

**Basics for reliable damage prognosis –
requirements and solutions
for Antakya**

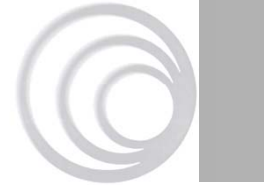
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**** Closing Workshop September 30 – October 2, 2010 ****

*** Antakya, Hatay (Turkey) ***

Introduction



What does “*Reliable*” damage prognosis mean?

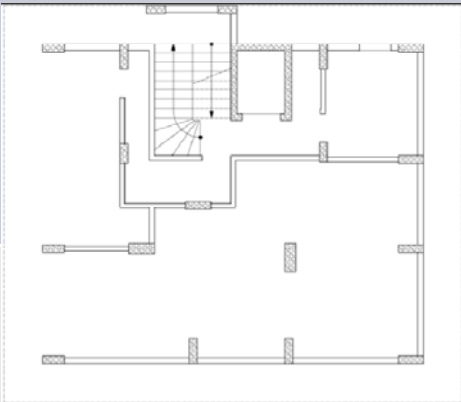


- *seriously, certain, established, successful and proven*

➔ Derivation of main criteria:

- *Use of well known and accepted methods, which are state of the art or transparent “reliable” new developed methods!*
- *Use of all available information from the investigation object and damaging events (impact)!*
- *Consideration of more or less all influencing factors!*



Introduction

Data Layer	Knowledge level	
	Single object	Study area
Investigation object - e.g. age, type of construction, ERD, ...		
Influencing factors - Code generation - Building particularity		
Impact - e.g. expected PGA		

→ What does it means practically for Antakya?

Study Area - Antakya



~ 145.000 inhabitants

~ 27.800 buildings

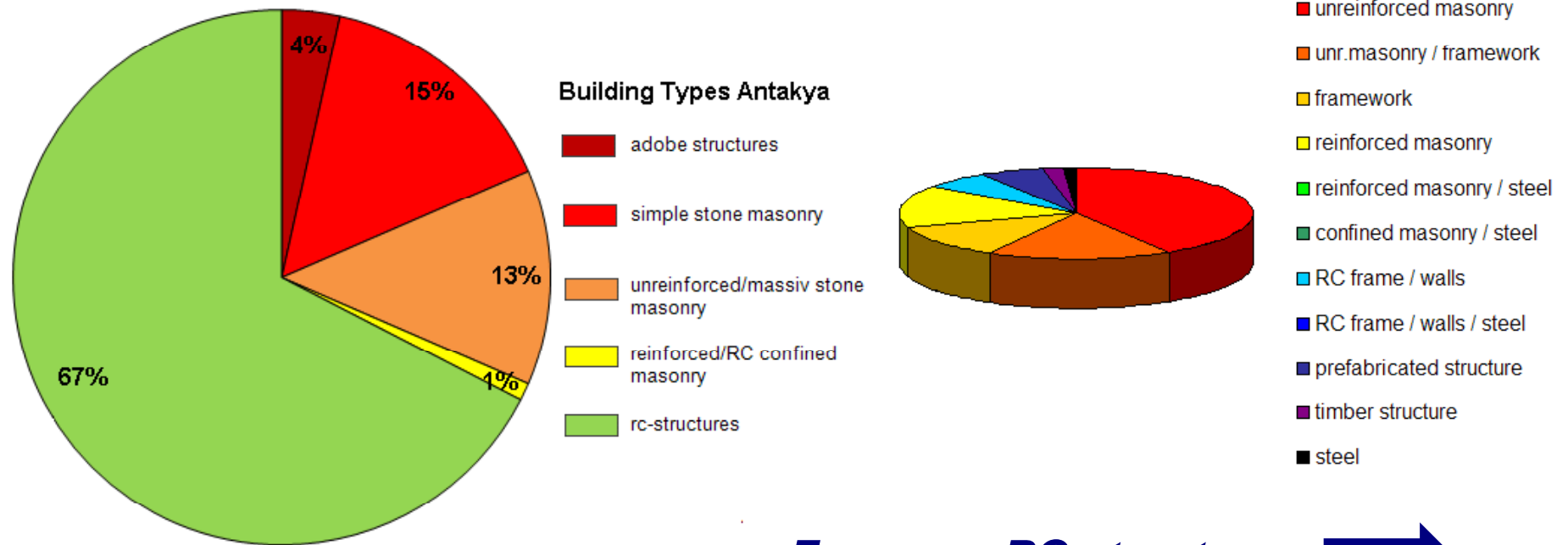
→ Is a “reliable” damage prognosis feasible?

State 2006



Study Area - Antakya

Outcome of EDAC building survey in frame of SERAMAR 2005 - 2007



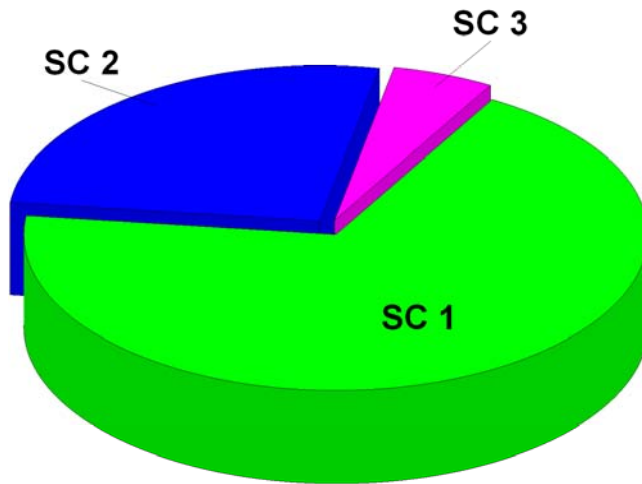
Focus on RC structures




Abrahamczyk, L., Schwarz, J., Lang, D.H., Leipold, M., Golbs, Ch., Genes, M.C., Bikçe, M., Kaçin, S. and Gülkan, P. (2008): „Building monitoring for seismic risk assessment (I): Instrumentation of RC frame structures as a part of the SERAMAR project.“ In Proceedings 14th World Conference on Earthquake Engineering, 12-17 October 2008, Abstract ID: 09-01-0140, Beijing, China.

