



Célébrons **175** ans 

Program: Geoscience Public Safety (2014/19)  
Project: National Scale Geohazard Risk Project

## **Regional Seismic Risk Assessment – ER<sup>2</sup> web application**

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# ER<sup>2</sup> project description

The **Problem** we are trying to solve is threefold:

- i) existing seismic risk assessment tools ill-suited for adaptation for Canadian hazard & exposure settings,
- ii) inadequate for application by the broader non-expert public safety community, and
- iii) no direct communication of the risk results to end users.

**Objective:** Reduce the communication gap between scientists and engineers and community needs to support informed emergency response and mitigation planning

**Method:** Development of a Canadian web-based application for easy to use multiple hazard risk assessment and mapping

- i) limited user input
- ii) standardized and internationally accepted risk computation methods
- iii) leverage open source data

**Output:** State of the art knowledge translated into an intuitive & easy to use software

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# Public safety community needs

Earthquakes, Floods, .....



**a) Emergency response**

**Rapid risk assessment**



**b) Mitigation planning**

**Modelling interactive scenarios**

**Risk assessment process** → **hazard** × **exposure** × **vulnerability**

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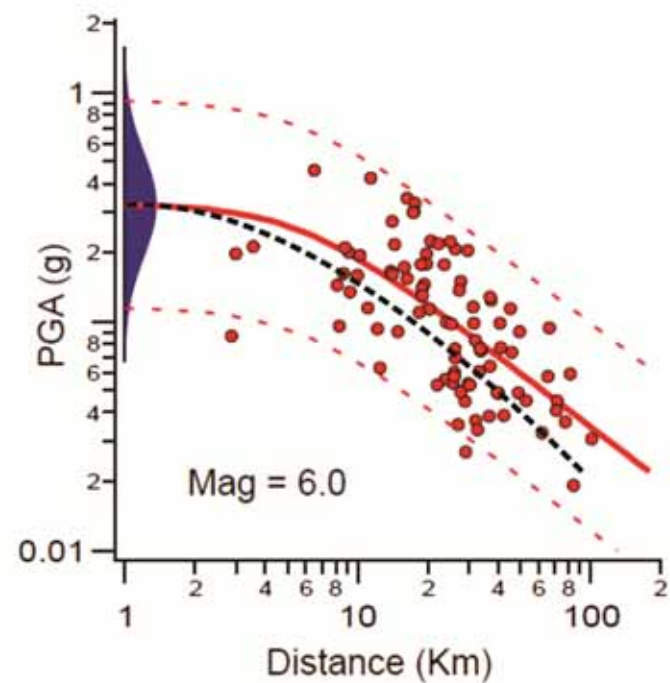
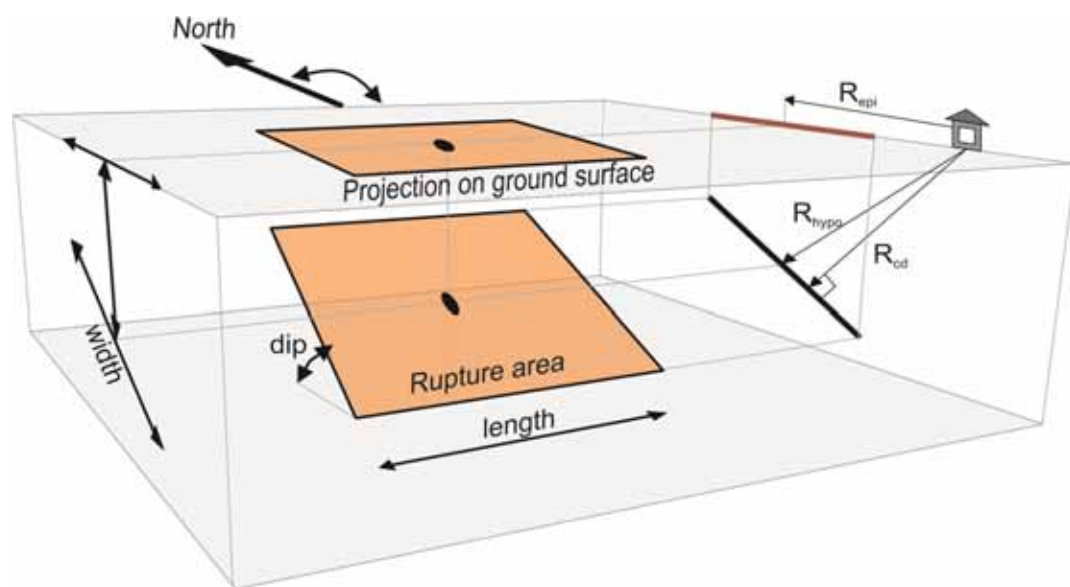


