Task 11.3, 11.4: Safety formats for NLNAs of RC structures

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This study describes a novel methodology within the Global Resistance Format (GRF) to assess the design value of the global structural resistance of reinforced concrete (RC) structures as a function of the peak reinforcement strain (i.e., $\varepsilon_{s,max}$).

Several experimental tests on RC structural members have been selected from the literature (Leonhardt and Walther, 1966; Lefas and Kotsovos, 1990; Filho, 1995; Foster and Gilbert, 1998) and numerically reproduced by means of non-linear numerical analyses (NLNAs) (Figure 1).

Then, considering the mechanical uncertainties (JCSS, 2001), a probabilistic analysis of 30 NLN simulations for each RC structure is developed to characterize the probabilistic distribution of the global structural resistance. For the concrete, a coefficient of variation (CoV) equal to V_c=0.15 has been assumed, whereas the CoV of the reinforcement steel equal to V_s=0.05. Therefore, for each RC system, the mean value and CoV ($V_{R,m}$) of the global structural resistance have been computed. Successively, these statistics have been correlated with the ratio between the peak and yielding strain (i.e., $\varepsilon_{s,max}/\varepsilon_y$) in the reinforcement (Fig. 2a).

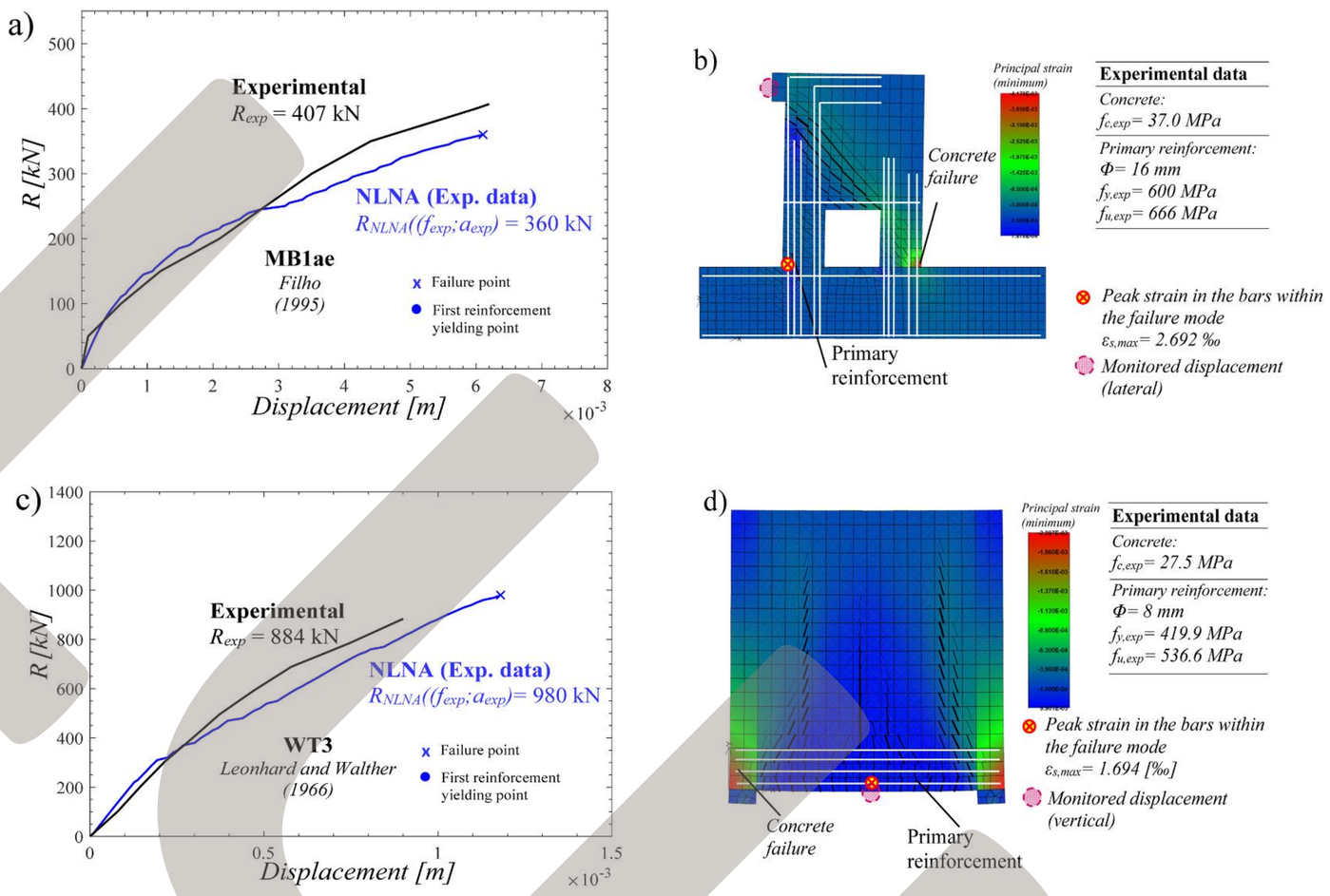

Figure 1 – RC members: comparison between experimental and NLNA results (a, c); representation of the failure mechanism in concomitance of failure (b, d).

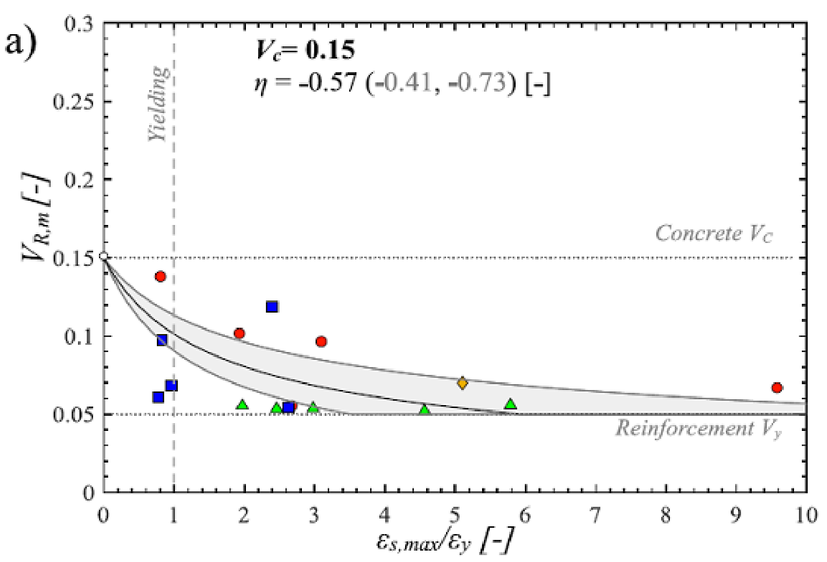

Figure 2 – CoV of the global resistance $V_{R,m}$ as a function of the strain ratio $\varepsilon_{s,max}/\varepsilon_y$ for a concrete with V_c=0.15.

For each RC system, the peak strain in the reinforcement derives from a NLNA having the mean values as input data for the material properties. In this way, a predictive expression (Figure 2b) has been proposed to define the CoV of the global structural resistance as a function of the peak reinforcement strain. This proposal is finalized to safety assessment.