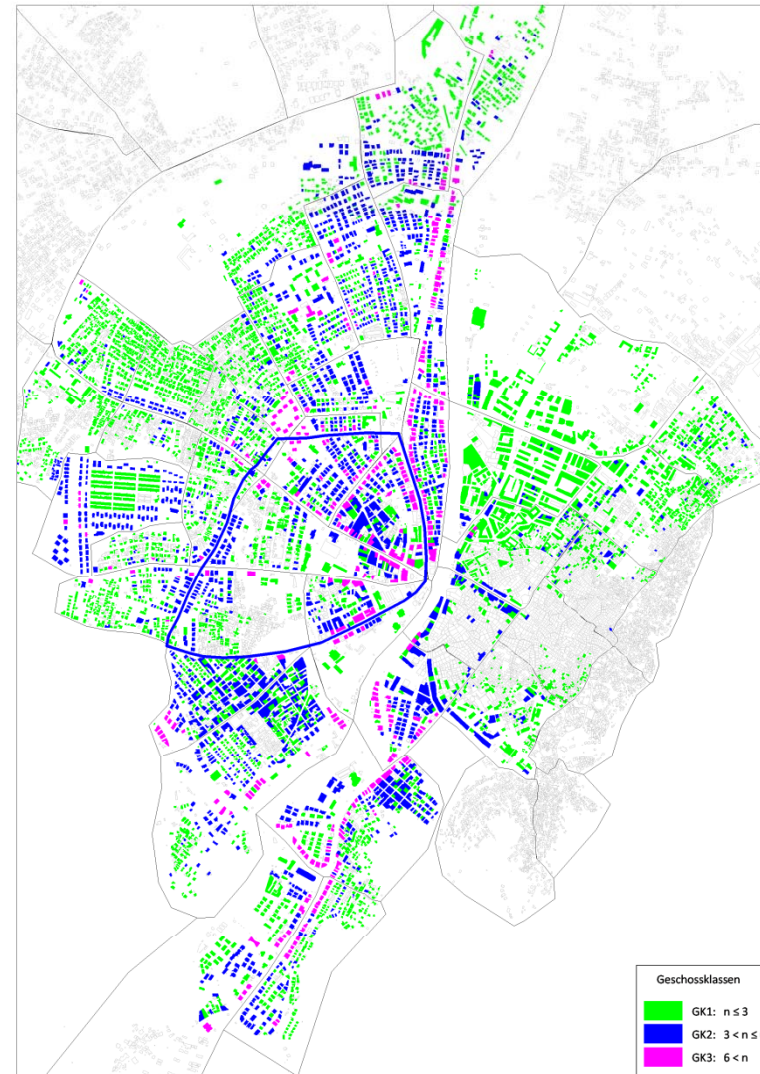


Study Area - Antakya

Story Classes SCi



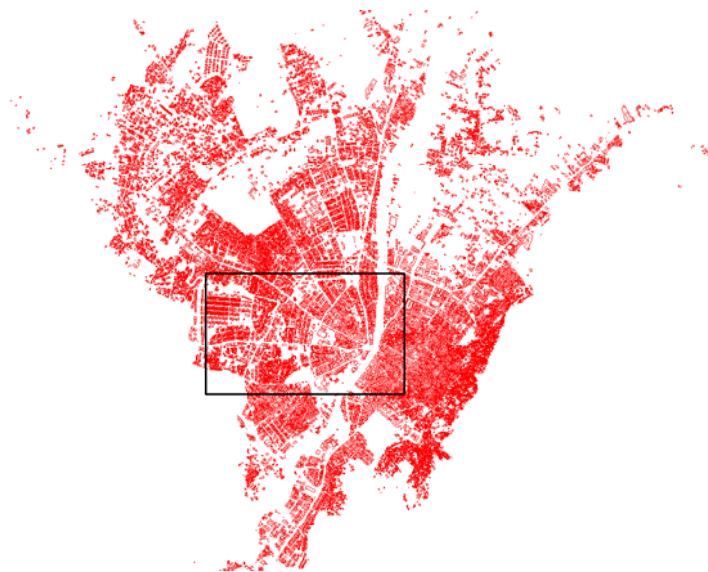
	SC 1:	$n \leq 3$
	SC 1:	$3 < n \leq 6$
	SC 1:	$6 < n$



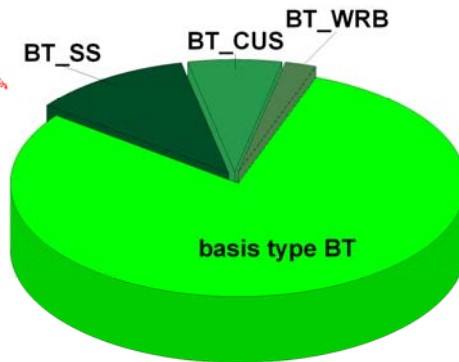


Procedure for damage prognosis

building stock



building typology



Earthquake Scenario

**allocation of
reliable damage**



Necessary for:

Loss [\$]

Loss [human]

