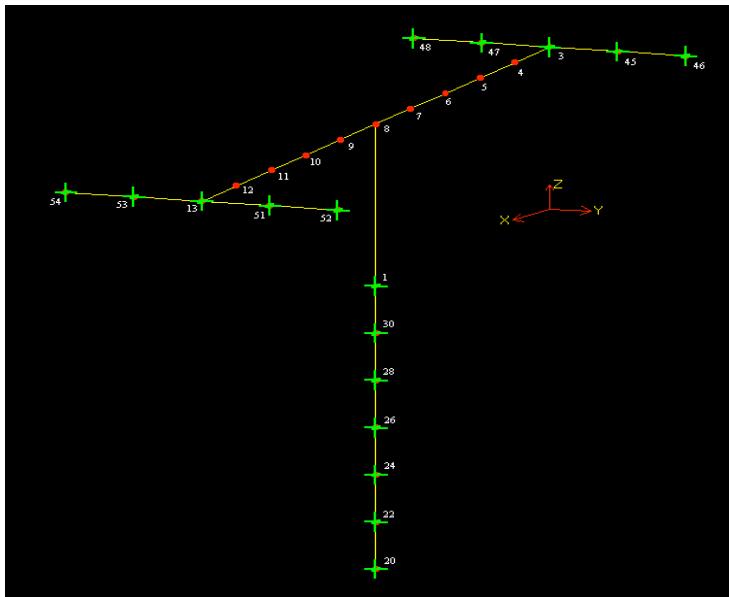


Relation between PSDA and IDA

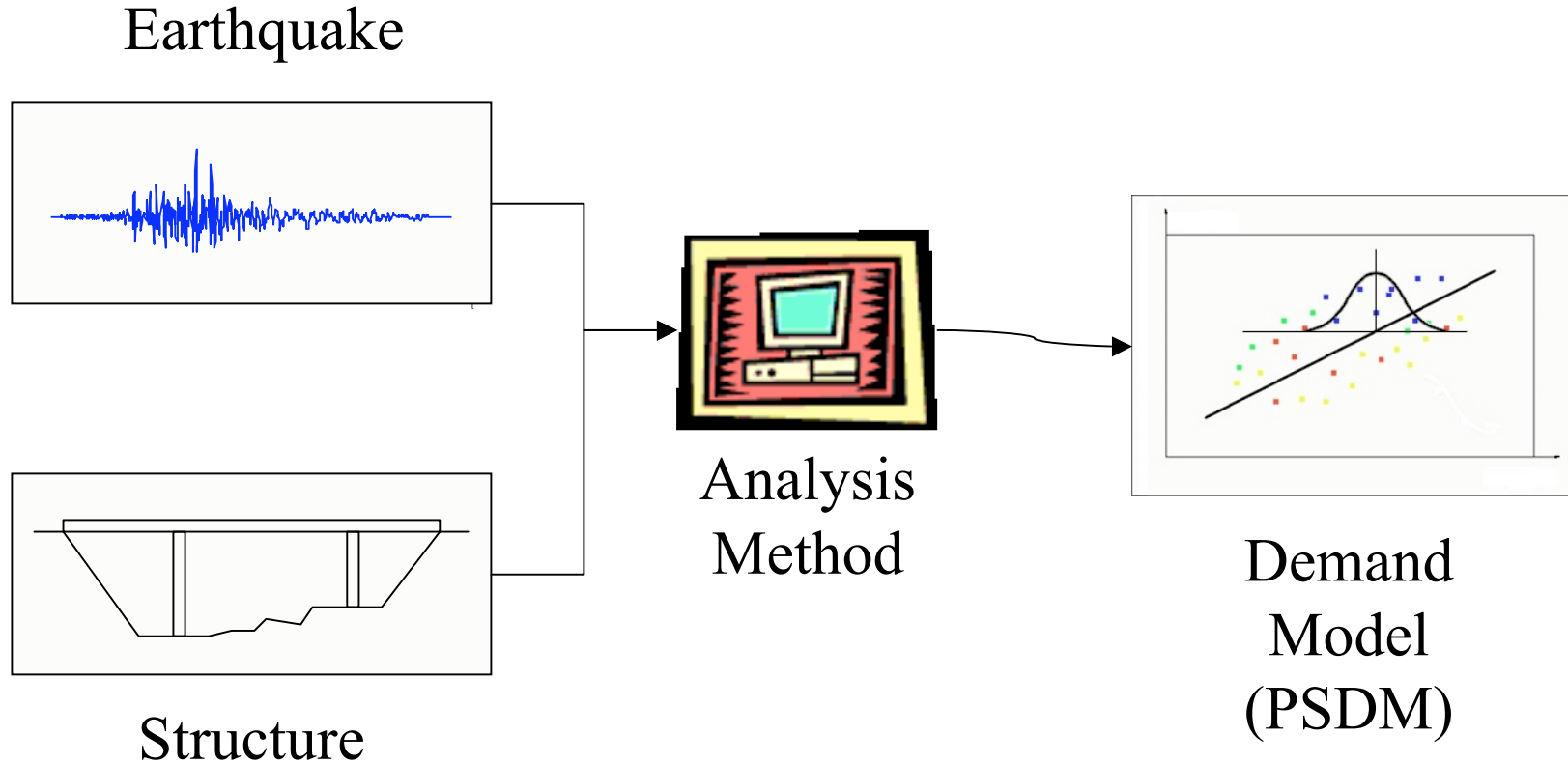


Kevin Mackie
 Bozidar Stojadinovic
 University of California, Berkeley

7th NCEE
 Boston
 July 22-25, 2002

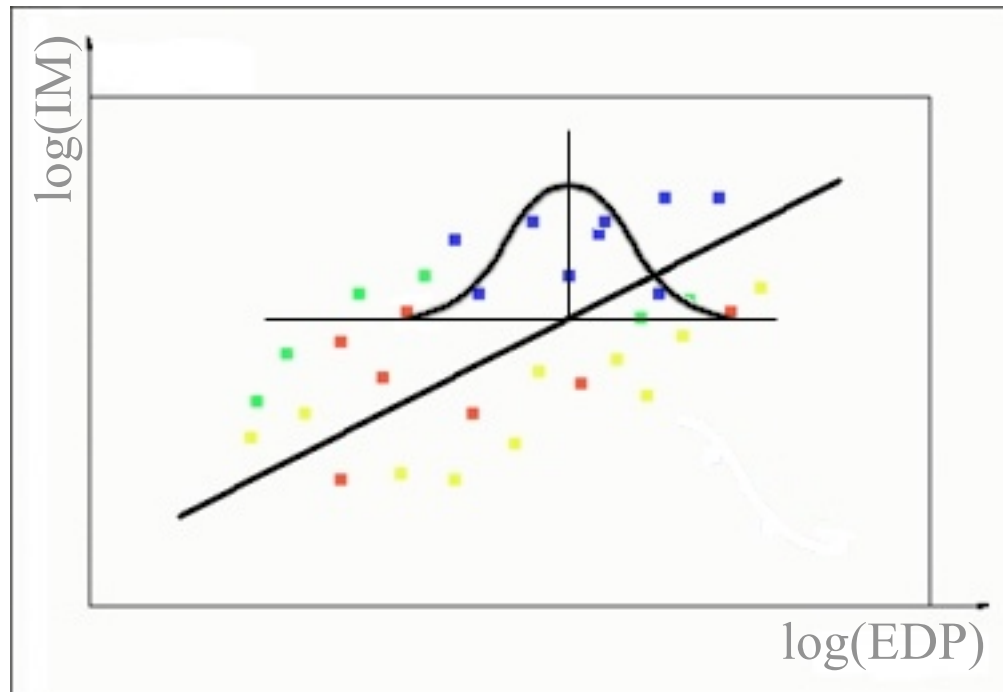
The Big Picture

General Probabilistic Seismic Demand Analysis



What is a PSDM?