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# Seismic hazard (fault mechanisms & attenuation)



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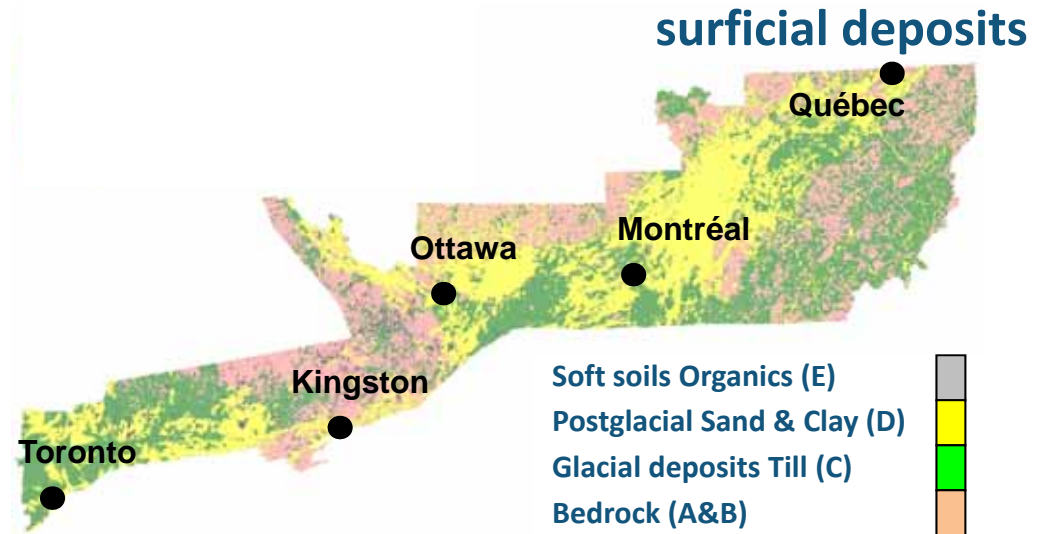
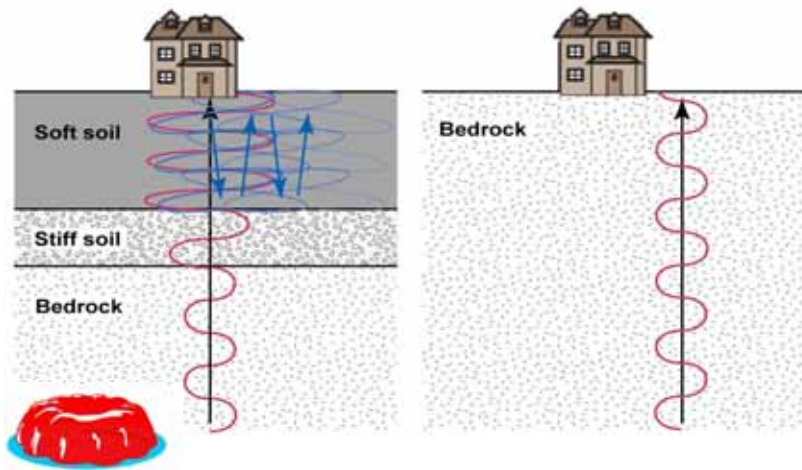
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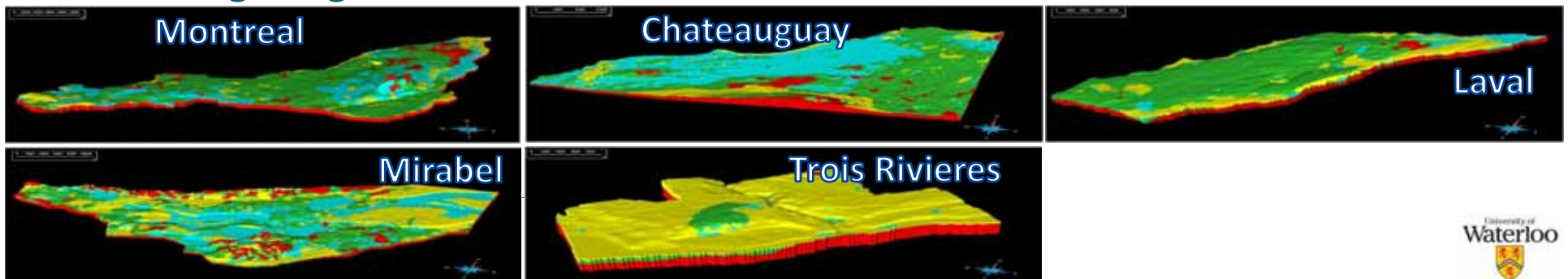