Determination of reliable damage



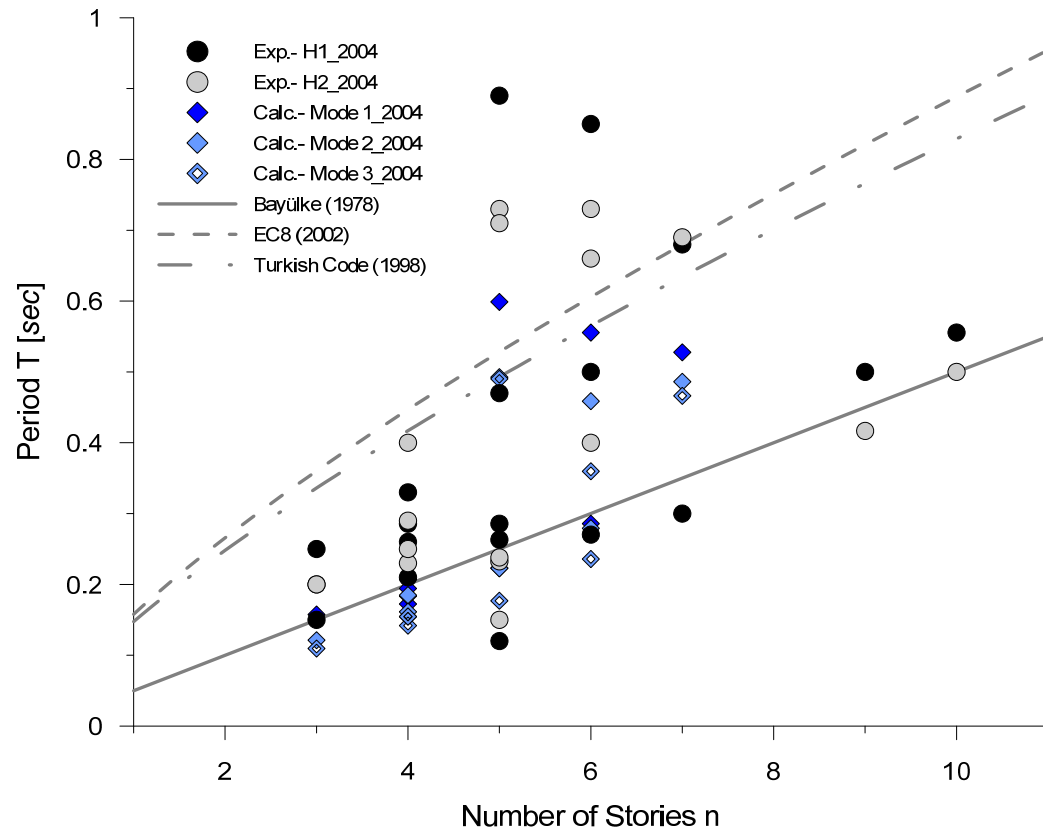
Step 1: selecting of representative buildings for analytical investigations





Determination of reliable damage

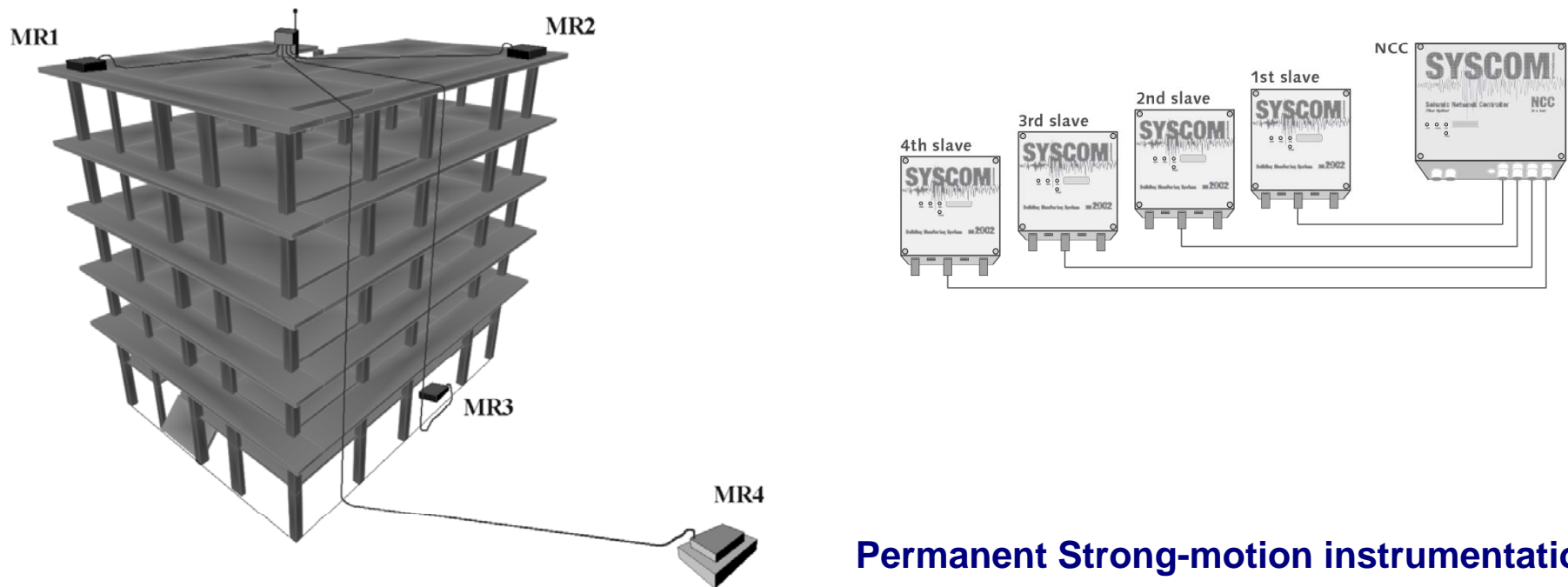
Step 2: collection of instrumental data for model calibration – Why?





