SASPARM 2.0

EUCENTRE European Centre for Training and Research in Earthquake Engineering

IUSS Scuola Universitaria Superiore Pavia

Support Action for Strengthening PAlestine capabilities for seismic Risk Mitigation

SASPARM 2.0

2014 PROJECT FOR CIVIL PROTECTION FINANCIAL INSTRUMENT PREPAREDNESS AND PREVENTION SCHEME

RETROFIT MEASURES PRACTITIONERS (introduction)

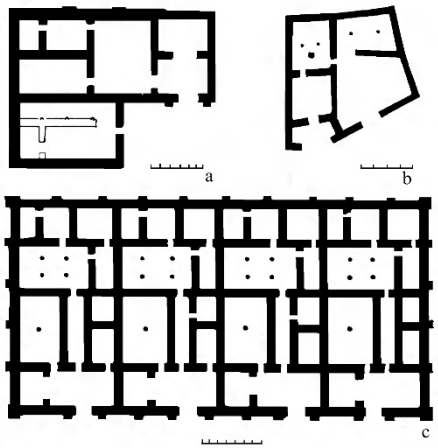
Pavia – Nablus
May 25, 2016

ECHO/SUB/2014/694399 - SASPARM 2.0 Support Action for strengthening PAlestine capabilities for seismic Risk Mitigation
Project co-funded by ECHO - Humanitarian Aid and Civil Protection

Presentation outline

1. General overview of structural analysis on existing buildings and concept of capacity design;
2. Classes of rehabilitation techniques;
3. RC: main deficiencies;
4. URM: main deficiencies;
5. Retrofit measures: common and advanced ones;
6. Implementation in Palestine.

Retrofitting of existing structures



1. Gather information about existing structure (plans)

2. Gather information about material conditions (non destructive testing methods)

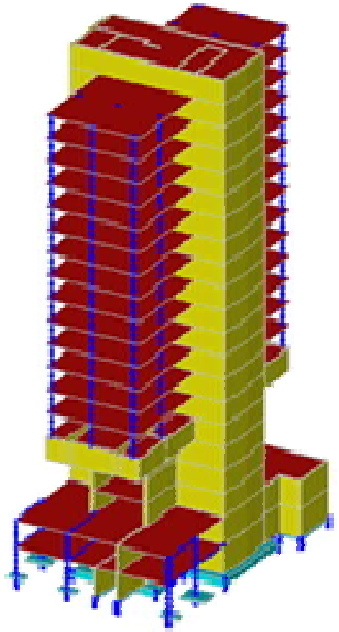
3. Structural assessment of existing structure

4. Propose retrofitting measures and assess corresponding direct and indirect cost

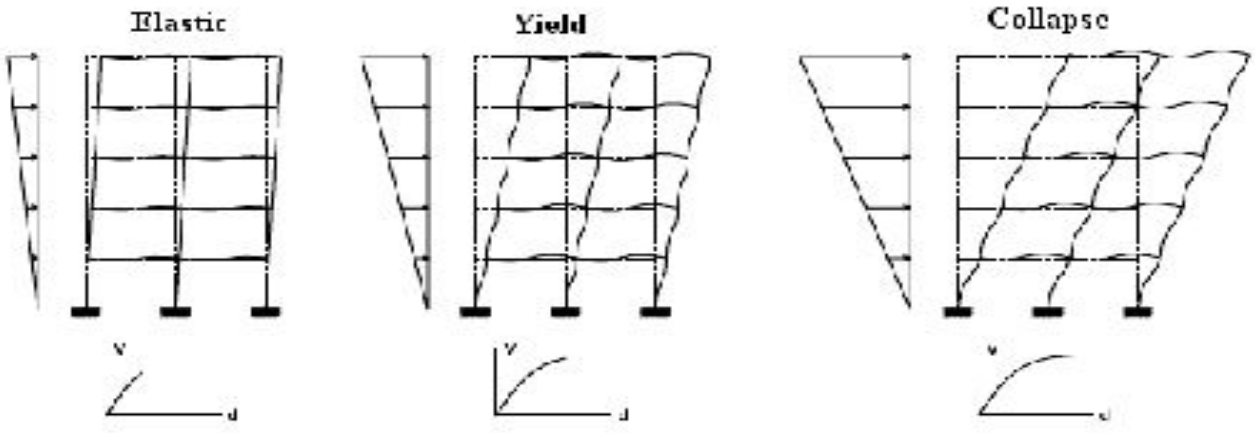
5. Implementation of retrofitting measures

Structural assessment of existing structure

1. No specific code for Palestine, code of reference UBC/JBC.
2. More complex than designing a new one. Less flexibility and more unknowns.
3. Need for inelastic nonlinear analysis.
4. Empirical approaches cannot be used to non damaged structures



Structural analysis



1. Only 3D models.
2. Impossible to do by hand.
3. Only inelastic nonlinear analysis valid to get reasonable cost-benefit estimates.
4. If the modeling assumptions are very conservative (linear elastic analysis), the "replacement cost new" can be quite close to the retrofitting one.
5. Pushover inelastic static analysis can be used for regular structures without dominant torsional modes.
6. Time history analysis is much more complex and computationally heavy. Record selection process is also very demanding.