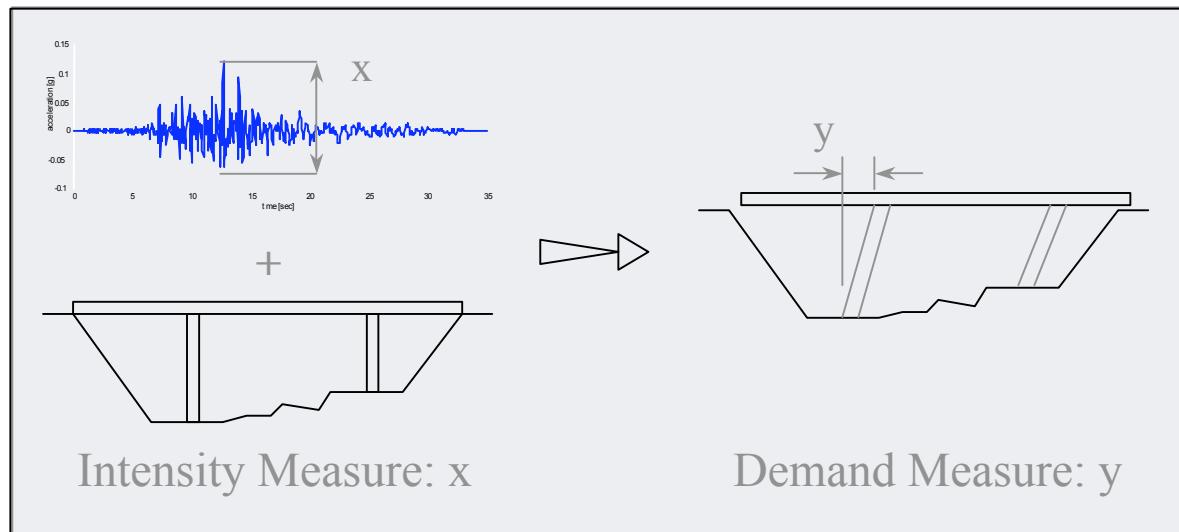
PSDM = Probabilistic Seismic Demand Model



Relationship of seismic Intensity Measures (IM) to structural Engineering Demand Parameters (EDP)

Why a demand model?

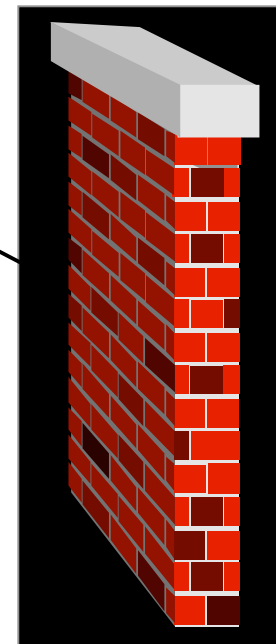
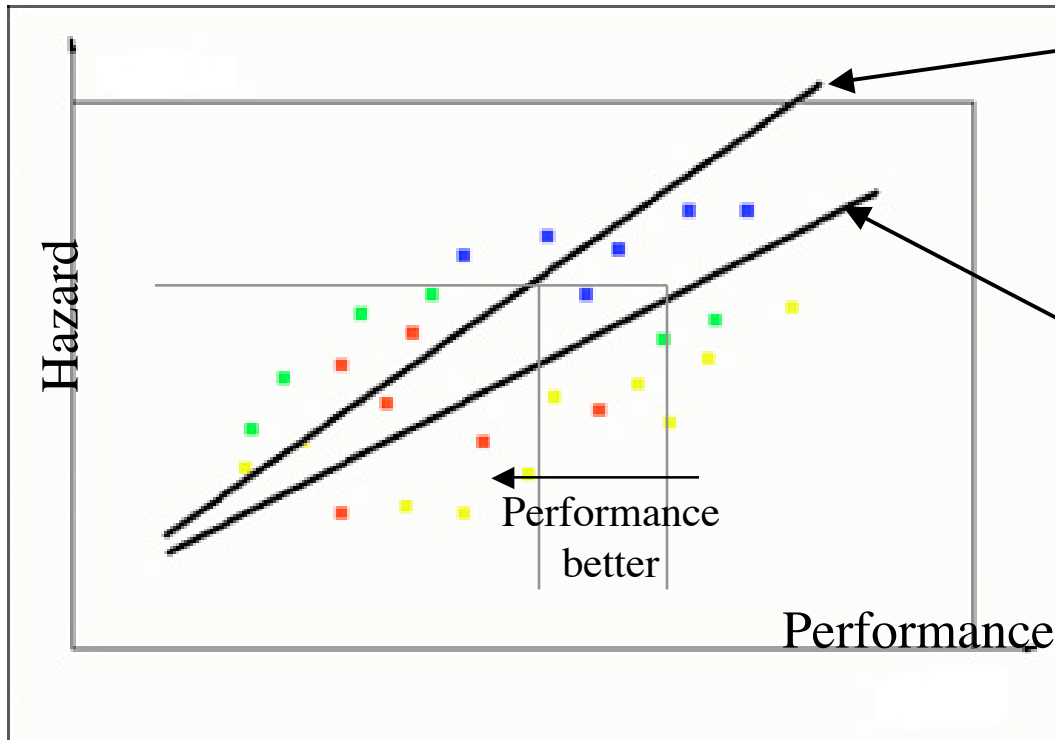
1.) Quantitative Performance Based Earthquake Engineering tool for designers of bridges



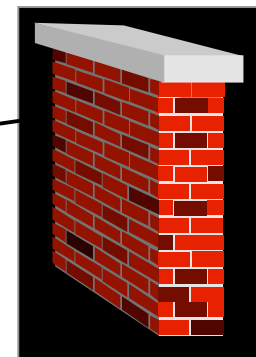
What is probability of y, given x?

Why a demand model?

2.) How do design parameters affect performance?