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# Seismic hazard (local site effects)

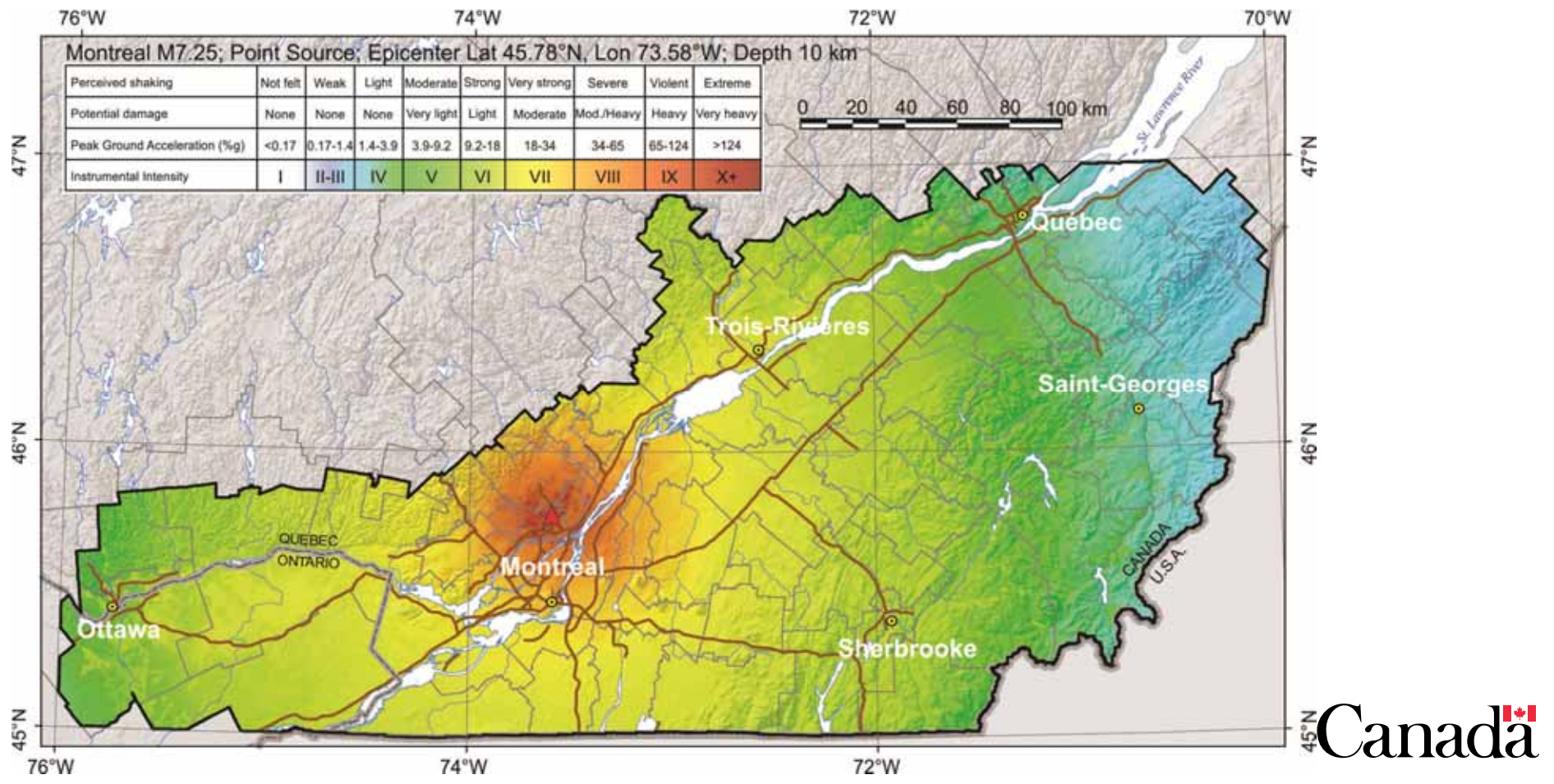


## 3D geological models





# Seismic hazard (M7.25 scenario)



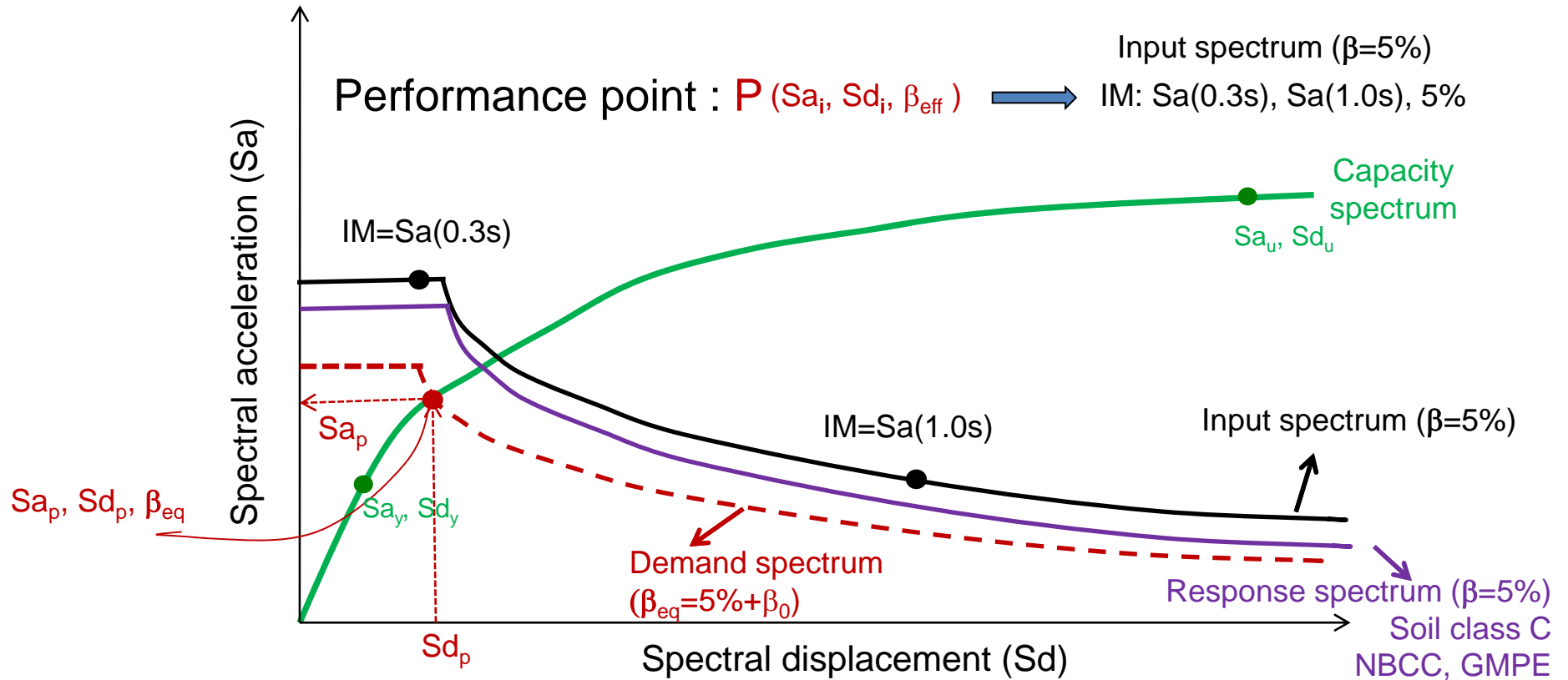


# Building inventory





# Vulnerability