Determination of reliable damage

Step 2: collection of instrumental data for model calibration – How?



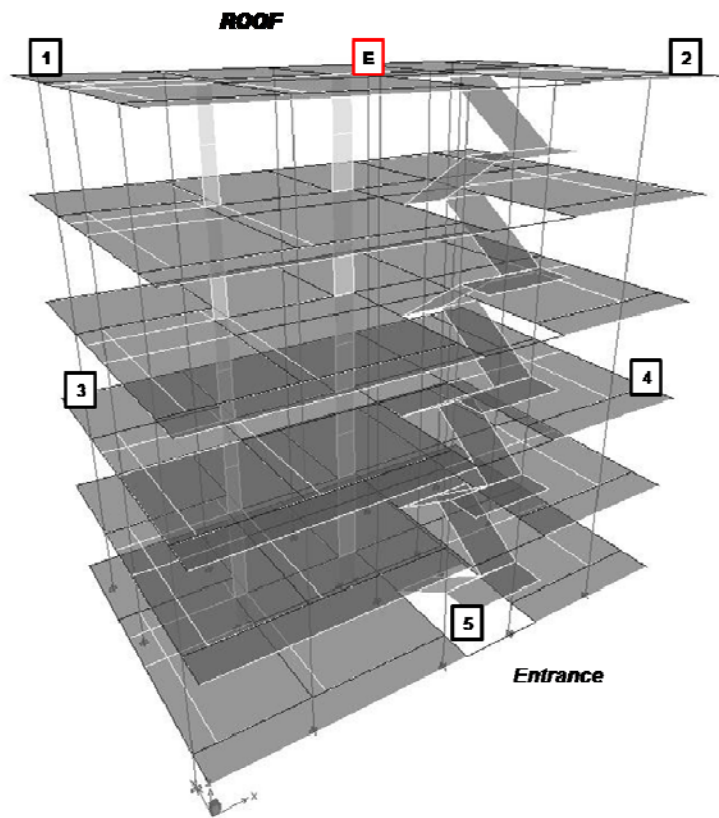
Permanent Strong-motion instrumentation

Schwarz, J., Lang, D.H., Abrahamczyk, L., Bolleter, W., Savary, C., Bikce, M., Genes, M.C., Kacin, S. (2006): *Seismic Building Monitoring of Multistory RC Structures in Turkey – A Contribution to the SERAMAR Project*. 1st European Conference on Earthquake Engineering and Seismology (ECEES). Geneva, Switzerland, 3-8 September 2006, Stand-alone abstract and poster presentation.



Determination of reliable damage

Step 2: collection of instrumental data for model calibration – How?