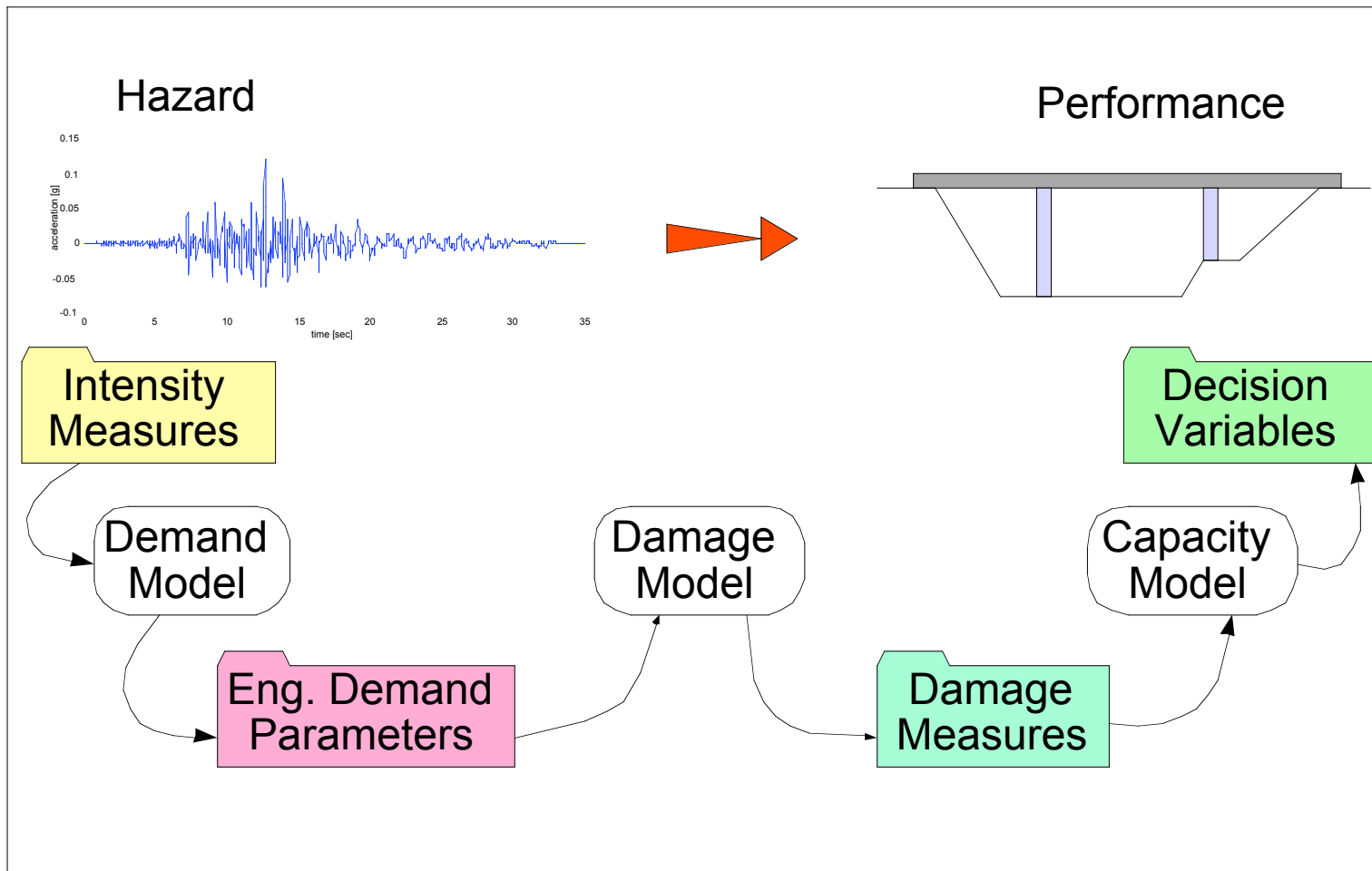
Taller
(flexible)



Shorter
(stiffer)

Why a demand model?

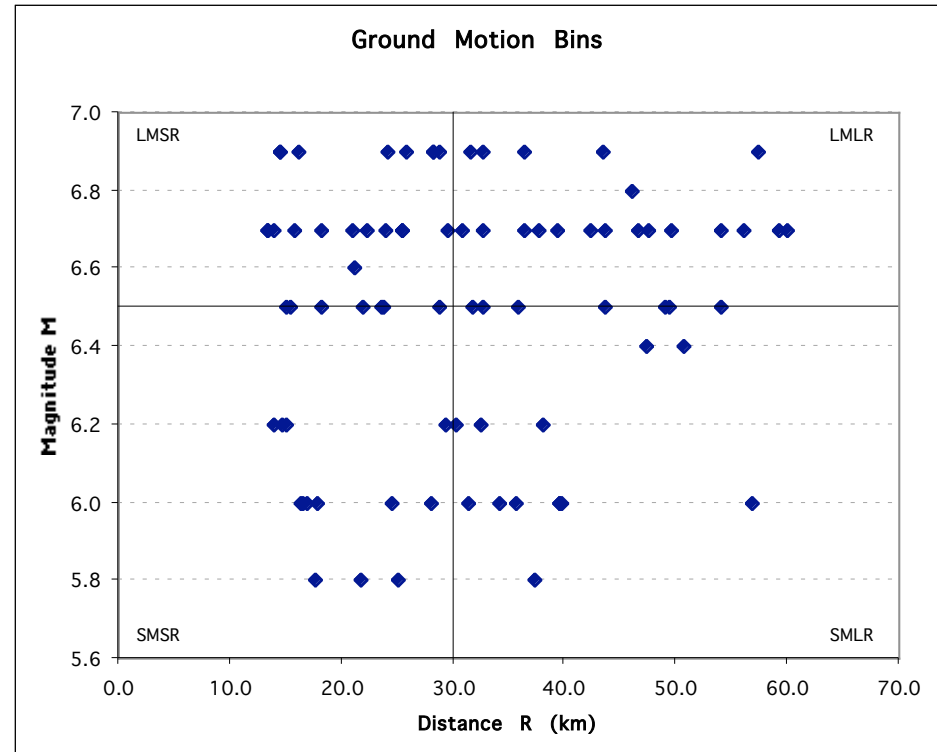
3.) Module in PEER performance-based desing framework



Seismicity: Ground Motions & IMs

- Period Independent Intensity Measures (in this study)
 - Arias intensity
 - PGA, PGV, PGD
- Period Dependent Intensity Measures
 - S_a , S_v , S_d
 - $S_{d,inelastic}$
 - Spectral combinations (Cordova, 2000)

$$S_{a_c} = S_a(T_1) \sqrt{\frac{S_a(2T_1)}{S_a(T_1)}}$$



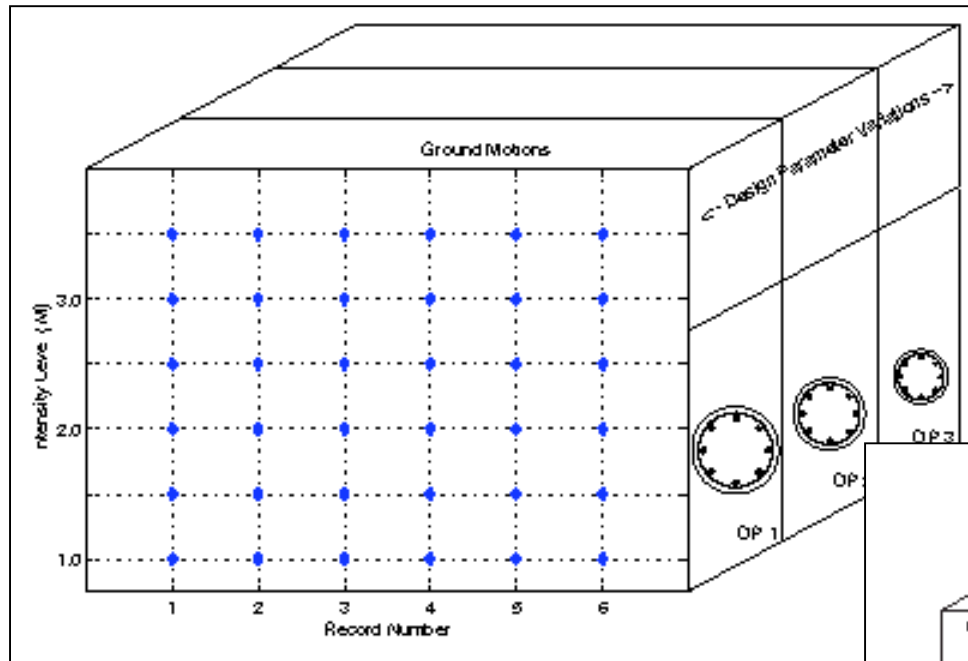
Demand: EDPs

- Local EDPs
 - Steel stress & strain
 - Concrete stress & strain
- Intermediate EDPs
 - Column curvature ductility
 - Maximum column moment
 - Plastic rotation
 - Hysteretic energy
- Global EDPs
 - Displacement ductility
 - Drift ratio
 - Residual displacement index