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# Vulnerability



**Slight (DS1):**  
First wall Flexural cracking



**Moderate (DS2):**  
First wall Shear cracking



**Extensive (DS3):**  
Maximum base shear capacity of the building



**Complete (DS4):**  
20% reduction in base shear capacity



**Collapse (DS5)**

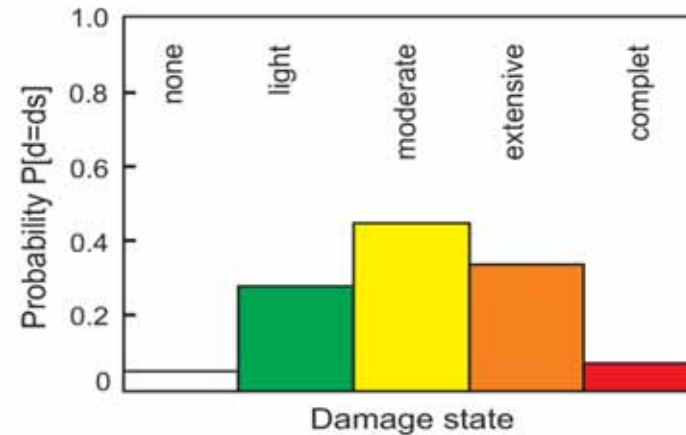
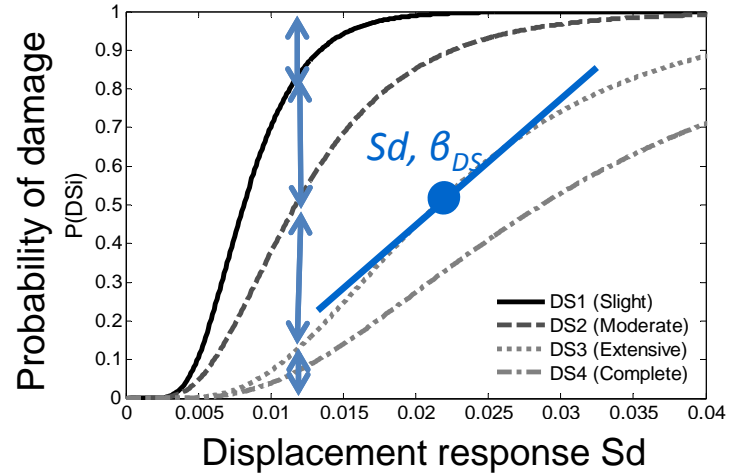
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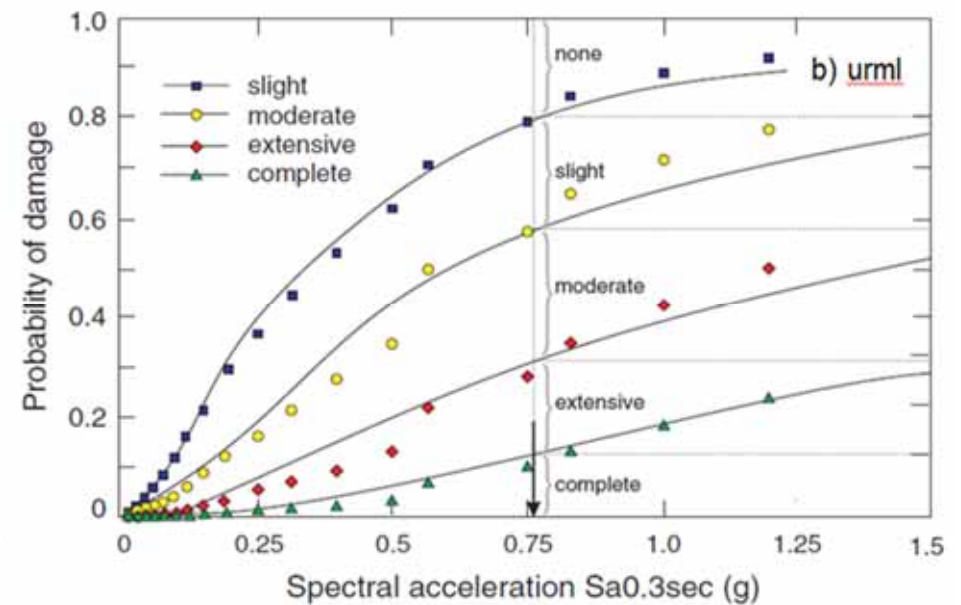
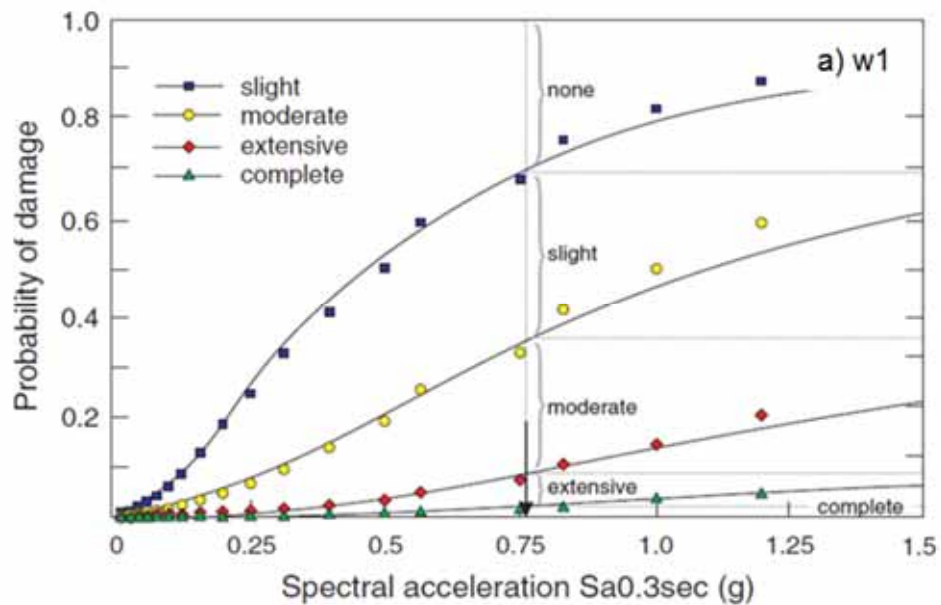
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## Fragility curve concept