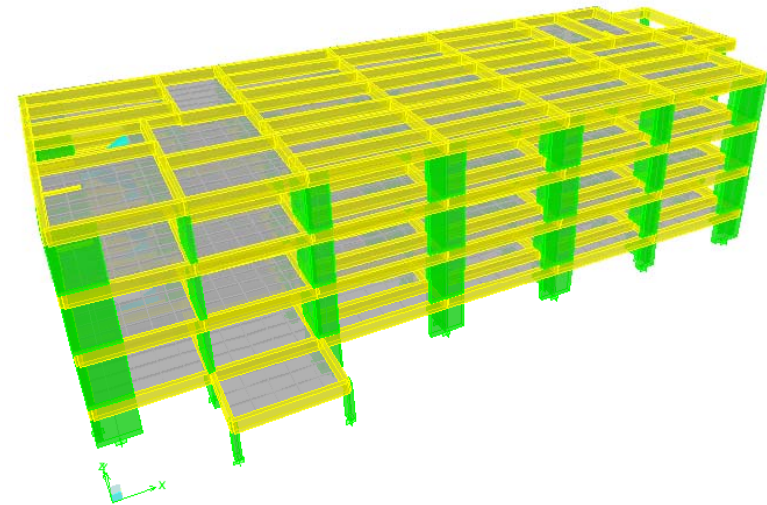


temporary weak-motion instrumentation

Determination of reliable damage



Step 3: Analytical model



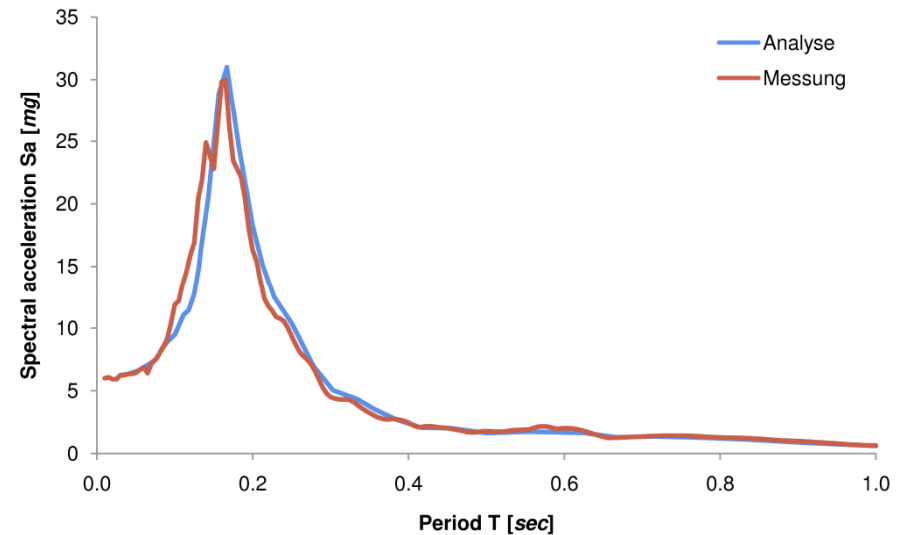
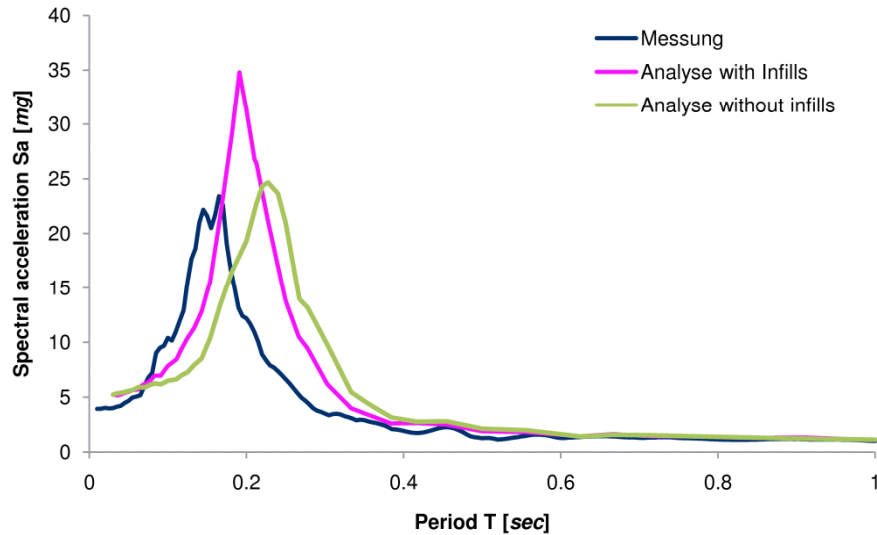
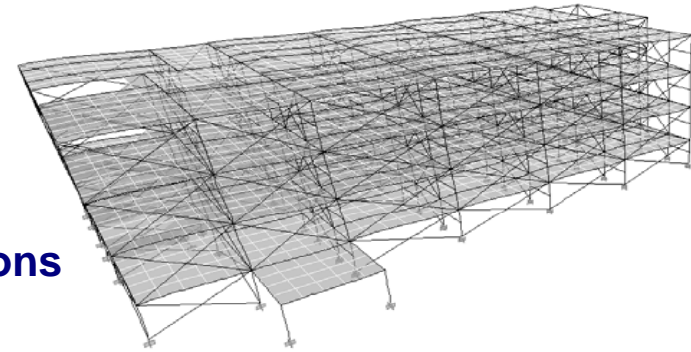
**Abstract of structural model for analytical investigation → creation of 3D models
e.g. by ETABS**



Determination of reliable damage

Step 4: Model Calibration (linear)

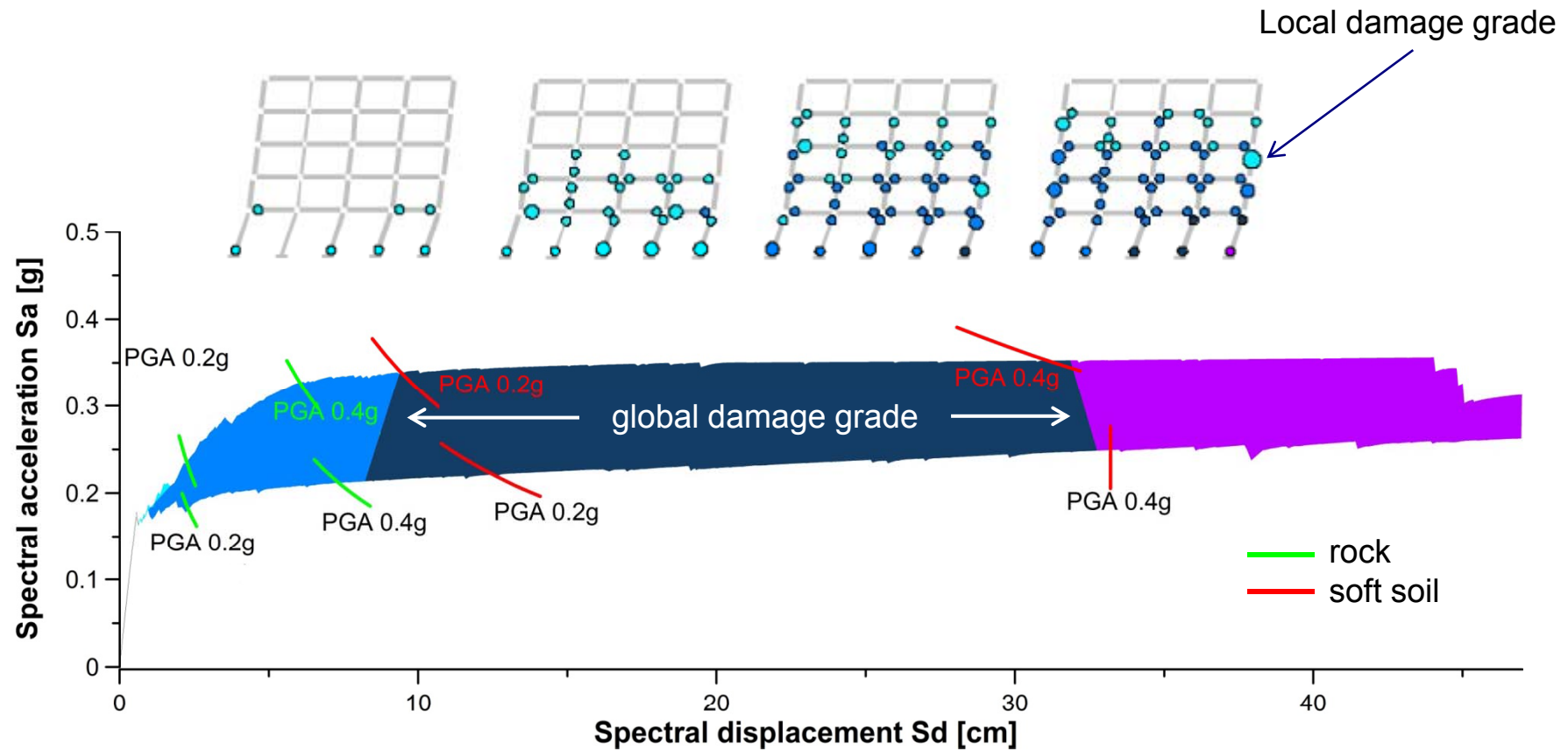
- Comparison between measurement and calculation
- Variation of material properties and model assumptions

