METHODOLOGY FOR THE GENERATION OF DAMAGE-CONSISTENT, INTENSITY-BASED, WAVEFORMS FOR SEISMIC RISK ASSESSMENT

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Outline

- Compile combined database of natural records and associated macroseismic intensity
- Development of database of intensity-based synthetic waveforms
- Testing of database of damage-consistent, intensity-based, synthetic waveforms
- Derive methodology for selection and generation of intensity compatible time histories

1. Development of a **C**ombined database of natural **R**ecords and associated observed **M**acroseismic **I**ntensity for **I**taly (CROMI-I)

Sources:

- Parametric Catalogue of Italian Earthquakes 2015 – CPTI15;
- Literature for macroseismic data of events happened after 01-01-2015;
- European Strong Motion Database - ESM (Itaca for Italian territory).

- ***Ask permission to access data***

Target intensity scale: **EMS** (and **JMA)**

Convert from **MCS** scale (CPTI) to **EMS** scale : $I_{MCS} \approx I_{EMS}$ (Musson et. al 2010)

Harmonization of the database format with the other groups

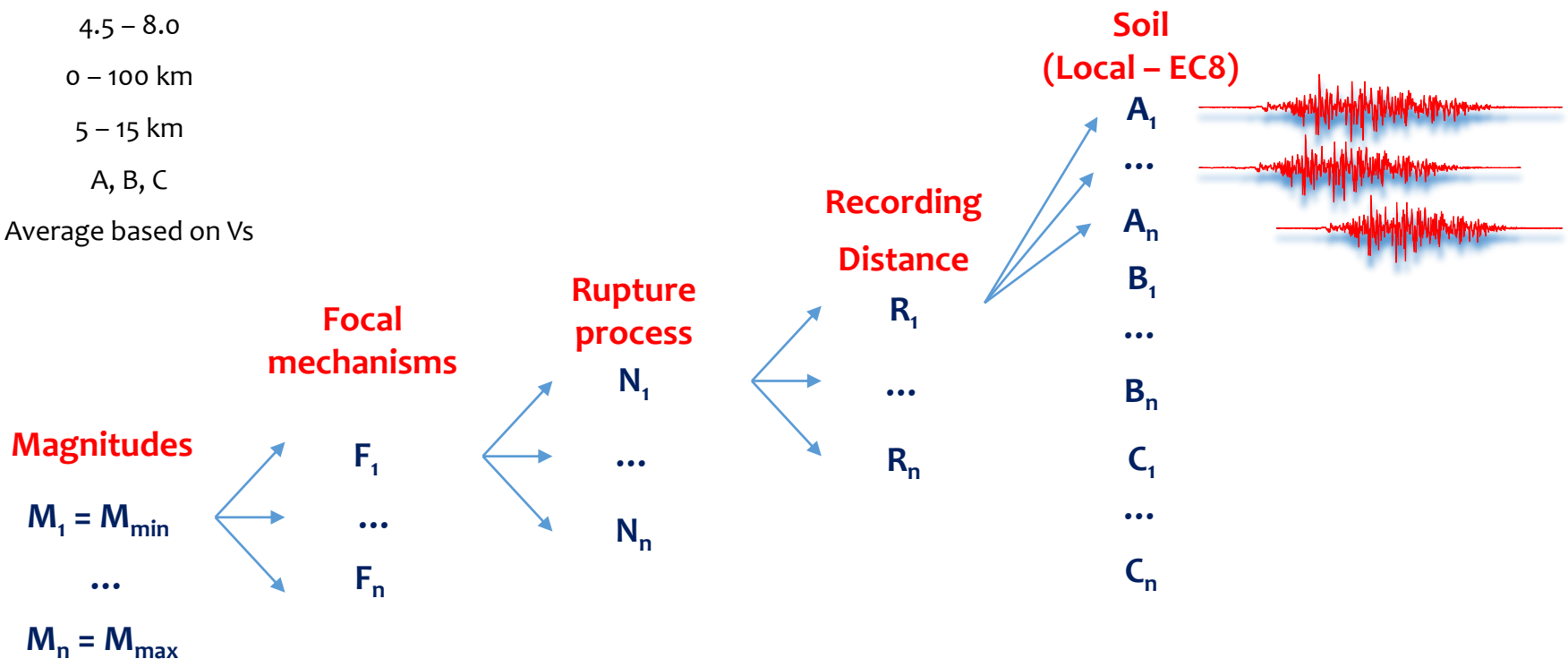
Optional:

