DIRECT COURSE Blast Shelter Entranceway and
Blast Door Experiments

by

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ABSTRACT

The DIRECT COURSE Event is a high-explosive simulation of a 1-kt height-of-burst nuclear weapon. DIRECT COURSE is sponsored by the Defense Nuclear Agency and is scheduled for September 1983 at the White Sands Missile Range, New Mexico. Three entranceway experiments will be fielded, one full size complete with two blast doors to document structural response and loading in the simulated 1-kt blast environment. Also, two 1/10-scale models, one double and one single entrance configuration, will be used to obtain blast pressure data that can be scaled to a 1-Mt blast environment. Results from these experiments will be used to evaluate and improve structural response calculations for the 1-kt environment, and to obtain loading data for a 1-Mt environment. These data will be used to design entranceways and blast doors for the key worker blast shelter.

INTRODUCTION

Several blast shelter entranceways, some including blast doors, were tested in the aboveground atomic tests at the Nevada Test Site during the 1950's, see for example References 1-7. The blast doors, or closures, tested were either massive reinforced concrete doors (4 and 5), vertical shaft entranceways with a submarine-type hatch (1, 2, and 3), steel doors with beam stiffeners (6), or doors tested at less than 10 psi (7). More recent tests have re-examined the steel door (8) and the vertical shaft with a hatch at ground level (9).

The most cost efficient closure and entranceway system, and one whose survivability has clearly been demonstrated, is the vertical shaft with a hatch-type closure. However, if a vertical entranceway is used for a large shelter, 100-person capacity or larger, it may not be possible to get everyone into the shelter in the allotted time (normally 15 min.). Therefore a cost efficient, walk down, entranceway and blast door design is needed for blast shelters such as the deliberate, 100-person capacity, Key Worker blast shelter that is currently being designed for FEMA by the USAE Huntsville Division.

OBJECTIVES

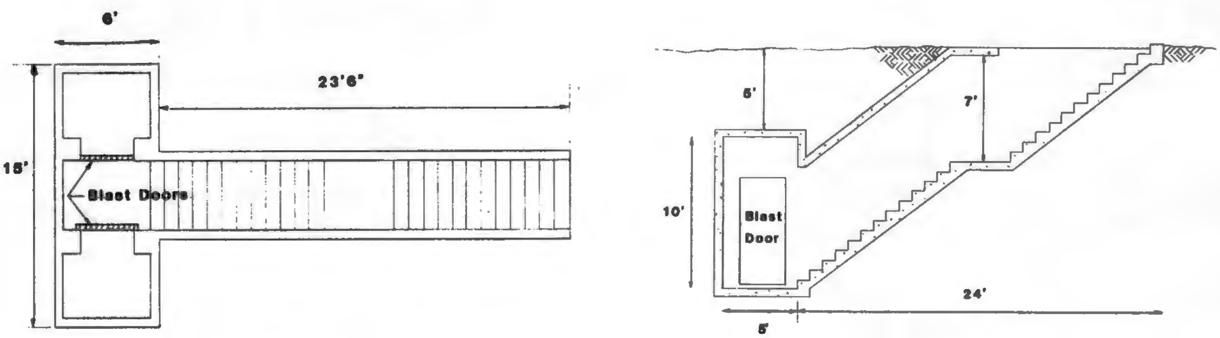
1. Evaluate the design of an entryway, complete with blast door, in a 1-kt simulated 50 psi airblast environment.

2. Obtain 1-Mt airblast loading data for single tunnel, dead end and double tunnel, pass through entryway systems using tenth-scale models.

3. Design and evaluate alternate blast door configurations.

ANALYSIS

A full-scale, single tunnel, dead end entranceway, as shown schematically in Figure 1, will be tested. Anticipated maximum pressures on the structure at the 50 psi overpressure range are shown in Figure 2 where the pressures shown are horizontal soil stresses at midstructure height, internal airblast pressures, and peak reflected pressure, P_r , at the tunnel dead end. The worst case loading of the entrance tunnel will occur with the entrance facing away from ground zero, thus loading the exterior of the tunnel with soil transmitted pressures before the tunnel becomes pressurized. Therefore, the loads used for tunnel design calculations were the soil transmitted pressures.



a. Plan view b. Elevation

Figure 1. Full-scale entranceway configuration.

The worst case loading for the blast door occurs with the tunnel facing ground zero, as shown in Figure 2, therefore, this will be the orientation for the DIRECT COURSE Test. Pressures in the tunnel were computed by Mr. Bob Britt, WES, using References 10 and 11. The pressure-time history computed at the center of the blast door, and used for the blast door response analysis, is shown in Figure 3.