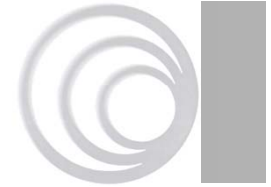




Determination of reliable damage

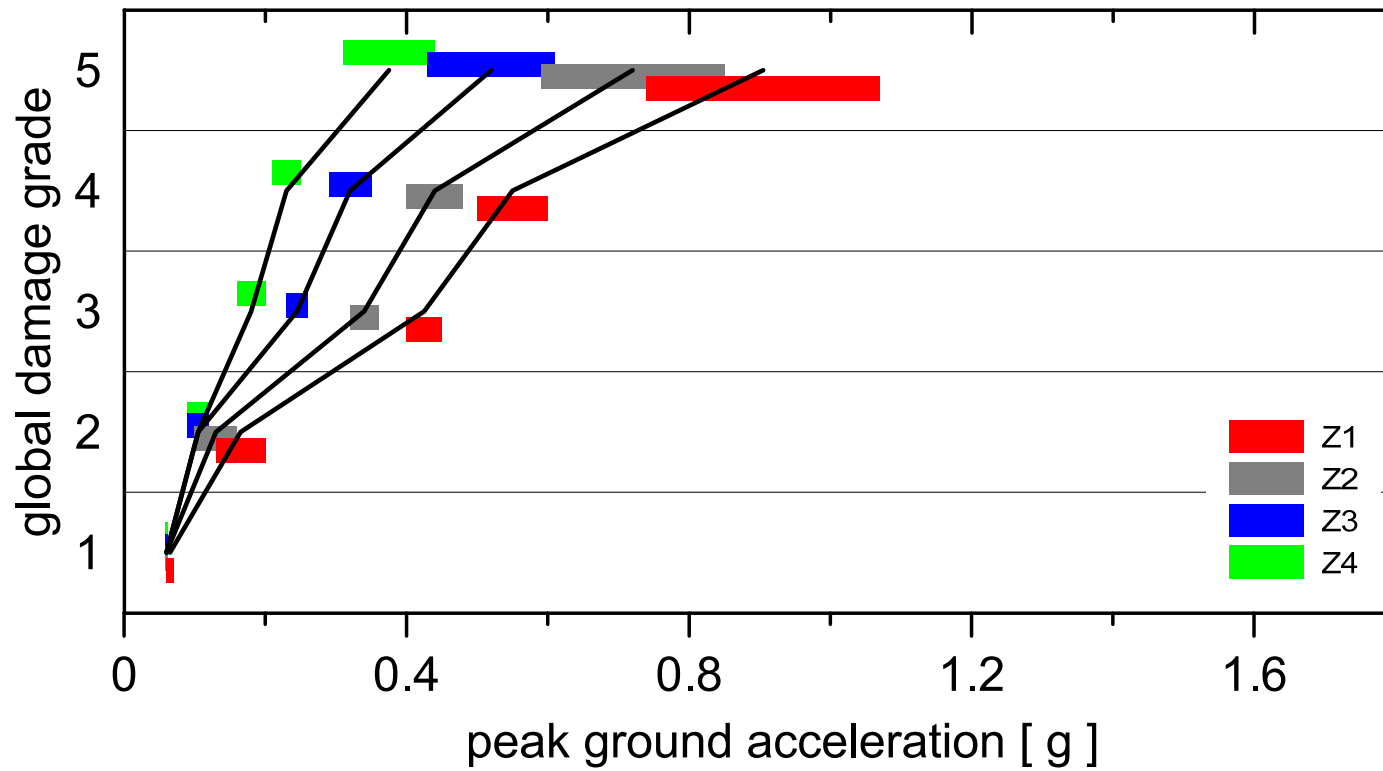
Step 5: Damage Prognosis

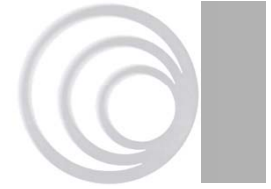




Determination of reliable damage

Step 5: Damage Prognosis





Determination of reliable damage

Step 6: Validation (non-linear)

Observed damage:

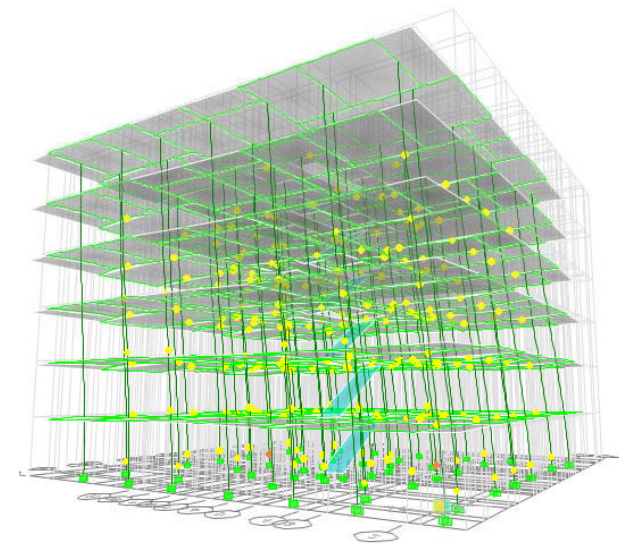


at ground floor level



in connection point at ground floor level

Calculated damage:



