DIVIDING WALL STUDIES

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DEVELOPMENT DIVISION

OCTOBER - DECEMBER 1971

Normal Process Development
Endeavor No. 215

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The purpose of this project is to finalize the studies of foamed concrete wall treatment with respect to its effectiveness in reducing wall missile velocities resulting from blast loading conditions.

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Section Q

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ABSTRACT

With the resumption of the Dividing Wall Studies most of this quarter was devoted to preliminary preparations for the proposed series of tests. Two shots involving one-fourth scale untreated walls were fired and analyzed. Four batches of foamed concrete were made and poured into one and one-half inch thick test slabs for future test fires. Seven day and twenty-eight day compression tests were completed on each of the batches.

DISCUSSION

In previous work on this project, small-scale concrete test cubicles were used to evaluate foamed, low density concrete and polyethylene foam as wall treatment materials. It was found that both materials were effective in reducing missile velocities with the foamed concrete being perhaps the better of the two(1). The small-scale cubicles proved undesirable because of the inherent problem of fireball and debris interfering with camera coverage of the wall missiles. To minimize this problem, an earth-covered steel tunnel was designed and fabricated. The tunnel was made of 4-inch thick steel with inside dimensions of 36 inches high x 40 inches wide by 72 inches long. The design allows clamping a 3 inch thick reinforced concrete slab to one end of the tunnel. An explosive charge can then be suspended inside the tunnel at a predetermined distance from the wall to provide the impulsive loading. One preliminary shot was fired to check the concrete slab retaining system. Camera coverage of this shot indicated that there is no significant problem with fireball and debris.

The test configuration for shot nos. T-1 and T-2 is shown in Fig. 1. A Fastax high speed motion picture camera was focused on the wall and aligned perpendicular to the long axis of the containment tube. A grid painted on a white background placed near the wall provided a reference for obtaining missile velocities from the broken wall. A chronographic screen was used to obtain further missile velocity information.

A two-pound, center initiated sphere of PBX 9404 charge was used. The charge was positioned to obtain the loading condition or Z-factor shown in Table I.

The Z-factor is given as $Z = \frac{R}{W^{1/3}}$ where R is the separation between the charge and wall in feet and W is the charge weight in pounds.

Equipment malfunction caused records of shot T-1 to be lost. However, post shot observation of the wall indicated the necessity of increasing the loading condition. The wall was badly cracked but remained approximately 90% intact. There were a few small missiles thrown approximately 50 feet.

NOTE: All Dimensions in inches

- High Speed Camera
 CS-Chronographic Screen
 VG-Velocity Grid

Fig. 1. Small Scale Dividing Wall Tests
Nos. T-1 & T-2 Configuration

Fig. 2. Compressive Strength Versus Density of Foamed Concrete

Table I. Summary of Test Results

Test No.	Distance from Wall (in)	Z(ft/lb ^{1/3})	Missile Velocity (ft/sec)		Remarks
				<u>Optical</u>	
T-1*	12.0	.794		Lost	All records lost because of equipment malfunction. Wall thrown ~ 30 feet, very few Missiles, some cracking but ~ 90% intact.
T-2	9.0	.595		125	Wall thrown ~ 40 feet, missiles as far as 150 feet; extreme cracking. Tunnel damaged.

* T denotes small scale tunnel test, and number denotes numerical sequence for this dividing wall series.

Table II. Foamed Concrete Compressive Strength Data

Batch No.	Density (lbs/ft ³)		Compressive Strength (psi)	
	<u>Wet</u>	<u>Oven Dried</u>	<u>7-day</u>	<u>28-day</u>
1	25.3	16.9	60	70
2	26.6	17.3	55	72
3	26.8	17.7	58	71
4	26.8	17.7	57	71

A summary of shot No. T-2 is also shown in Table I. The measured missile velocities were in the desired range of approximately 200 ft/sec. Missiles were thrown as far as 150 feet.

CELLULAR CONCRETE

Foamed concrete test slabs one and one-half inches thick were fabricated and tested for upcoming shots. This foamed concrete was made in accordance with the procedures established by the U.S. Corps of Engineers, Waterways Experiment Station, Jackson, Mississippi (WES). In the mixing operation a predetermined amount of Portland Type III cement and water was mixed for six minutes, at which time a predetermined quantity of foam was added and mixed for another six minutes. Mixing time is arbitrary but must be fixed for the sake of reproducibility in that mixing tends to drive entrained air out of the mixture. The foam additive used was generated separately in a pressurized vessel in which water and a foaming agent, Mearlcrete P Foam Liquid(2) were premixed in fixed ratios and then forced into an expansion chamber or nozzle where it was mixed with air to form the desired foam.

Four batches of concrete were made as above. The resultant density was approximately 27 lbs/ft³ in three of the batches and 25 lbs/ft³ in the other. Seven day and twenty-eight day compression tests were conducted on samples taken from these batches and are summarized in Table II and illustrated in Fig. 2 for comparison purposes with WES's 28 day compressive strength data. The compression test method used was that as described in ASTM Standard C495-69. This standard applies to all lightweight concrete having an oven-dry weight not exceeding 50 lbs/ft³(3).

FUTURE WORK; COMMENTS; CONCLUSION

The steel tunnel is presently undergoing modifications; one weld was cracked during shot no. T-2.

One more shot involving an untreated wall is planned next period along with three or four tests involving one and one-half inch thick foamed concrete test slabs.

No information has been obtained thus far from the chronographic screens; however, because of the potential for additional velocity information, more work will be done on developing a technique for their use.

REFERENCES

1. R.J. Slape, Dividing Wall Studies, Normal Process Development Quarterly Report for October-December 1969.
2. A stabilized, hydrolyzed protein concentrate manufactured by the Mearl Corporation, Roselle Park, New Jersey
3. Standard Method of Test for Compressive Strength of Lightweight Insulating Concrete, ASTM Designation C495-69.