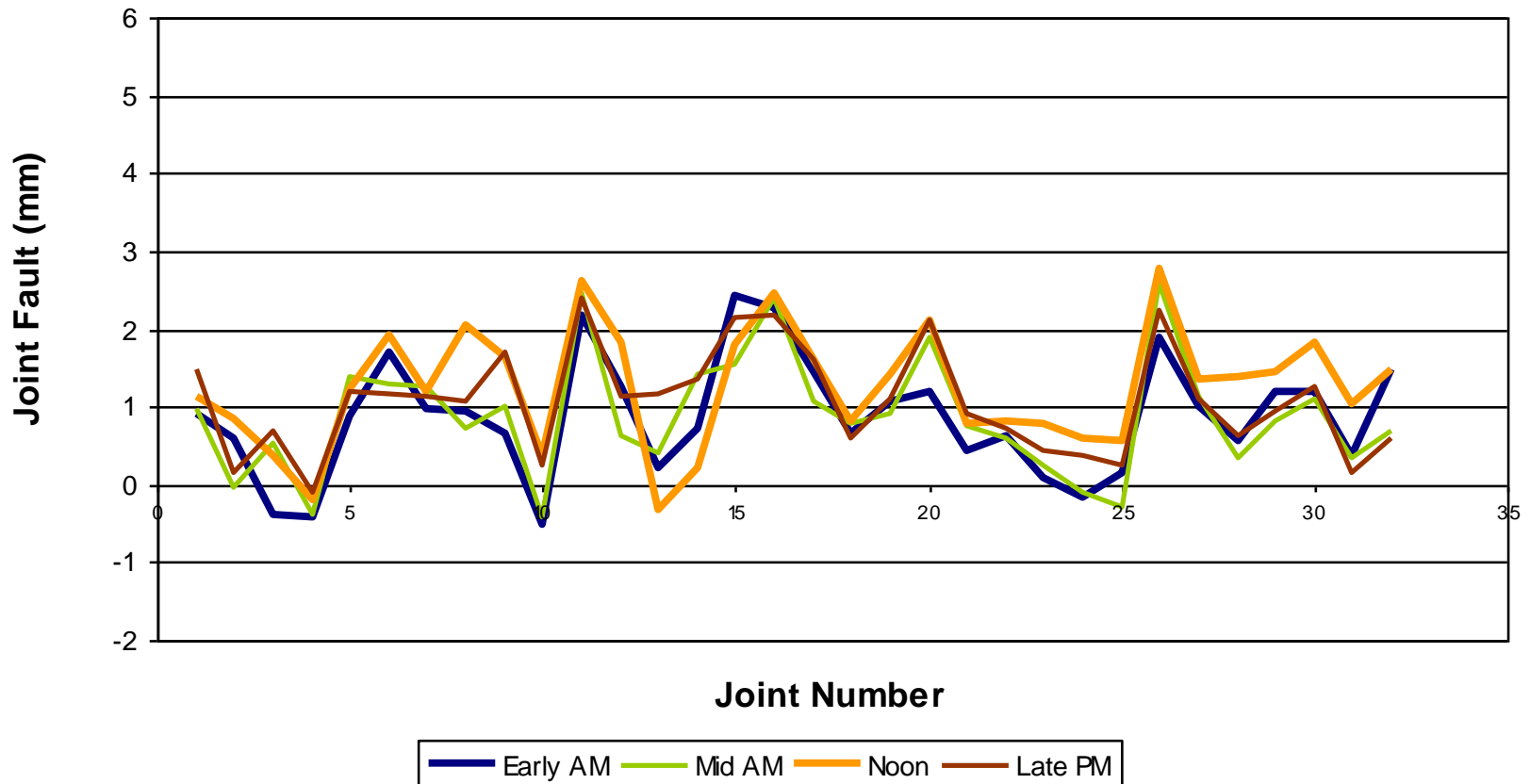
Global Analysis of Joint Functionality

CA_008e, main lane



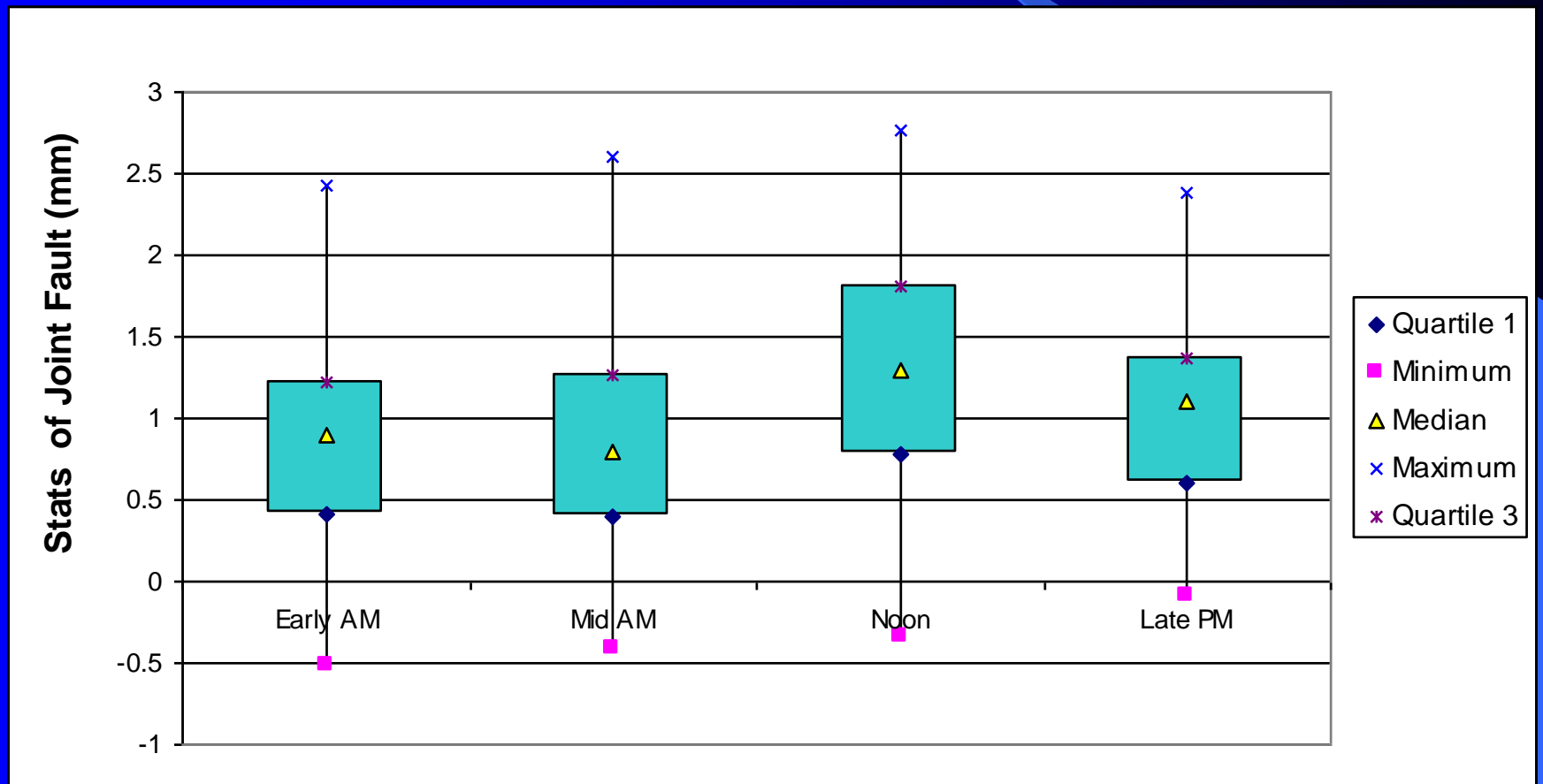
Global Analysis of Joint Faulting

CA_008e, spring, main lane



Global Analysis of Joint Faulting

CA_008e, spring, main lane



Research Products

- An Algorithm to Characterize of JCP Joint Hinge Functionality
- A Robust Method to Estimate JCP Joint Faulting
- A Classification System for JCP Edge Geometry

Next Steps

- Practical Requirements for Profile Measurements
- Joint Finding + Joint Fault Estimate
 - ⇒ A ProVAL module to estimate joint faulting
 - + Replace Manual Measurements and Save Lives