Single column/bent
highway overpasses in
California

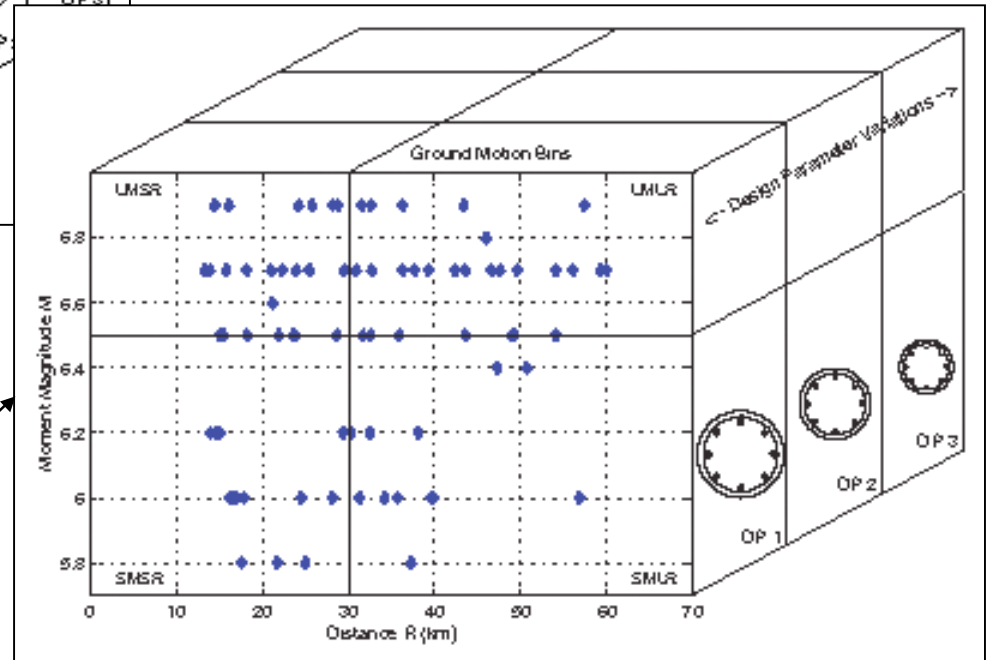


Analysis Method

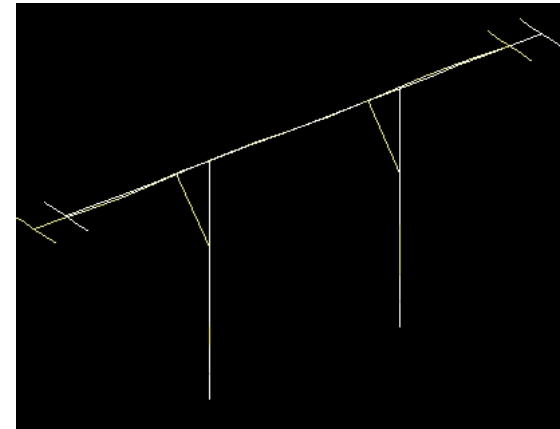
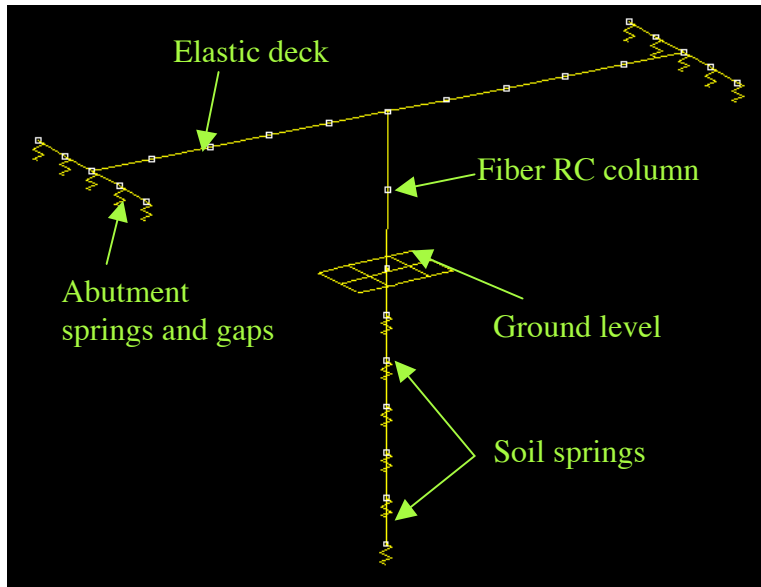


Incremental
Dynamic Analysis
(IDA)

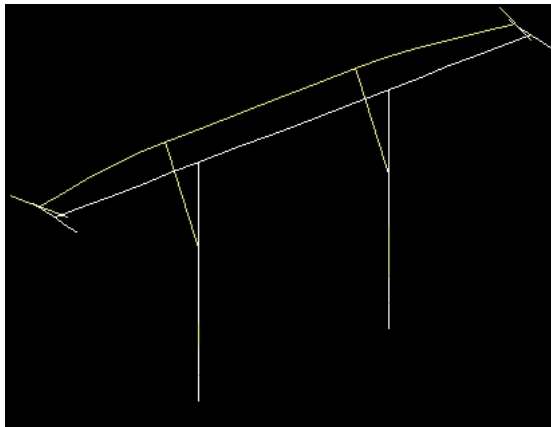
Probabilistic Seismic
Demand Analysis
(PSDA)



