IABSE reports = Rapports AIPC = IVBH Berichte
77 (1998)
Seismic rehabiliation of existing buildings in Romania
Crainic, Liviu
https://doi.org/10.5169/seals-58278

#### Nutzungsbedingungen

Die ETH-Bibliothek ist die Anbieterin der digitalisierten Zeitschriften. Sie besitzt keine Urheberrechte an den Zeitschriften und ist nicht verantwortlich für deren Inhalte. Die Rechte liegen in der Regel bei den Herausgebern beziehungsweise den externen Rechteinhabern. <u>Siehe Rechtliche Hinweise</u>.

#### **Conditions d'utilisation**

L'ETH Library est le fournisseur des revues numérisées. Elle ne détient aucun droit d'auteur sur les revues et n'est pas responsable de leur contenu. En règle générale, les droits sont détenus par les éditeurs ou les détenteurs de droits externes. <u>Voir Informations légales.</u>

#### Terms of use

The ETH Library is the provider of the digitised journals. It does not own any copyrights to the journals and is not responsible for their content. The rights usually lie with the publishers or the external rights holders. <u>See Legal notice.</u>

**Download PDF:** 19.05.2025

ETH-Bibliothek Zürich, E-Periodica, https://www.e-periodica.ch



# Seismic Rehabilitation of Existing Buildings in Romania

Liviu CRAINIC Professor Techn. Univ. of Civil Engineering Bucharest, Romania



Liviu Crainic, born 1938, received his civil engineerng degree from the Technical University of Cluj/Romania (1960) and his PhD in 1974, from Technical University of Construction Bucharest. He is currently professor, head of the Department of R/C Structures of TUCB.

### Summary

The preservation of existing buildings in Romania involves accurate seismic assessment and implementation of appropriate methods for their repair/strengthening. An analytical procedure for assessment of r/c structures is presented herein and its role in seismic behavior investigation and identification of structural system weak components is discussed. Procedures for selecting appropriate upgrading solutions, currently implemented in Romania, are briefly described. Examples illustrate the above considerations.

# 1. Static Post-Elastic Procedure for Seismic Capacity Evaluation

The present article proposes a static post-elastic procedure for determining the seismic shear force capacity. Incremental loading with *imposed displacements*, similar to those generated by seismic action, is considered. Thus, the structure capacity degradation, due to progressive elements failure, and the weak structural components, are stressed out. This information is turned into relevant input data for selecting the appropriate *rehabilitation solution*.

The following steps define the procedure:

(i) Determine internal forces in critical sections due to gravity loads  $\{S_g\}$  and to seismic equivalent forces  $\{S_E\}$ .

(ii) Determine lateral displacements of the structure, due to seismic forces  $\{\Delta_E\}$ .

(iii) Calculate the moment capacity of critical sections  $\{M_{cap}\}$ .

(iv) For each critical section *i* determine the coefficient  $\gamma_i = M_{E,i} / (M_{cap,i} - M_{g,i})$ . (v) Select maximum magnitude of  $\gamma_i : \max{\{\gamma_i\}} = \gamma_j$ . In section *j* a plastic hinge will occur. (vi) Determine the horizontal seismic force (basic shear force)  $F^{(1)}$ , internal forces  $\{S_E^{(1)}\}$  and lateral displacements  $\{\Delta_E^{(1)}\}$  corresponding to the plastic hinge occurrence:  $F^{(1)} = F/\gamma_j$ , ;  $\{S_E^{(1)}\} = \{S_E\} / \gamma_j$ ;  $\{\Delta_E^{(1)}\} = \{\Delta_E\} / \gamma_j$ .

(vii) Check-up the magnitude of plastic rotation and shear force in critical sections - plastic rotation and/or shear force within accepted limits  $\rightarrow$  continue

- excessive plastic rotation and/or shear force  $\rightarrow$  member failed  $\rightarrow$  delete failed member from structure  $\rightarrow$  go to (i) (with new input data, considering the structure without the failed member).
- (viii) Determine the stiffness matrix of the structure, considering a plastic hinge in section *j* (ix) Increase lateral displacements with an accepted increment.

(x) Calculate internal forces corresponding to displacements of step (ix)

(xi) Go to (iii).

## 2. Seismic Rehabilitation

The selection of a seismic rehabilitation strategy and decision has to take into account: the potential or existing damage and failure of structural and non-structural components, and other similar factors. Basically, the rehabilitation has to rectify "weakness" at both local and overall scale of the building.

The seismic rehabilitation solutions for reinforced concrete structures, currently implemented in Romania are: (a) *jacketing* of existing elements and (b) *addition of new structural elements*, especially structural walls. The adopted solution depends upon the *diagnosis* resulted from insitu inspection ("qualitative assessment"), analytical evaluation and cost-benefit analysis.



Fig. 5 Foundation system of a newly added structural wall.