EXTREME LOAD RESISTANT DESIGN OF NUCLEAR POWER PLANT STRUCTURES

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SUMMARY

In nuclear structural design, extreme dynamic loads of low probability of occurence have to be considered. They may be external loads (earthquake, blast-wave, aircraft impact, or aircraft engine impact) or internal loads (blown-down pressure, jet forces or pressure due to a pipe break accident, pipe whip effects, missile impact, fragment impact due to local rupture accidents, thermal and pressure transients due to loss-of-coolant accidents, etc.).

In Germany these loads, apart from earthquake, are treated as deterministic excitations. They are given by representative dynamic load definitions. The maximum dynamic response can be obtained from time-history analyses. The load determination and the response determination cannot be separated in any case. E.g. the impact of a missile, which is relatively rigid compared to a partly penetrated reinforced concrete structure, cannot be defined by a general load-time function, rather than by its velocity, form, mass distribution, force-deformation characteristics, etc. The load-time function then essentially depends on the dynamic behaviour of the resistant structure and its reaction.

This latter dynamic load type of rigid mass impact on a deformable structure is mainly dealt with in this paper. In this special field, certain problems and gaps of knowledge have to be solved. This cannot be done by any sophisticated theoretical analysis, rather than by interpretation and evaluation of experimental results, by derivation of substitute theories, assumptions and substitute structural models able to simulate the experimental phenomena, and by quantification of certain unknown parameters from experimental data. Of course, lots of experiments are necessary for general solutions.

Some experiments of rigid mass impact on reinforced concrete structures, which recently began to be performed, are presented and analyzed with regard to the design for nuclear power plant structures for ultimate dynamic resistance. Conclusions for computational treatment of such problems are given, which are valid for a certain range according to the range of validity covered by the special experiments. The applicability on other ranges and on other extreme dynamic load problems with reinforced concrete structures is treated finally.