STRUCTURAL RESPONSE OF A CONCRETE WALL TO BLAST LOAD

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SUMMARY

A conservative estimate of the maximum weight of an explosive charge whose detonation can be resisted by a reactor building wall can be arrived at through the analysis of the response of a flat wall subjected to various blast conditions. Since direct contact explosions are not considered in this study, generally available spherical air blast pressure and impulse curves based on conventional weapons test data are used. A parametric study is carried out wherein this data is integrated over a circular segment of the wall which is assumed to respond to the blast; however, the actual diameter is a parameter which is adjusted to maximize a computed damage factor. The wall resistance forces are computed by the ultimate strength method commonly used in the design of concrete structures, considering both the flexural action of the wall and its strength as a membrane. The deformation of the wall is then computed from the impact of the blast, the mass of the affected segment and the ultimate strength. The variation in the blast wave time of arrival and in the positive pressure phase duration over the affected area is not specifically taken into account.

Two types of wall construction are considered: first, a conventionally reinforced 2.5 ft thick wall representative of earlier shield building designs; and second, a prestressed 3.5 ft thick wall. The effect of a steel liner anchored to the interior face of the concrete wall is also taken into consideration. The diameter of the segment of the wall responding to the blast is in the range of only one to five wall thicknesses; hence, the wall boundary conditions become relatively unimportant to this study.

Damage criteria based on deformation as well as displacement limits are considered. Deformation criteria of both a 5° rotation limit at yield lines, which is assumed to correspond to a structurally acceptable damage level, and a 12° rotation limit are used. Limits of 3 and 12 inches are applied as displacement criteria. Spallation and scabbing were also considered in this study, however these items are discussed in a separate report.

The results of this study are best presented in graphical form. The input parameter matrix of the various criteria, charge standoff distances and wall constructions provides a three-orders-of-magnitude range of resulting critical charge weights. For example, with a 5 foot standoff distance the critical charge weight for the 2.5 foot reinforced concrete wall is in the range of 300 to 750 lb; for the 3.5 foot prestressed wall it is 1000 to 2500 lb. The critical weight is roughly proportional to the standoff distance if a deformation criterion is used; but it varies approximately as the cube root of the standoff distance for a displacement criterion. Including a liner plate of conventional dimensions in these computations has little effect on the numeric results; however, it may influence the nature of the debris produced.