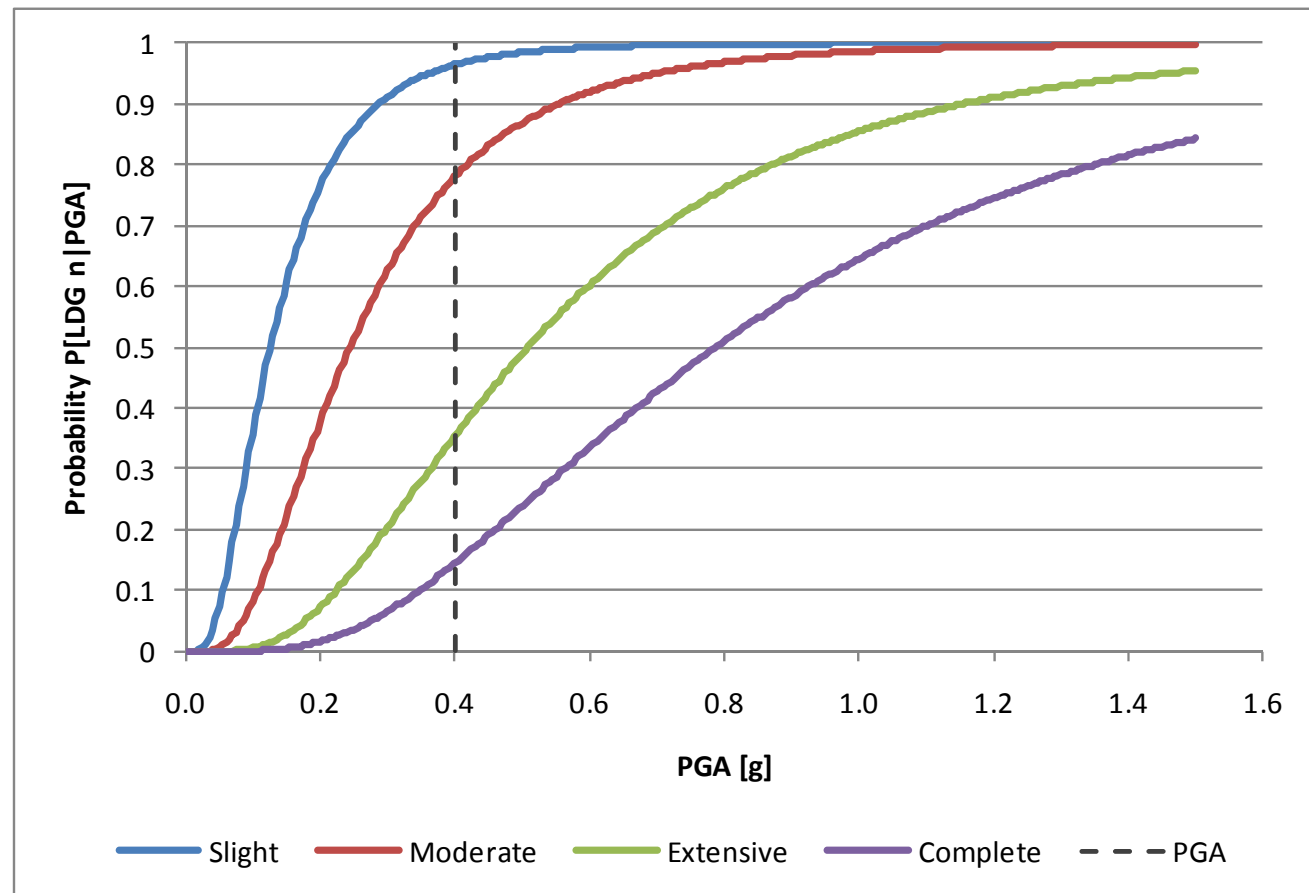
at performance point calculated with ETABS.