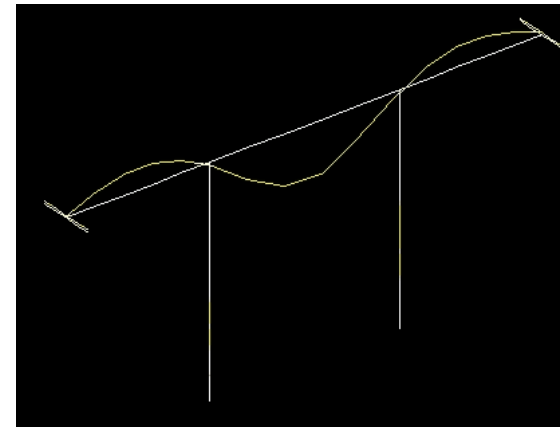
OpenSees Bridge Model



Mode 1 - Longitudinal

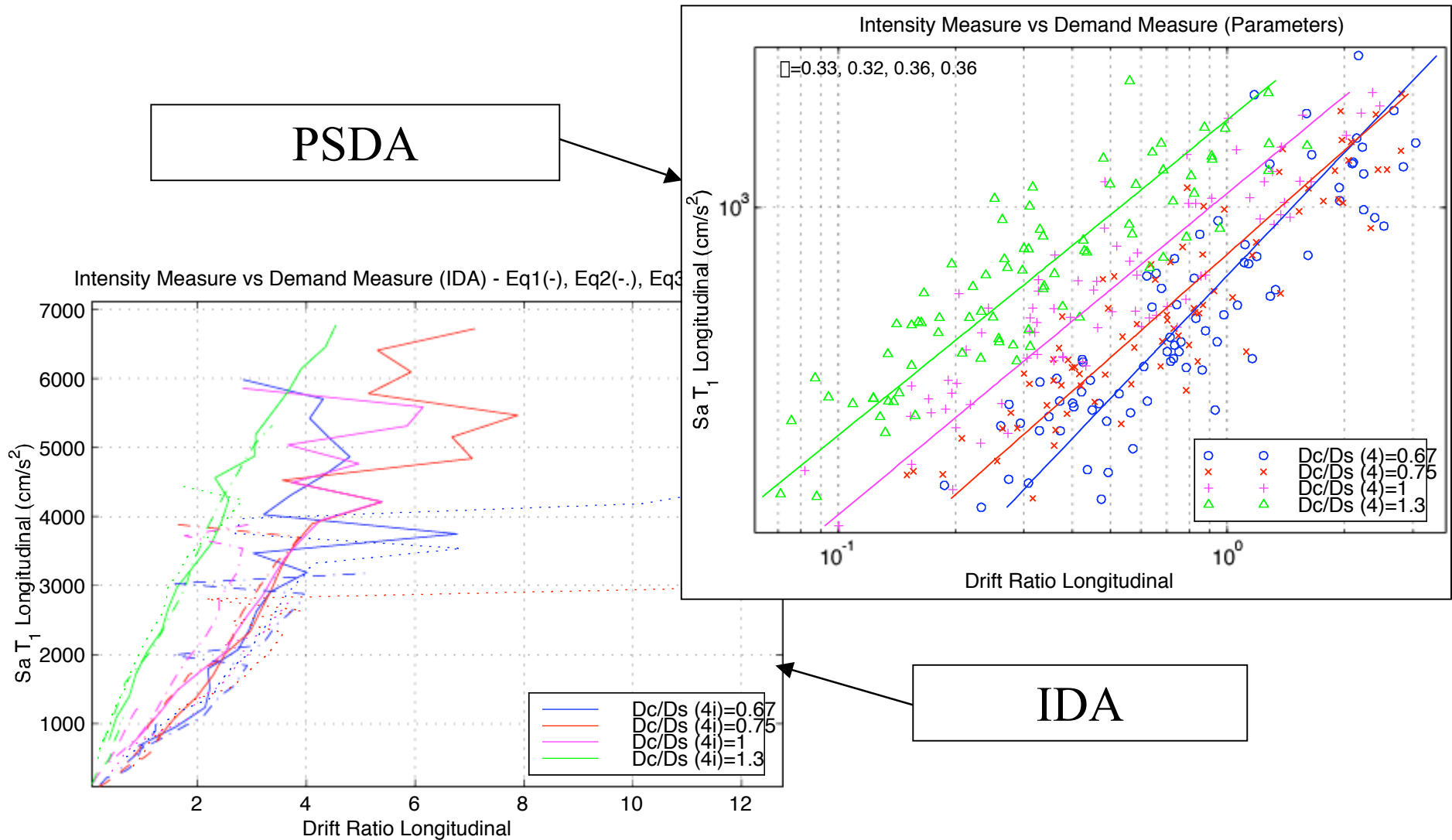


Mode 2 - Transverse



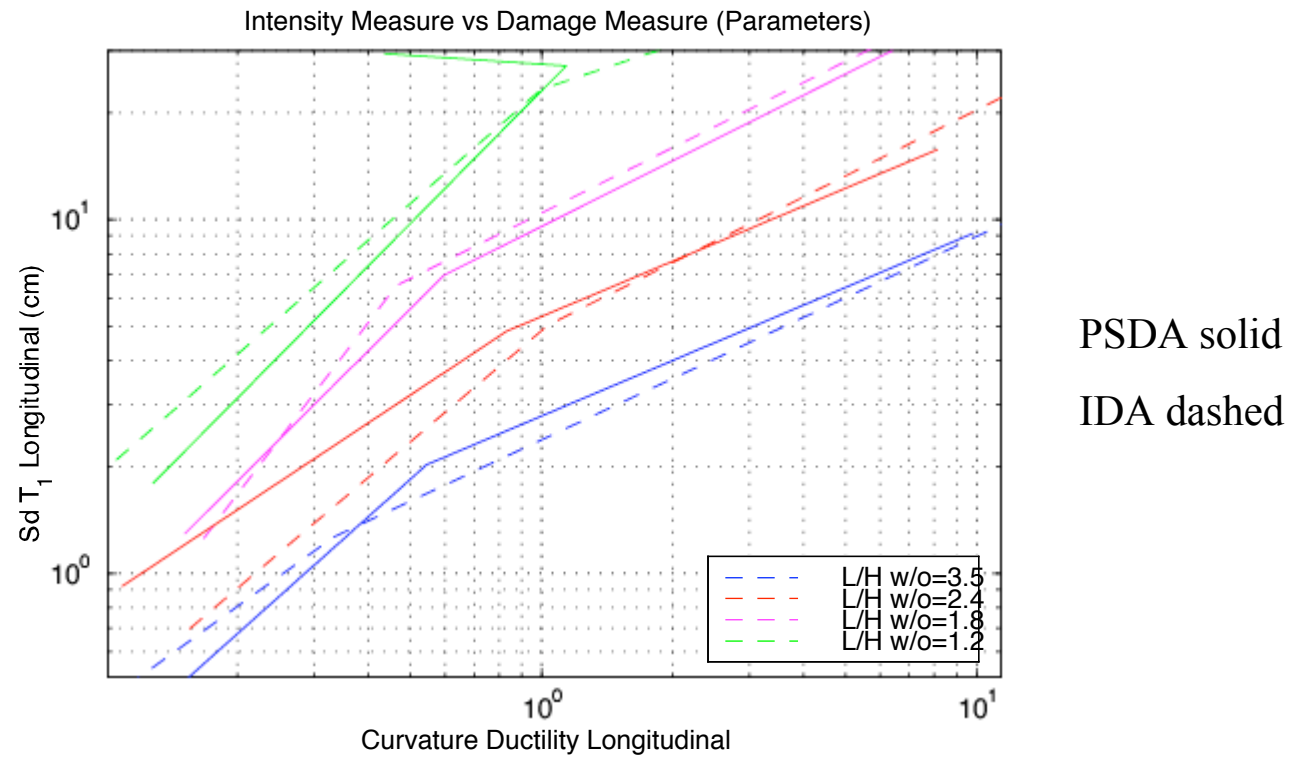
Mode 3 - Vertical

Resulting Demand Models



IDA-PSDA Median Comparison

Sd_{T1} -curvature ductility (bilinear), 4x20 IDA matrix

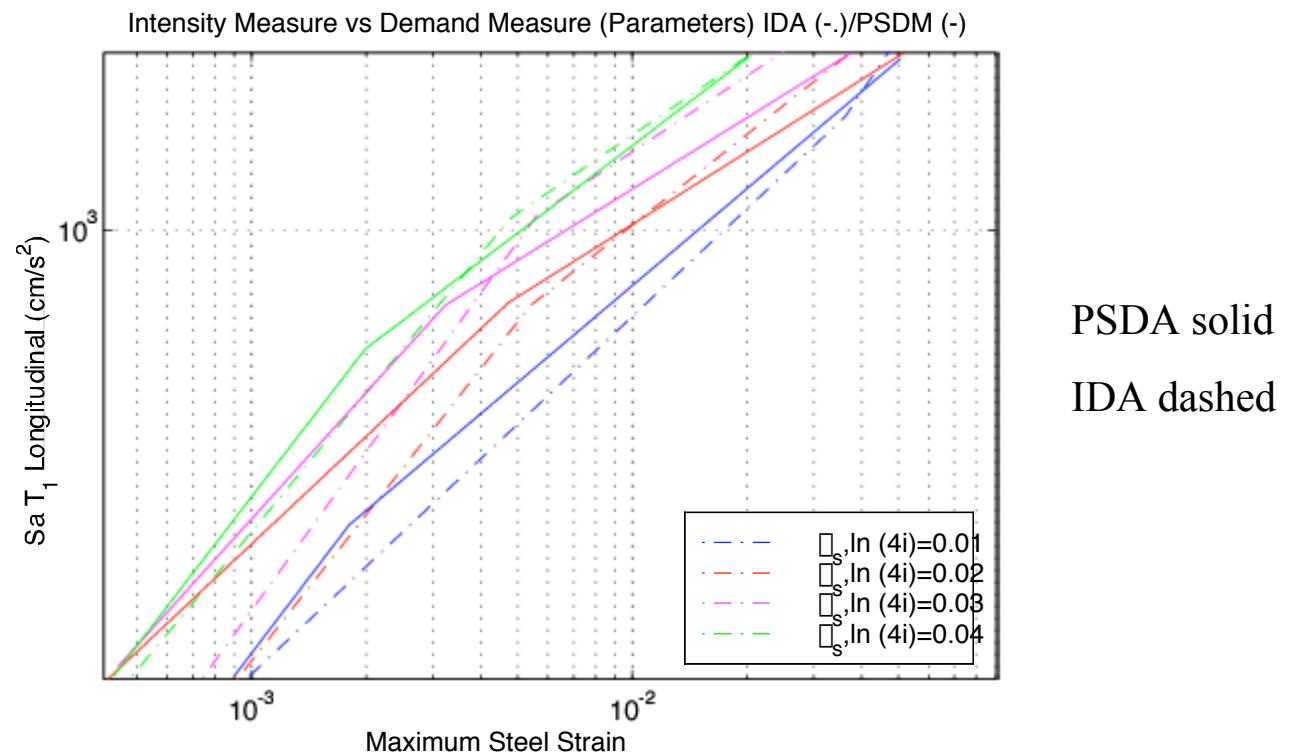


Span length to column height (L/H) sensitivity