Consideration of macroseismic intensity data and associated records from other European countries (e.g. Switzerland, Germany, France, …)

2. Generation of a damage-consistent, intensity-based dataset of physics-based accelerograms

a. Dataset to be computed varying magnitude, epicentral distance, type of soil according to EC8

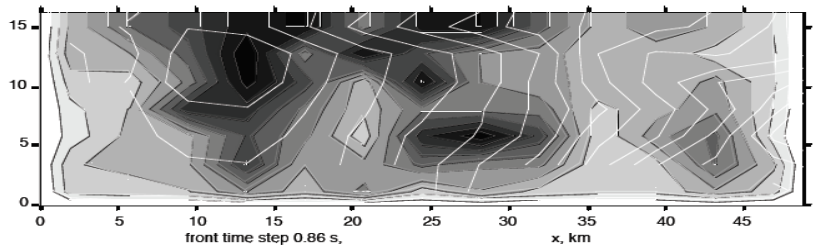
Parameter	Range
M	4.5 – 8.0
R	0 – 100 km
Depth	5 – 15 km
Local Soil	A, B, C
Q	Average based on Vs



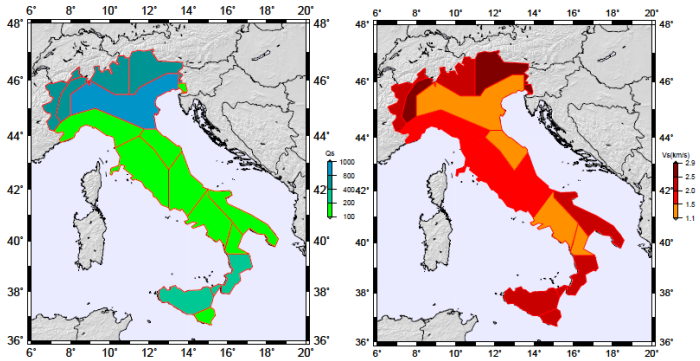
2. Generation of a damage-consistent, intensity-based dataset of physics-based accelerograms

a. Dataset to be computed varying magnitude, epicentral distance, type of soil according to EC8

- Computation of acceleograms is based on:
  - the Modal Summation (MS) technique for epicentral distance R_{epi} >20kM (Panza et al. 2001, Panza et al. 2012);
  - the Discrete wavenumber (DWN) technique for epincentral distance R_{epi} ≤20kM (Pavlov 2009).
- The source is treated as Size and Time Scaled Point Sources (STSPS) or Extended (ES) (Gusev 2011, Magrin et. Al 2016):
  - the source is based on an kinematic model provided by the PULSYN06 algorithm (Gusev, 2011) and takes into account a reference scaling law for source spectra (SLSS);
  - rupture front evolution is simulated kinematically from random rupture velocity field – multi-realization;



- a set of average structural models composed by flat, parallel anelastic layers (Panza et al. 2001).



2. Generation of a damage-consistent, intensity-based dataset of physics-based accelerograms

b. EMS intensity is assigned to synthetic accelerograms using:

i. correlations with ground motion data available in literature:

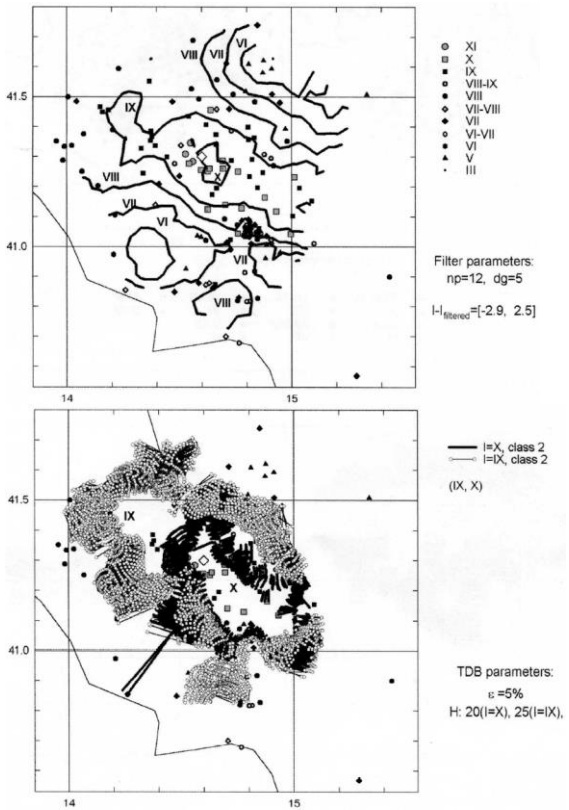
Intensity	PGV (cm/s)
V	0.5 – 1.0
VI	1.0 –2.0
VII	2.0 – 4.0
VIII	4.0 – 8.0
IX	8.0 – 15.0
X	15.0 – 30.0
XI	30.0 – 60.0

(Panza et. al 1997)

ii. correlations between EMS intensity and ground-motion Intensity Measures (using resultants components of linear and non linear SDOF) developed with the database prepared at point 1 (CROMI)

At least one intensity degree of uncertainty

1688 – Matese M_m=7.3



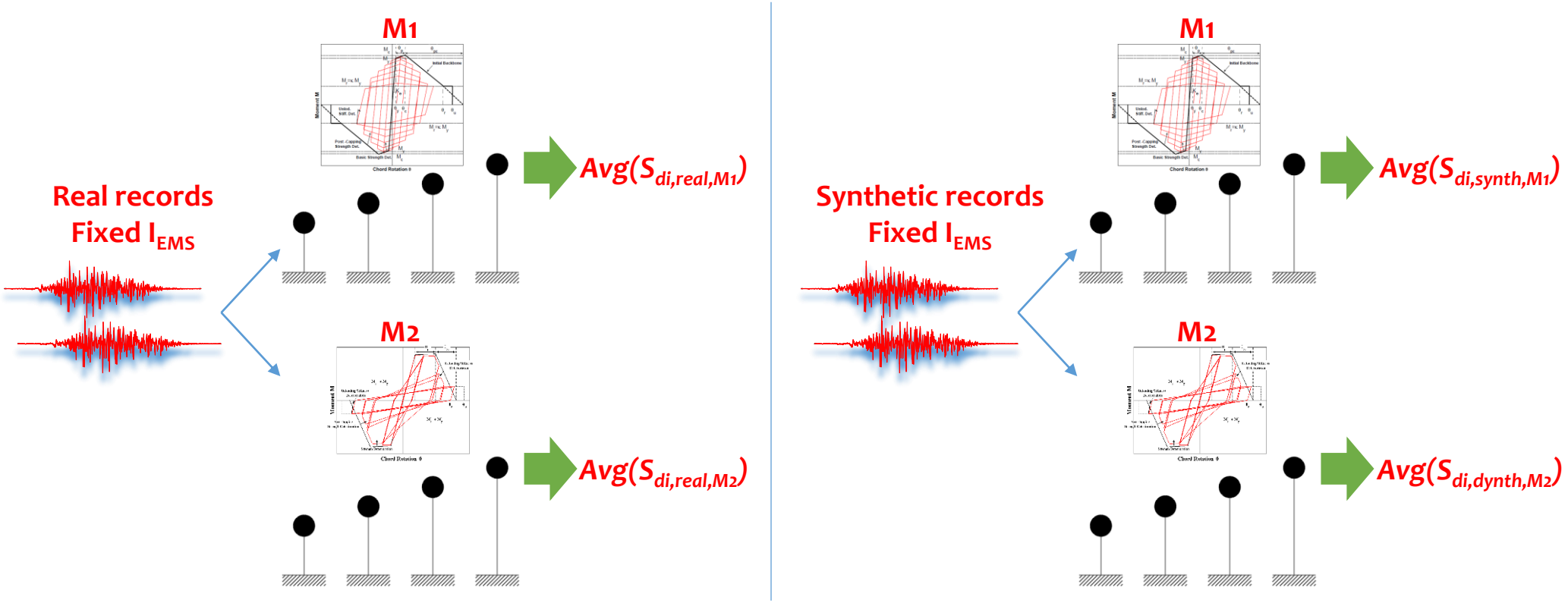
(Kronrod et al. 2000)