# Vulnerability

Examples of fragility curves used in ER<sup>2</sup>:



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## Vulnerability: ER<sup>2</sup> damage database

- *Generated 3 tables for different GMPEs (AB06, AA13, B97)*
- *Structural, non-structural drift and non-structural acceleration damages and human losses*
- *128 building types*
- *x 4 magnitudes: 5, 6, 7, 8*
- *x 5 distances: 10km, 20km, 30km, 40km, 60km*
- *x 5 NEHRP soil types: A, B, C, D, E*
- *x 51 spectral displacement values: 0.25mm – 25m*
- *= 652,800 records per GMPE*

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# Validation against Hazus results

- *HAZUS parameters + two tables for GMPE: AB06 and B97*
- *Structural damage, and casualties for:*
  - 13 building types: "W1-h", "W1-m", "S1L-m", "S2L-m", "C1M-m", "W1-p", "S1L-p", "S1M-p", "S2L-p", "S2M-p", "S5L-p", "URML-p", "URMM-p"*
- *x 4 magnitudes: 5, 6, 7, 8*
- *x 5 distances: 10km, 20km, 30km, 40km, 60km*
- *x 5 NEHRP soil types: A, B, C, D, E*
- *x 51 spectral displacement values:  $10^{-2}$  –  $10^3$ in*
- *= 66,300 records per GMPE*



## Validation against Hazus results

- *At lower magnitudes the results were almost identical to those from HAZUS*
- *In average, the deviation from Hazus results for structural damage and indoor casualties was  $\leq 1\%$ .*
- *The maximum observed deviation was 11.8% for one M8 scenario*

Building type	M6		M7		M8	
	Avg	Max	Avg	Max	Avg	Max
W1-m	0.24	1.71	0.53	1.94	0.82	2.94
URML-p	0.28	2.49	0.46	2.01	0.30	3.46
W1-p	0.28	1.64	0.69	2.09	0.85	3.50
S1L-p	0.31	1.85	0.80	1.86	1.75	4.18
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
W2-m	0.68	6.16	1.33	4.56	1.99	6.39
W2-p	0.78	3.18	1.78	4.18	3.89	9.59
MAX DEV	1.33	6.16	2.03	5.20	4.88	11.81
AVG DEV	0.22	-	0.59	-	1.00	-

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# Conclusions

- Rapid Risk Assessment methodology has been successfully developed and tested ;
- Precomputed databases consist of:
  - thickness and type of soil materials
  - number of building categories, occupancy, value....
- Vulnerability database consists of fragility curves with respect to earthquake Ims :  
Sa0.3sec and Sa1.0sec ;
- Web application is under development ;
- High interest among the public safety community.

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# ER<sup>2</sup> web application



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## Questions ?

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