1-bent bridge without abutments

IDA-PSDA Median Comparison

Sa_{T1} -steel strain (bilinear), 4x20 IDA matrix

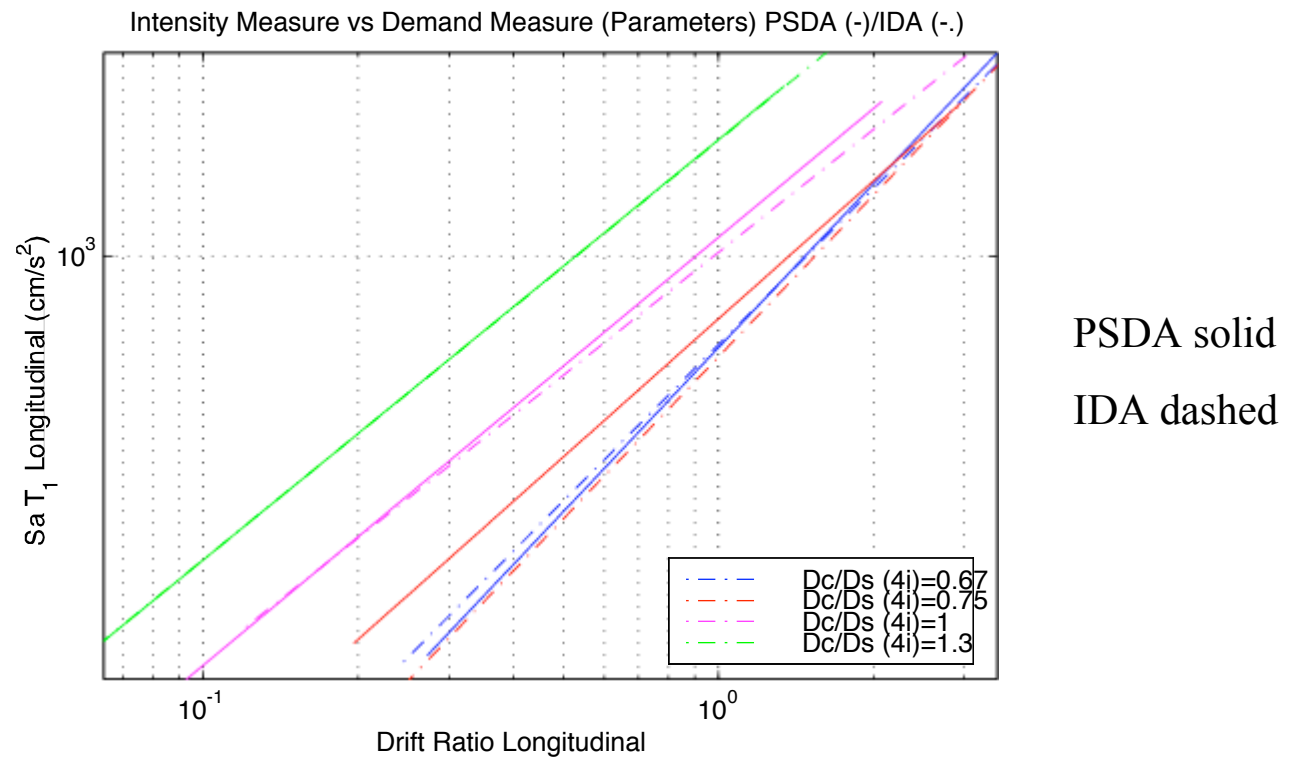


Column longitudinal steel ratio (ρ_s) sensitivity

1-bent bridge with abutments

IDA-PSDA Median Comparison

Sa_{T_1} -Drift ratio (linear), 4x20 IDA matrix, “i” Bin

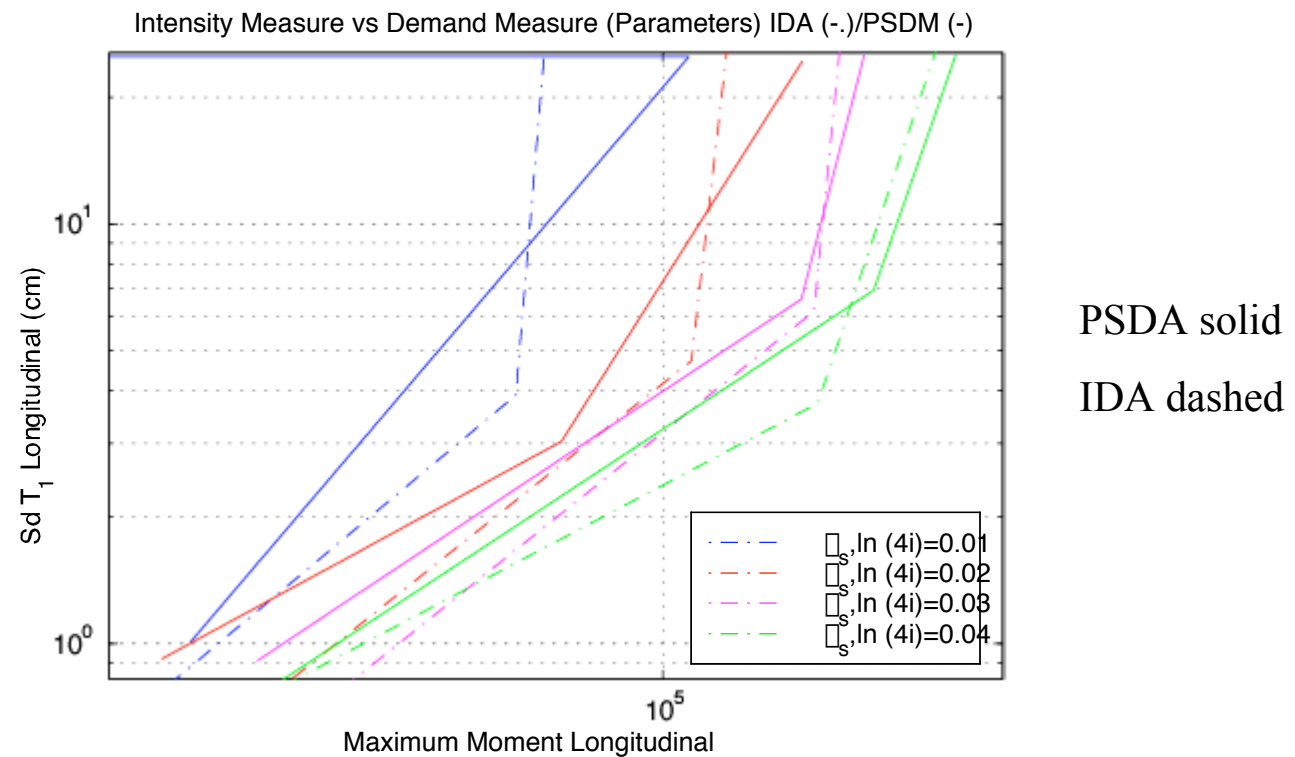


Superstructure depth to column diameter ratio (Dc/Ds)