3. Testing of the database developed for item 2

a. Test with SDOF systems:
   i. define SDOFs with different non-linear hysteretic behavior and strength (equivalent to different building vulnerability classes);
   ii. for each EMS intensity degree, perform non-linear time history analyses using the corresponding bin of records in the database of natural records (see item 1);
   iii. identify the mean degree of damage (e.g. inelastic displacement) for each intensity degree and each hysteretic behavior;
   iv. define sets of intensity consistent synthetic accelerograms and check the adequacy of the mean degree of damage → has to be the same observed with natural records.
b. Test with 3D FEM models:
   i. Model buildings with different dynamic behavior (e.g. RC-MRF with 2 and 4 floors);
   ii. Repeat steps from ii to iv of test with SDOF for 3D FEM models.
c. Using existing fragility functions developed for SMART 2008/2013 project

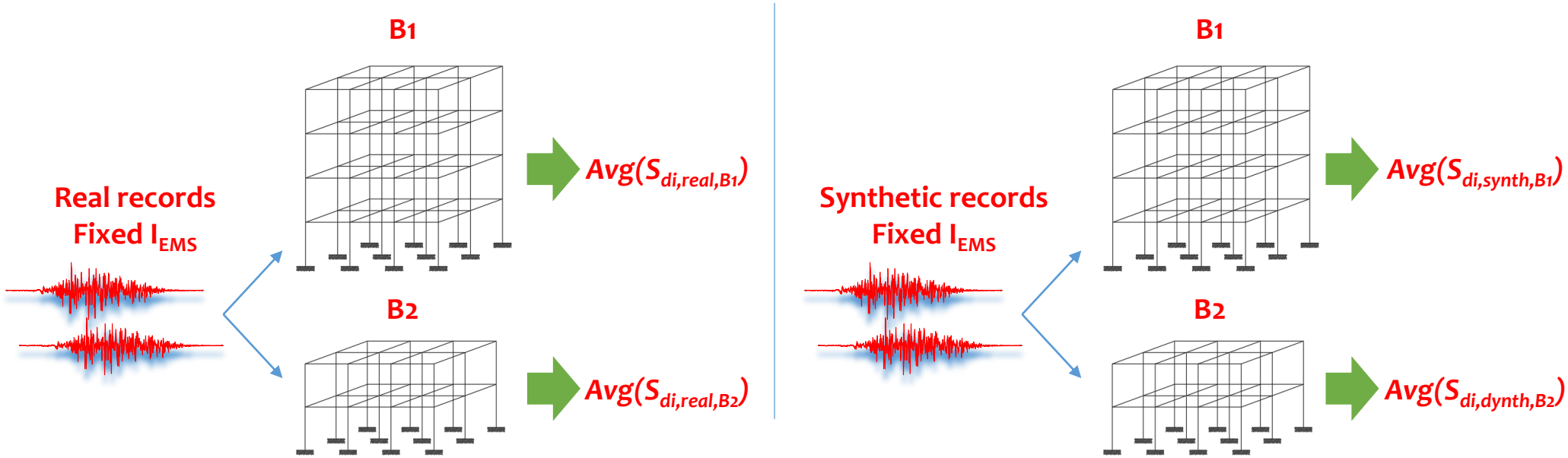
3. Testing of the database developed for item 2

a. Test with SDOFs systems



3. Testing of the database developed for item 2

b. Test with 3D FEM models:



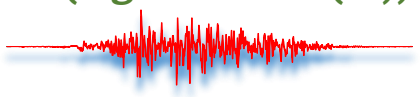
$Hp: Avg(S_{di,real,B1})=Avg(S_{di,dynth,B1})$

