

SUMMARY OF SESSIONS

SESSION I

Three papers were presented, one from France, two German papers.

The French contribution, presented by Mr. Gantenbein, gave an overview and a description of methods of seismic analysis for complex structures such as nuclear power plants.

This seismic analysis of the building was taking into account structures with important mass or stiffness. The input to the building analysis, called ground motion, is described by a response spectrum. Various methods as for example impedance method and finite element method are available to calculate the response of the structure.

The author further presented methods to calculate floor response spectra which are the data for equipment analysis and also presented methods on seismic analysis for both monosupported and multisupported equipment.

The first German paper, presented by Mr. Hansen, dealt with earthquake analysis with non linear soil structure interaction and non linear supports of components performed in a working group on further optimization and standardization of the HTR 100 power plant. The concept of the reactor building which has a relatively high structure compared with the dimensions of the foundation and the deep embedment of the structure in the soil has led to a considerable influence on the results of soil-structure interaction. The obtained results were also of general interest regarding at events like earthquake, impact of an airplane and gas explosion.

The second German paper presented by Mr. Altes considered the contribution of earthquakes to the risk of a HTR 100 nuclear power plant. This study recently has been carried out by the Institute of Nuclear Safety Research of KFA. The structural response of the primary circuit within the reactor building has been calculated using a 3d finite element model including the soil structure interaction. Different soil properties have been considered. In a sensitivity study the influence of changing the support conditions for the reactor vessel and its internals on the response behaviour has been analyzed.

SESSION II

Three papers from Japan described the site response assessment and alternative compliance and finite element methods for SSI analysis of the HTTR structures at Darai.

Mr. Suzuki's paper described the determination of the S1 earthquake from a consideration of historical seismicity (a return period of 200 years being considered appropriate) and local faulting. A peak of 0.18 g was determined for this event. The S2 earthquake was determined from seismological considerations and is intended to represent a 10^{-4} probability of exceedence. A peak of 0,48 g has been derived.

Because the S1 and S2 earthquakes are defined at bedrock the site transmission characteristics have to be assessed and, at this particular site, the result is determined from both experiment and analysis.

The papers by Mr. F. Yagishita and Mr. Y. Yamagishi described SSI analyses using compliance and FE methods respectively. It was noted that the FE results gave less important results than the compliance method.

There was some interesting discussion on these three papers concerning the justification of taking advantage of the reduction of motion with depth for these deeply embedded structures. Technically this was considered to be correct but this will be the first Japanese site where such a procedure has been approved by the Japanese licensing authorities.

The fourth paper in the session, by Mr. F. Allen, UK, described the influence of the requirement for a seismic capability on the design of the Heysham II AGR. The major factors were the PCPV restraint rig, the fuel machine clamps, boiler restraints, seismic instrumentation and snubbers for pipework. The total resulting cost increase of implementing the seismic assessment was estimated to be of the order of 10 % of the cost of the station.

The final paper in the session by Mr. F. Tajirian described a SASSI SSI analysis of the deeply embedded modular HTGCR. Because of the depth of embedment the reduction of motion with depth was recognized as being extremely important, especially for a design intended to be capable of construction at 65 % of US sites. The effect of interaction between two adjacent structures has also been assessed and is expected to increase responses by 5 % to 15 %.

Some discussion regarding the need to consider the effect of soil separation on the vertical sides of the embedment took place during the session and opinion was fairly uniformly divided regarding the necessity for such parametric studies.

SESSION III

In Session III, there were 5 papers, three papers from Japanese HTTR project and two papers from Soviet Union activities.

Japanese are now focusing the construction of the HTTR to achieve the initial criticality in 1995. Then, a lot of activities concerning aseismic design has been performed for the reactor internal components.

The first paper presented by Dr. S. Shiozawa referred to the seismic response analysis of the HTTR core with SONATINA-2V Code. The experimental results were also introduced in comparison with the analytical results. In general, the analytical results showed a good agreement with the test results.

The discussion was made mainly on the difference between key/key-Way system and dowel/socket system.

The SONATINA-2V Code has been originally developed for the HTTR, however, it is hoped to be applicable for general purposes to treat impact forces upon block to block collision.

The second paper presented by Mr. T. Miki referred to the core bottom structures. He emphasized that the analytical model was successfully developed on the basis of largescale vibration tests.

In the third paper by Mr. S. Katagiri, an excellent scammability was shown by the vibration tests. The discussion was made on the possibility of the misalignment of the control rod guide blocks and also the reliability of the oil damper which reduces the acceleration imposed on the control rod drive.

Finally, the presentations by Ms. T. Chikunova and Mr. V. Silaev from the Soviet Union were made, concerning the aseismic principle of BTM type, high temperature gas-cooled reactor. The finite element model (beam model) was described and numerical results were given.

SESSION IV

In Session IV - 3 papers were presented mainly on core behaviour:

- 2 on HTR core (german project),
- 1 on AGR core and boilers (UK - Heysham)

HTR Core

The first paper was related, mainly, to the experimental work which was performed on the Jülich shaking table.

The aim of this work was to study:

- The pebble bed - Parametric tests were performed (influence of the excitation level, frequency of the sinusoidal excitation ...). The main conclusions were: there is no behaviour comparable to sloshing, there is a 2 % compaction.
- The top reflector - It allows the validation of a spring mass model with impacts.
- The side reflector - This structure shows a very good behaviour under seismic load.

A question on the consequence of the compaction on the reactivity was asked during the discussion. The answer was that it has been studied, the consequences are acceptable and this is partly due to the fact that on the top there are new pebbles.

The second paper was related to the analytical model of the pebbles. An anisotropic finite element model was developed based on Darbre and Wolf theory.

The application of this model shows the very great influence of the friction between the pebbles.

AGR Core

The paper was related to the study of the boilers and of the core. For both structures a short description was given, followed by the presentation of the tests and of the analysis.

In conclusion for boilers the tests were useful but not essential, but for the core the tests were necessary.

Two questions arise during the discussion:

- due to the program on AGR, was this work on Heysham II be done because of new requirements. The response was yes: but no new seismic requirements were given for other AGR.
- Could comments on the statistical method to study core be given. Response: up to now no.