Damage functions

Probability of damage for building types

- E.g. RC frame with masonry infill walls
- More than 7 stories
- ~1980
- rock

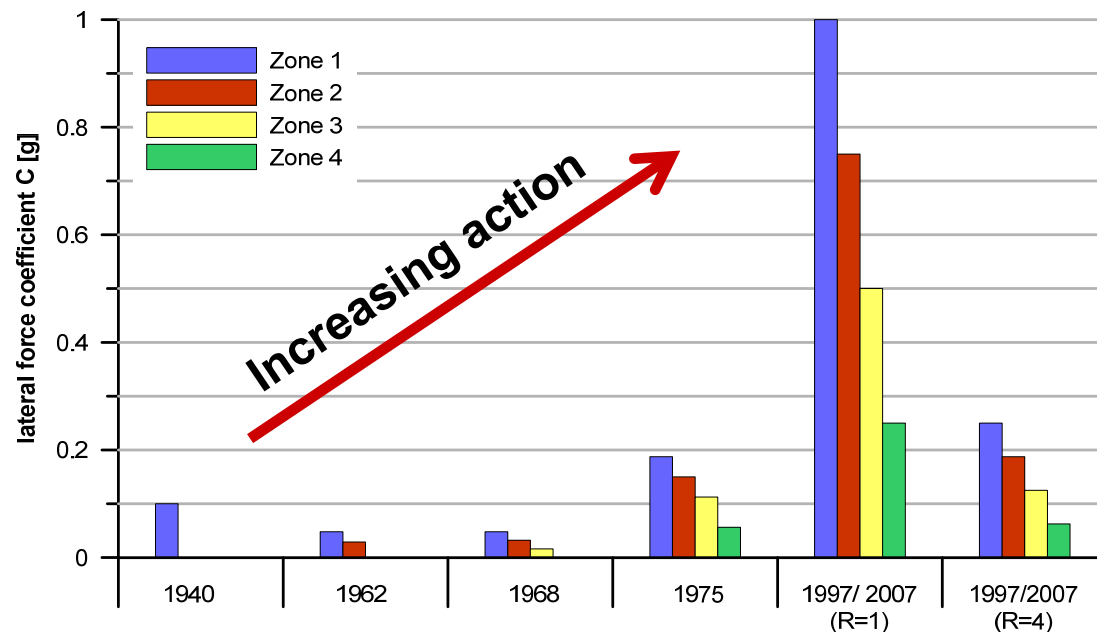


Allocation/ transfer to local building stock

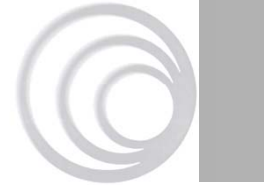


Needs from each building for a “reliable” damage prognosis:

- *age of the buildings level of earthquake resisting design*
→ **Interaction with local authorities**
- *Code generation (impact, design and material)*
→ **local partner**



Allocation/ transfer to local building stock

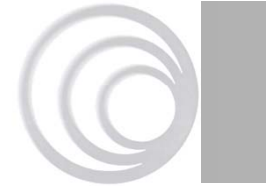


Level of completeness/ accuracy

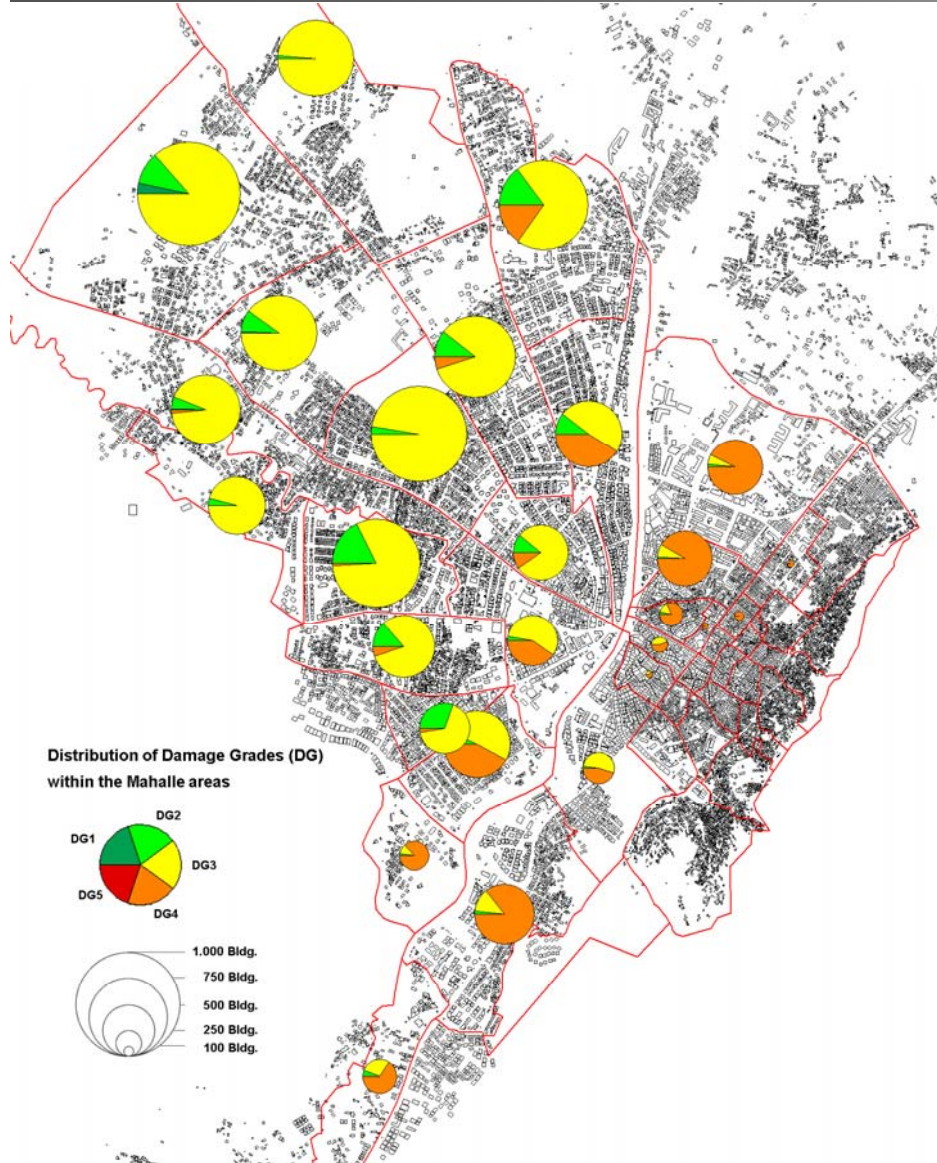
- *Investigation of representative buildings from each building type and code generation*

Experience

- *Use of available damage functions*
 - from other countries or other regions (literature)



Damage scenario



- **PGA 0.4g (design spectra acc. to Turkish Code)**
- **RC structures**

Requirements and solutions for Antakya



Task	Solution	Current state
Completion of building typology	Extension to other building types (e.g. masonry)	RC – structures
Investigation of representatives	WM-Measurements	~ 20 records
Building behavior	SM-Instrumentation	4 Buildings (in operation)
Local subsoil conditions, regional GMPM	Long-term EQ recording	In process Instruments are installed
Preparedness Studies (Social aspects)	Completion of interviews in all mahalle	few interviews

Questions?



Thank you for your attention!

Çok teşekkür ederim