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235 MWe Containments in India

Enceinte de réacteur nucléaire de 235 MW, Inde

Das Containement für einen 235 MW Kernreaktor

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Two units each of 235 MWe reactors are under construction at two sites at Kaiga (Kaiga 1 & 2) and Ravatbhata (RAPP 3 & 4) using standardised designs. The civil designs for containment structures are based on identical design philosophy but making suitable site dependent modifications. The containment has to remain integral and effective in the most unlikely combination of the postulated events wherein the extreme natural disasters can combine with the internal accidental release of steam/air mixture creating high pressure and temperature loading. To decide upon the magnitudes of design basis events arising out of natural disasters, detailed studies of specific sites were made. After establishing the design parameters, most appropriate containments capable of protecting the reactors from the environment and the environment from the internal accidents were designed.

1. THE NATURAL DISASTERS AND DESIGN BASIS

1.1 Earthquake Parameters:

The IAEA guidelines were used to determine the S1(OBE) and S2(SSE) level earthquakes. In determining the SSE, studies of regional geology alongwith RIS potential were used with a seismotechtonic approach to establish the maximum potential magnitudes of earthquakes on various causative faults. The maximum ground motion at the site is then calculated using appropriate attenuation laws.

1.2 Wind Effects:

RAPP has a meteriological station from which data is available. The statistical analysis of the same was carried out to establish the extreme design wind velocities. For Kaiga site - in absence of meteriological station at site - codal recommendations are adopted with suitable modification to return period for special structures. Kaiga site has a special feature of forming atmospheric inverted bowl effect due to existence of high hills all around covering a large percentage of periphery around the site.

1.3 Flood Effects:

Both of the project sites are located on the foreshore banks of the reservoirs formed by constructing dams across major rivers. On these rivers, more dams have been built upstream of the sites. The safety of these dams has been studied for extreme events. In addition, flood routing studies have been made to establish the maximum water level at site due to postulated dam break of the upstream dams.

1.4 Geological studies:

Geotechnical parameters were established including the rock levels and foundations conditions. A detailed study of aggregate sources was made since a portion of Kaiga region has a small percentage of strained quartz.

2. SOLUTIONS EVOLVED

2.1 Reference is made to Fig. 1 showing the section through the containment. Double containment philosophy has been used wherein any leakage from the inner containment is entrapped in the annular space and is not allowed to mix with the environment before scrubbing and filtering.

The inner containment in prestressed concrete is designed to remain leaktight and its structural response fully within elastic ranage for all the combinations of loading. In addition, ultimate safety factors are checked by limit state approach to assess the strength aspects. Outer containment in RCC is designed for extreme wind and the earthquake effects. The common base raft is designed as water retaining RCC structure giving due consideration to the shrinkage and heat of hydredation effects.

2.2 At Kaiga site, due to earthquake effect there is a case of lift off of the raft, loosing contact of over 60% of area. Also the embedment effect in rock is not available due to highly joined nature of the rock mass with thin lenses of chovrite and mica schists and small cover of rock over the founding level. A ring of prestressed flexible rockanchors was provided in annular space. The rock mass was treated carrying out the consolidation grouting. At RAPP site rock anchors were not necessary due to low seismocity and also good massive intact rock, giving embedment effect, was available.

2.3 The plant is located at elevations above computed flood water levels postulating upstream dam break and further flood routing.

2.4 Petrographic studies were carried out on the stone samples from source quarries to assess the presence of strained quartz in the rock. Experiments were carried out, using the mortar bar expansion method, using varying contents of total alkali in the cement samples. Based on these studies cement of low alkali was specified and specially manufactured for use.

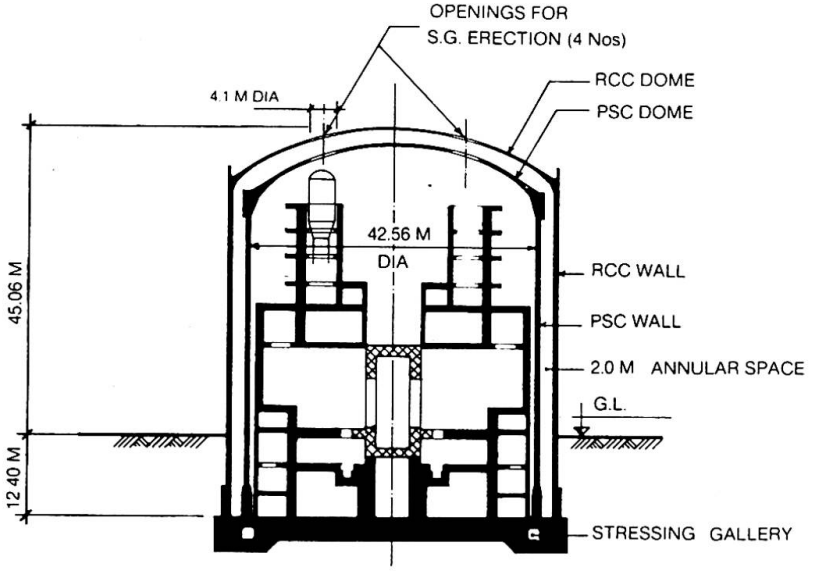

Fig.1 Cross Section - Kaiga Atomic Power Project