The blast door was designed with the objectives that it be relatively inexpensive (less than about $500) and that it be constructable at the construction site to save transportation cost. A reasonable approach would be to preconstruct the formwork and then pour concrete in the door at the construction site. Four types of doors, with cross sections shown in Figure 4, were considered. To withstand the blast loads, the door must have a flexural capacity of approximately 150 psi. To minimize the cost of hinges and make handling easier, it should weigh no more than about 1500 lb, and it should transmit no more than about 50 rads of prompt radiation. The use of high-density concrete was considered because of its increased radiation protection. Reference 12 was used for radiation calculations. Based on a 1-Mt weapon at a range of 5000 ft (50 psi overpressure), gamma radiation in front of the door is about 9.6×10^3 rads. Based on the analysis results in Table 1, a Type 4 door, 3 inches thick, and using standard concrete was selected. Maximum deflection for this door, with the loading shown in Figure 3, and a negative steel reinforcement ratio of 1.1 percent, is 0.39 in., which is a ductility (ratio of maximum to elastic deflection) of 1.4.

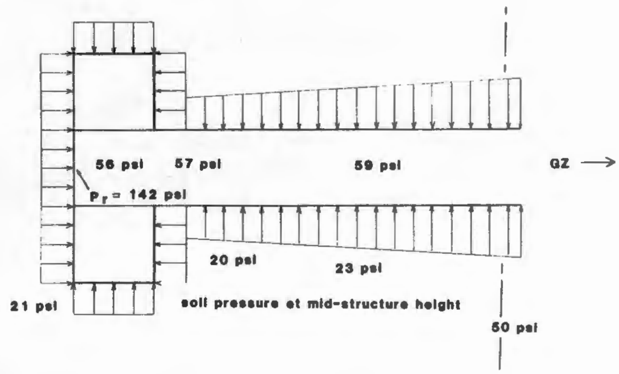


Figure 2. Entranceway loading at the 50 psi overpressure range from 1-kt airburst.

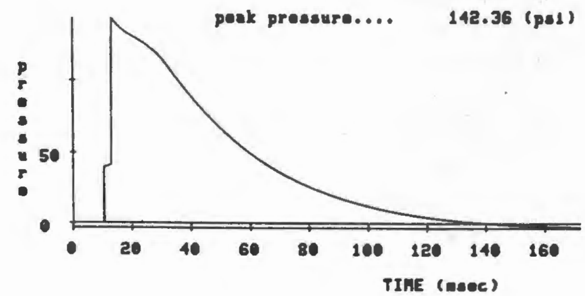


Figure 3. Computed pressure at the center of the blast door.

