NONLINEAR MODELLING OF REINFORCED CONCRETE STRUCTURES FOR DESIGN AND ASSESSMENT

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Abstract

The nonlinear analysis and simulation of real structural behaviour is often used to check the reliability of safety critical structures. The nonlinear analysis can be used to calculate pushover curves for seismic assessment, but an analogical concept can be used to check other design criteria such as for instance the ultimate limit state. Several safety formats are proposed in Model Code 2010 for the verification of safety of resistance calculated by non-linear analysis. The paper summarizes the experience of the author obtained in recent years in various projects involving the application of nonlinear finite element analysis and the new safety formats from Model Code 2010.

Keywords: nonlinear analysis, global safety formats, Model Code 2010, reinforced concrete design, pushover analysis

1 Introduction

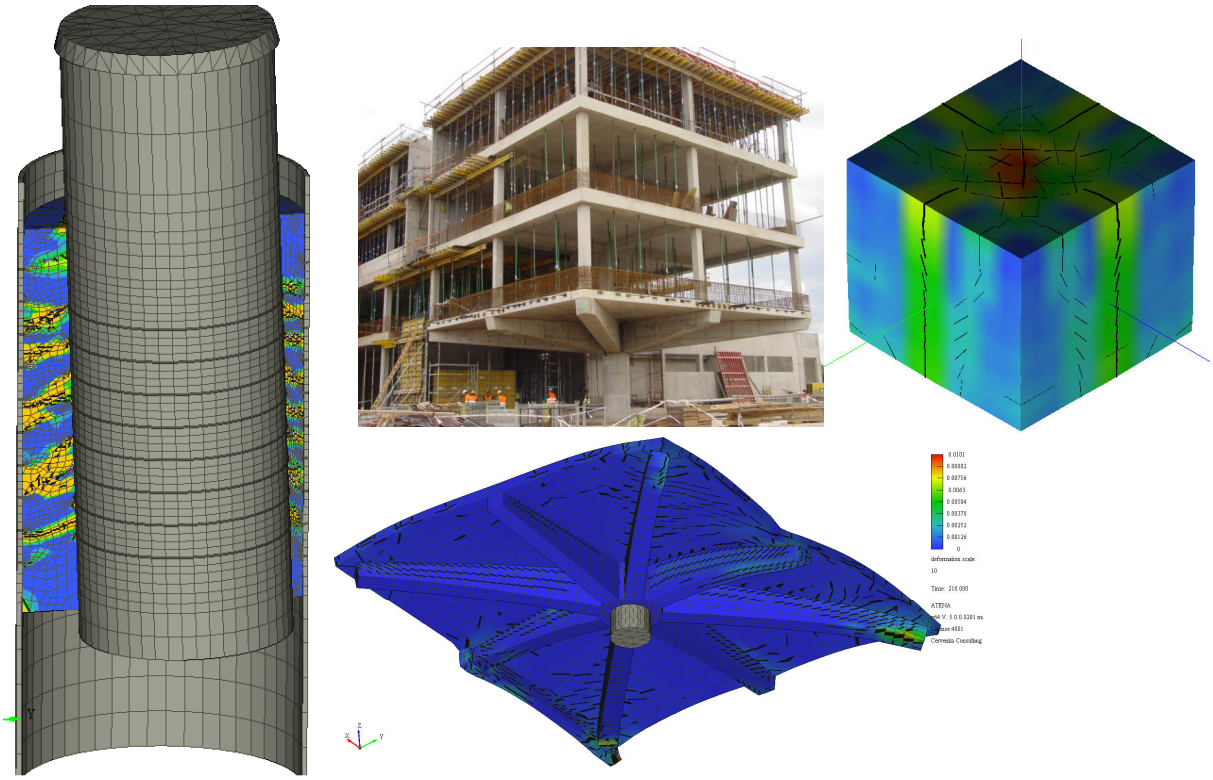
Non-linear analysis can be regarded as a virtual testing, where a section-oriented local safety verification is not relevant and a global safety format should be applied. In Cervenka V. (2013) a comparison of global safety by several methods is presented. This investigation included some typical concrete structures with failure modes due to bending and combined shear-bending and compression, and is supported by the new fib Model Code 2010, where rational safety assessment approach is presented. In the paper, several examples from practice are presented, where pushover analysis or the global resistance format is used for design or assessment of real engineering structures (see Fig. 1 and Fig. 2).

The presented examples are analysed with program ATENA for non-linear analysis of concrete structures. ATENA is capable of a realistic simulation of concrete behaviour in the entire loading range with ductile as well as brittle failure modes as shown for instance in Cervenka, Pappanikolaou (2008).

2 Conclusions

The paper summarizes the available safety formats for global design or assessment of reinforced concrete structures. Authors have used the global safety formats in many practical consulting projects. Four selected example projects are presented here. They involve a grouted connection design of the jacket supporting structure for off-shore wind turbines, design of a pre-stressed concrete slab, reliability verification of cracked massive concrete columns, and the seismic assessment of a nuclear power plant.

In most current design projects, the authors used mainly the EN 1992-2 approach and the PSF method. The EN 1992-2 approach is attractive since it is using material properties that are close to the average material parameters. The PSF method on the other hand can be easily explained to practitioners or any verification authority. From theoretical point of view the ECOV, which was used in the seismic assessment (see Fig. 2) is more rational since it is better reflecting the random variation of resistance. In this case a model uncertainty should be considered appropriately. In practise, the ECOV and full probabilistic format is used for special structures with high risk to public and society.



(a) (b) (c)

Fig. 1 Application examples: (a) grouted connection, (b) prestressed slab, (c) cracked massive concrete column.

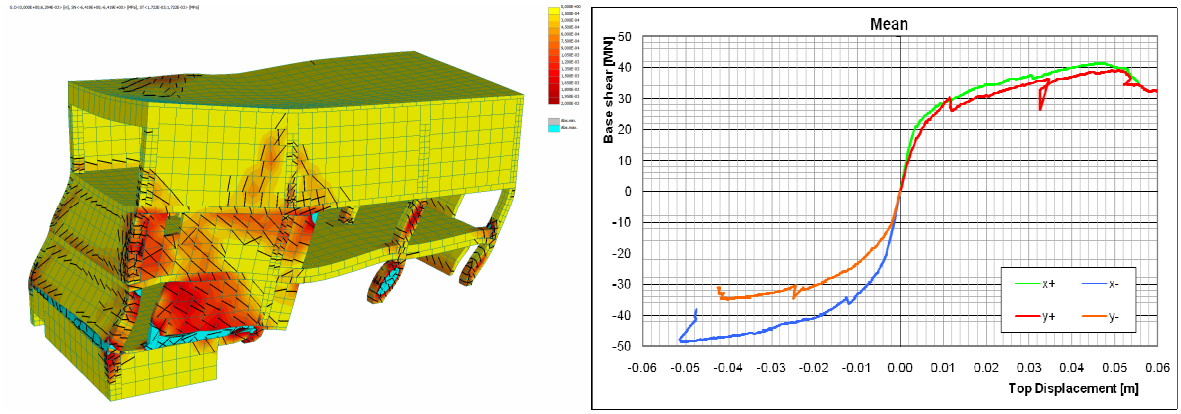


Fig. 2 Pushover analysis of a reinforced concrete building housing the nuclear power plant control room

Authors gratefully acknowledge the support from research projects TA01011019 "SimSoft" from TAČR and Eurostars project E!7521 "SE-Lab".

References

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