1-bent bridge with abutments

IDA-PSDA Median Comparison

Sd_{T1} -Moment (bilinear), 4x20 IDA matrix

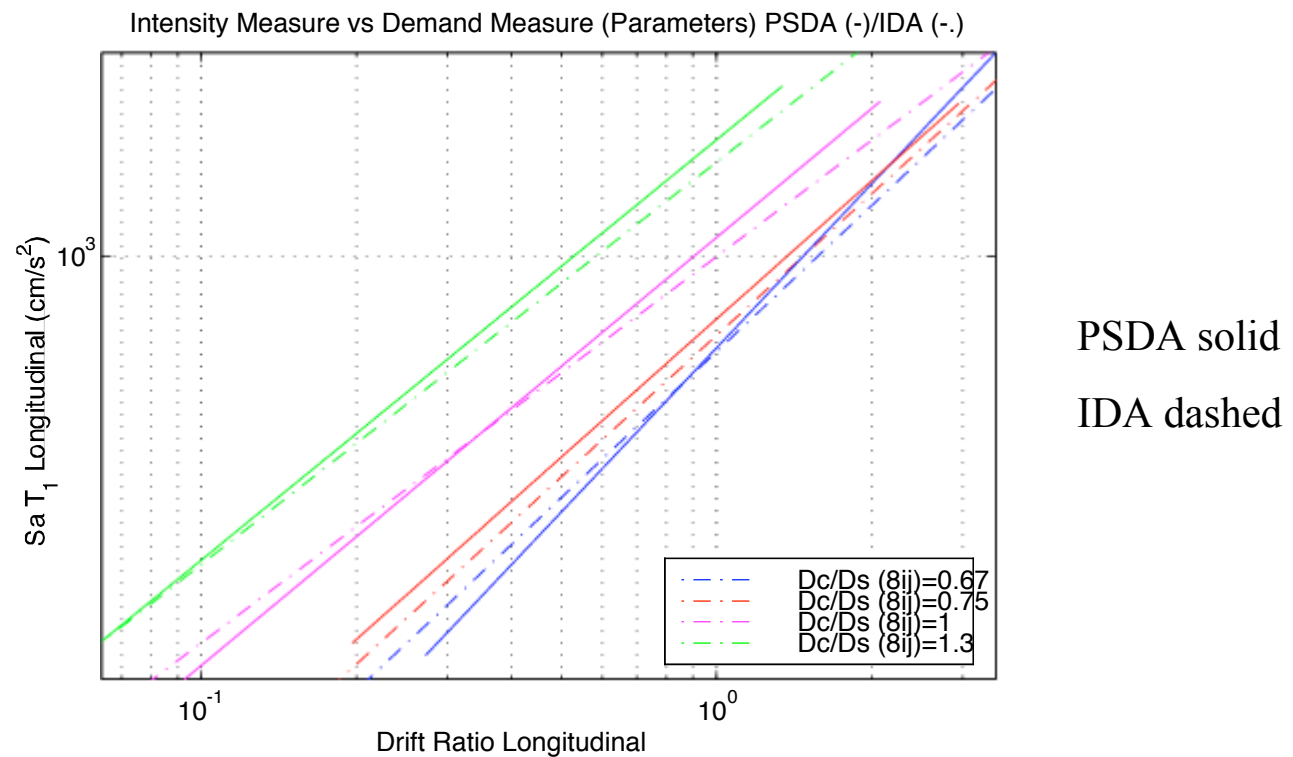


Column longitudinal steel ratio (ρ_s) sensitivity

1-bent bridge with abutments

IDA-PSDA Median Comparison

Sa_{T1} -Drift ratio (linear), 8x10 IDA matrix

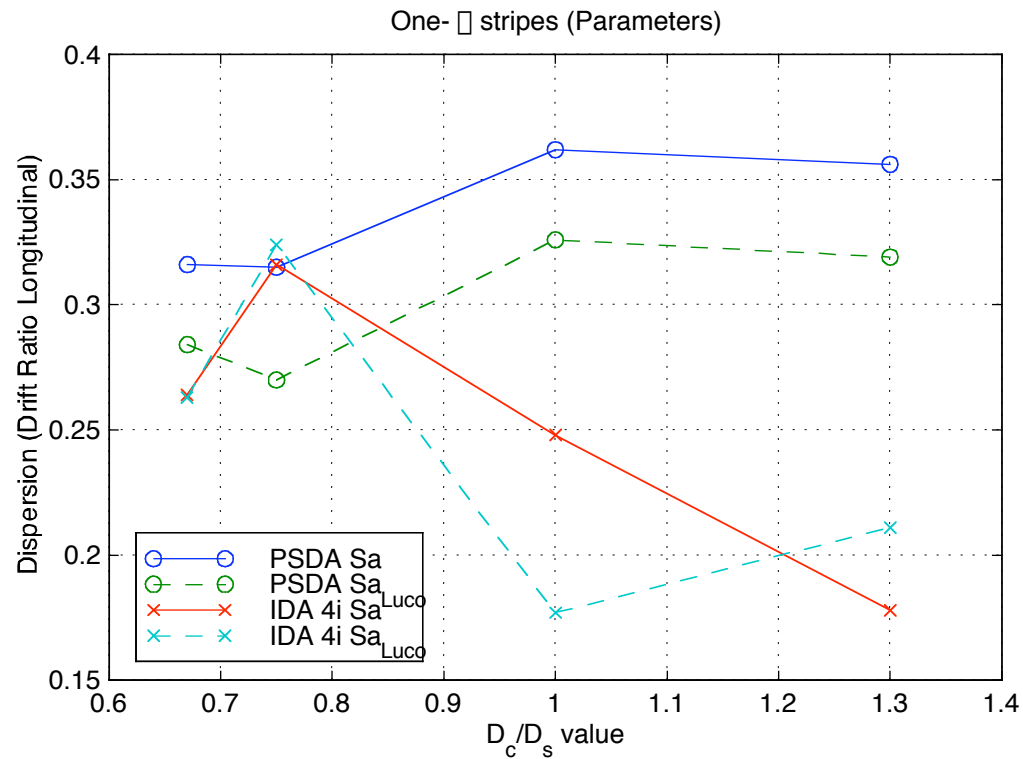


Superstructure depth to column diameter ratio (Dc/Ds)