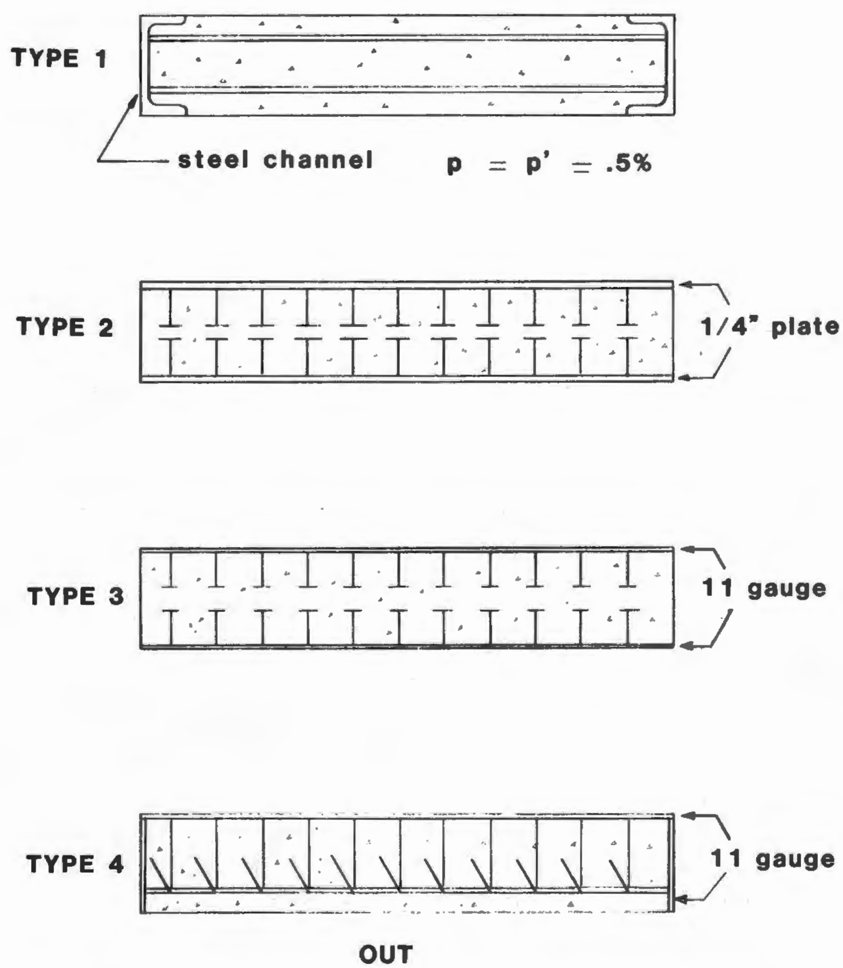


Figure 4. Blast door cross sections considered (not to scale).

Table 1. Blast Door Analysis Results

Slab Thickness in.	Type 1			Type 2			Type 3			Type 4		
	WT lb	R psi	γ in. rads	WT lb	R psi	γ in. rads	WT lb	R psi	γ in. rads	WT lb	R psi	γ in. rads
Standard Concrete, 150 lb/ft^3												
6	2300	110	14									
5	1910	70	20									
3				1630	532	26	1330	244	40	1210	180	48
2				1280	369	46	980	166	71			
High-Density Concrete, 200 lb/ft^3												
6	2975	110	6									
5	2470	70	9									
3				1980	532	17	1680	244	23	1560	180	31
2				1510	369	34	1210	166	48			

A standard steel fire door with supports as shown in Figure 5 will also be tested. Three W 6 x 12 beams will support the door. The pins, shown going through the door, will attach to the support beams and prevent rebound forces from opening the door.

Two 1/10-scale nonresponding entranceway models, one single tunnel similar to the full-scale structure and one pass-through tunnel, will be tested. These models will be instrumented with airblast gages to obtain airblast loading data. These data can then be scaled, using cube root scaling, to a 1-Mt event and used for design calculations.

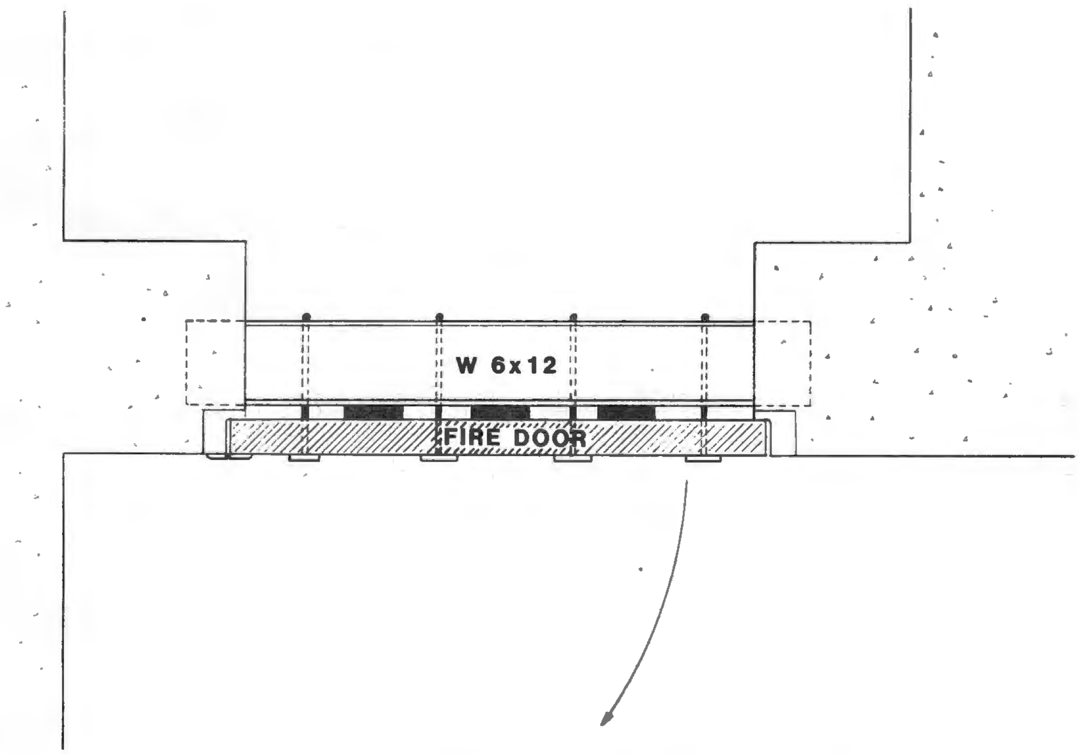


Figure 5. A supported steel fire door.

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