$Hp: Avg(S_{di,real,B2})=Avg(S_{di,dynth,B2})$

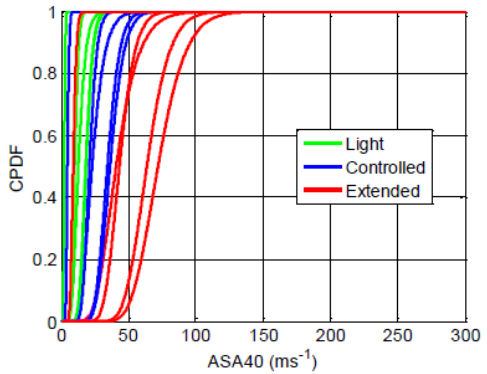
3. Testing of the database developed for item 2

c. Using existing fragility functions developed for SMART 2008/2013 project

Extract GM parameters (e.g PGA or SA(T1))



SMART project - 2013



(b) ASA40 intensity measure

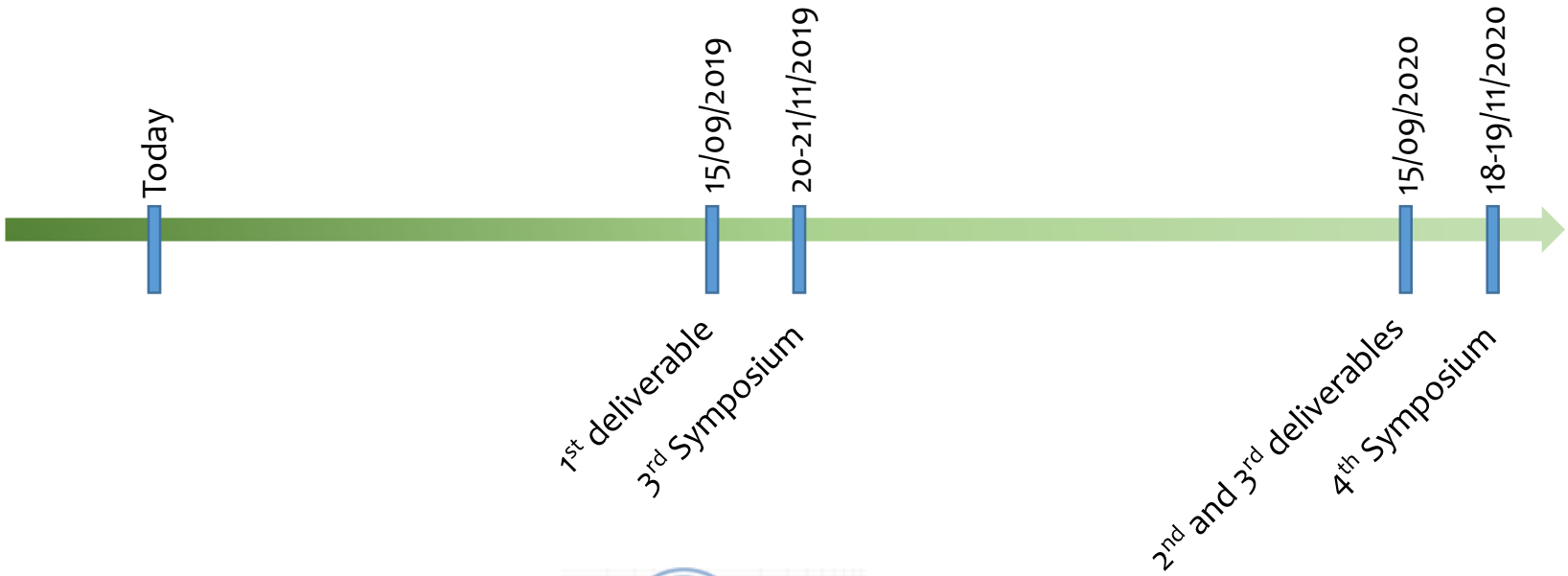
Define Damage grades

Information on quantities (probability)

Intensity

Schedule and Deliverables

- 1st - Combined database of natural records and associated macroseismic intensity
- 2nd - Database of intensity-based synthetic waveforms; Testing of database
- 3rd - Report on methodology for selection and generation of intensity compatible time histories



Thank you for your attention

Acknowledgment

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