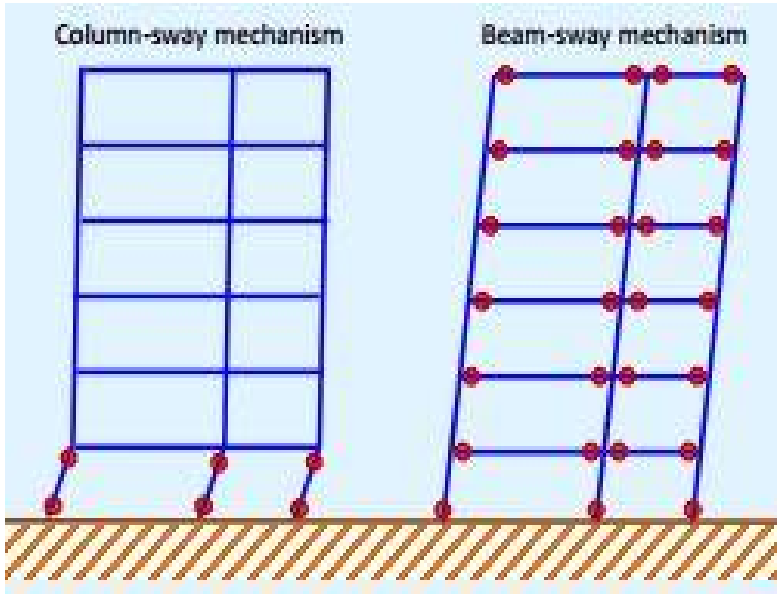
General concept of capacity based design

- ✓ The modern way of designing new structures or redesigning existing ones;
- ✓ Capacity design: designing flexural capacities of sections of a structure based on its behavior in responding to seismic actions;
- ✓ Assumption: critical regions occur simultaneously at predetermined locations to form a collapse mechanism simulating ductile behavior.

General concept of capacity based design

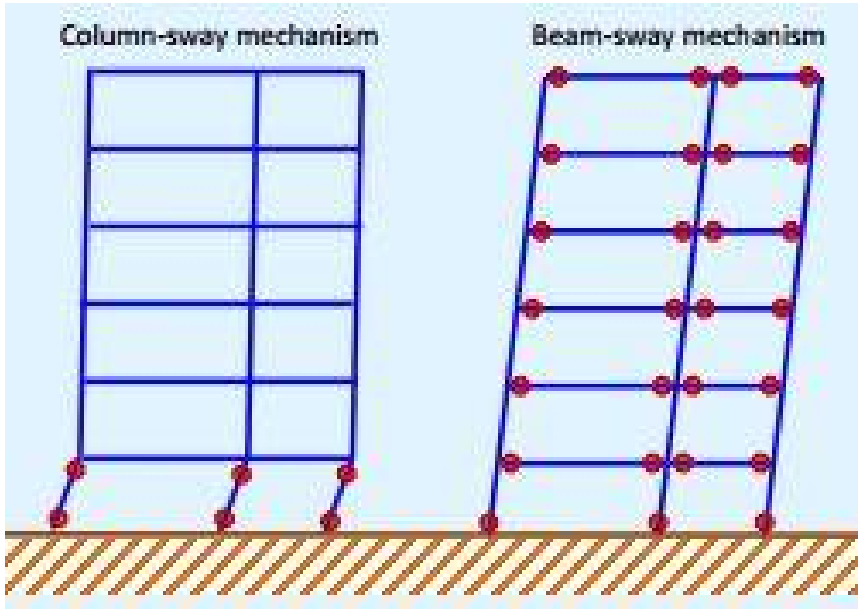
- ✓ Key feature: avoid undesirable modes of failure (shear).
- ✓ Capacity design: aims at establishing a favorable hierarchy of strength in the structures;
- ✓ Strength of columns is higher than that of adjacent beams, with possible allowance for beam over strength – **weak beam – strong column concept**;

General concept of capacity based design



- ✓ Even if weak beam – strong column concept is applied, a column plastic hinges must still form at the base of the column;
- ✓ **Beams yield before columns**;
- ✓ Column sway mechanism is avoided in the structure;
- ✓ **Larger energy dissipation and drift capacity**

General concept of capacity based design



- ✓ Better to develop **plastic hinges in all beams instead of only in the first storey column**;
- ✓ Overall ductility demand (large deflections) is much more readily achieved;
- ✓ The column hinge mechanism imposes plastic hinge rotations;
- ✓ Good detailing. **Small spacing and large diameter of stirrups** (i.e. Φ10/100 in mm)

End of introduction.

Part 3 follows….