1-bent bridge with abutments

IDA-PSDA Dispersion

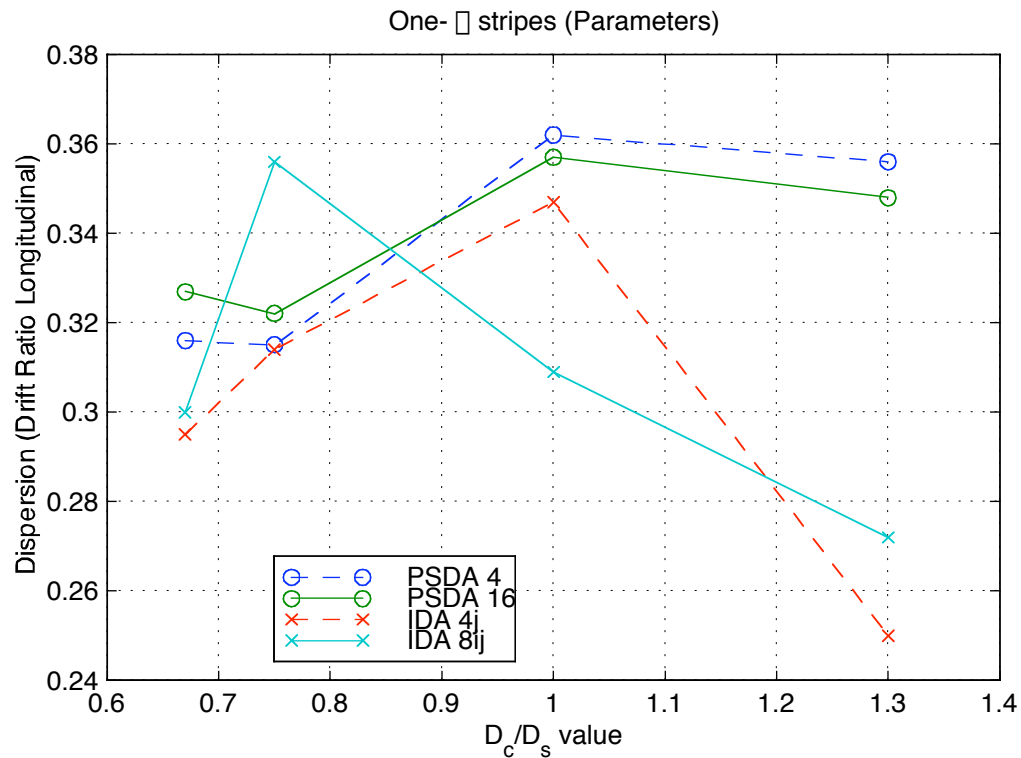
Sa-Drift ratio, 4x20 IDA matrix



- SaC reduces real dispersion
- IDA under-predicts with 4x20 matrix

IDA-PSDA Dispersion

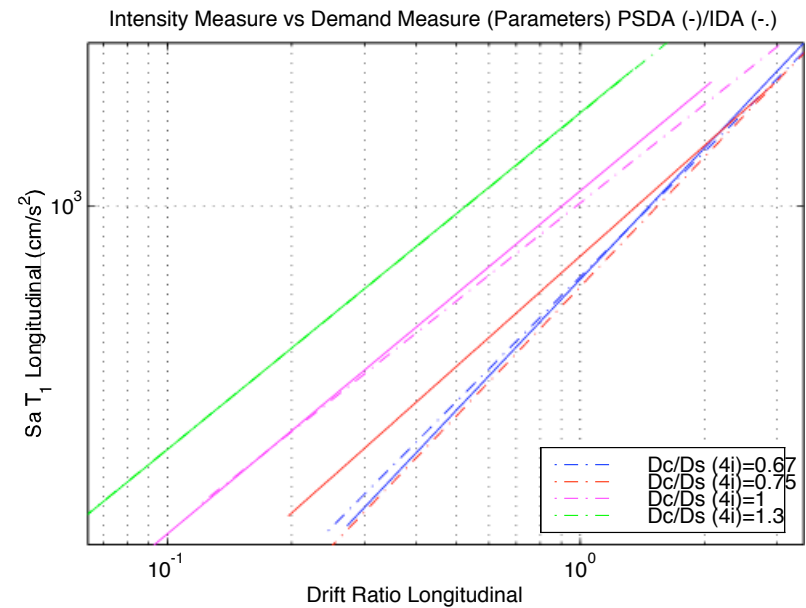
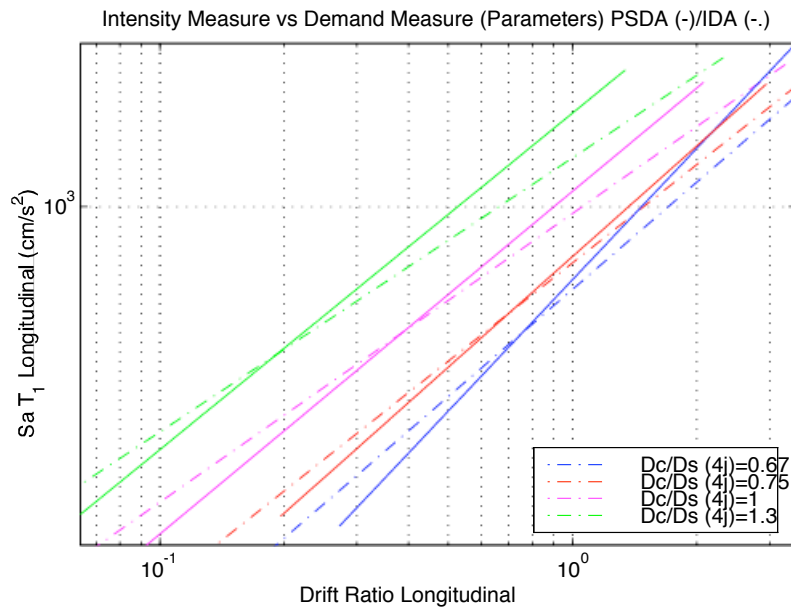
Sa-Drift ratio, 8x10 IDA matrix



- IDA 4x20 under-predicts dispersion
- IDA 8x10 approaches real dispersion

IDA Bin Dependence

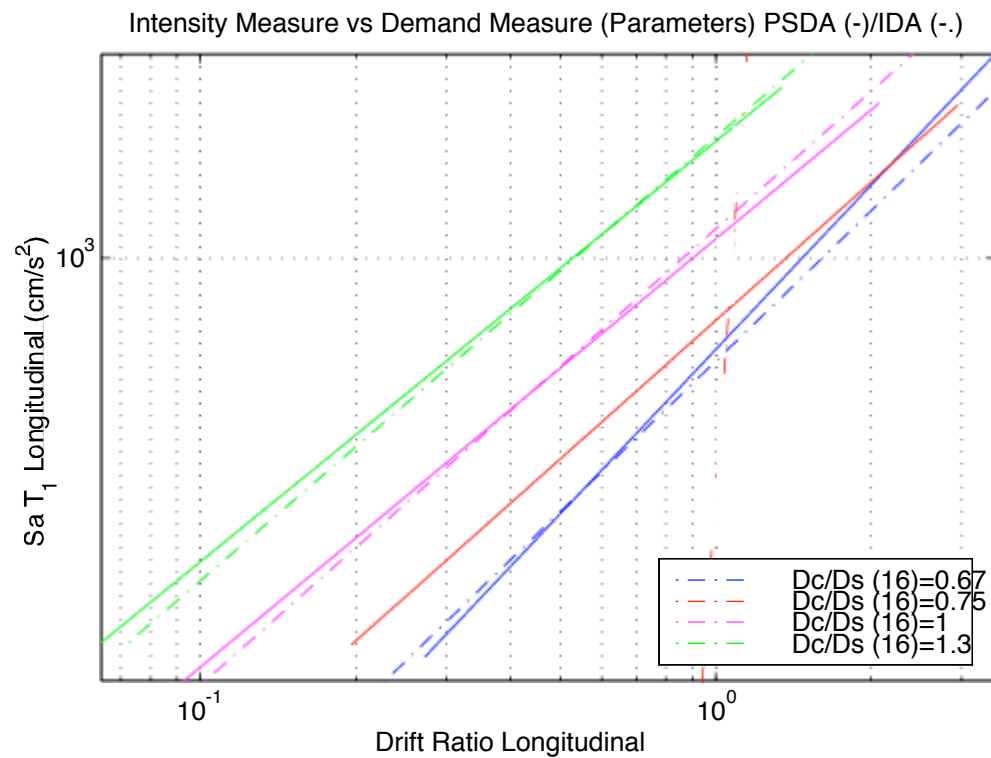
Sa_{T1} -Drift ratio (linear), 4x20 IDA matrix, “j” Bin



1-bent bridge with abutments

Verification of PSDA

250x4 PSDA matrix to verify “real” median and dispersion



Conclusions

- PSDA captures “real” model median and dispersion
 - > Use for developing PSDMs
- IDA 4x20 captures median, under-predicts dispersion
- IDA sensitive to ground motion selection for 4 bins
- IDA 8x10 mostly captures median, dispersion
 - > Use for “stripe” analysis

Thank You!

- Questions?
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- Visit <http://millerbird.ce.berkeley.edu>



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