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6220 CULEBRA RD. 78238-5166 • P.O. DRAWER 28510 78228-0510 • SAN ANTONIO. TEXAS. USA • (210) 684-5111 • WWW.SWRI.ORG
CHEMISTRY AND CHEMICAL ENGINEERING DIVISION
DEPARTMENT OF FIRE TECHNOLOGY
WWW.FIRE.SWRI.ORG
FAX (210) 522-3377

FIRE PERFORMANCE EVALUATION OF LITE-FORM TECHNOLOGIES' LITE-DECK FLOOR/CEILING INSULATING CONCRETE FORM SYSTEM TESTED IN ACCORDANCE WITH ASTM E 119-00, *STANDARD TEST METHODS FOR FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS*

FINAL REPORT
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Prepared for:

Lite-Form Technologies
1950 West 29th St.
South Sioux City, NE 68776

Prepared by:

Michael Luna
Research Engineer
Fire Resistance Section

Approved by:

Gladys M. Miller for

Marc L. Janssens, Ph.D.
Director
Department of Fire Technology

ABSTRACT

Southwest Research Institute's® (SwRI®) Department of Fire Technology, located in San Antonio Texas, conducted a fire performance evaluation for Lite-Form Technologies' Lite-Deck Floor/Ceiling Insulating Concrete Form System in accordance with ASTM E 119-00, ***Standard*** *Test Methods* ***for*** *Fire Tests of Building* ***Construction*** *and Materials.* Testing was conducted on August 19, 2005. The floor/ceiling assembly was exposed to the temperature conditions specified in the standard under load-bearing conditions for an unrestrained assembly.

The Lite-Deck insulating concrete forms were mounted on top of SwRI's large horizontal furnace and the test assembly was cast in-place. The floorlceiling assembly was constructed with a test exposure area of 12 × 15 ft. The interlocking form assembly consisted of expanded polystyrene base panels with 18-gauge C-channel steel stiffeners, 6-in. thick top hats, reinforced concrete, and 5/8-in. Type X gypsum wallboard. The test assembly was subjected to a 250-lb/ft^2 load and tested for 111 min and 30 sec.

Lite-Form Technologes' unrestrained floorlceiling system did not exceed the temperature rise limits. **At** 108 min the assembly began to rapidly lose its structural integrity and, shortly thereafter, failure occurred. As a result, the unrestrained floorlceiling assembly with **a** load of 250-lb/ft^2 obtained a 1-54 hr fire resistance rating according to ASTM E 119-00.

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1.0 INTRODUCTION

The ASTM E 119-00, Standard *Test* Methods *for Fire Tests* of *Building Construction* and Materials, is intended to evaluate the duration for which the described assembly will contain a fire, or retain its structural integrity, or display both properties dependent upon the type of assembly involved, during a predetermined fire test exposure.

This test measures the response of the assembly to exposure in terms of the transmission of heat and hot gases through the assembly. This standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment, which takes into account all the factors that are pertinent to an assessment of the fire hazard of a particular end use.

This report describes the testing and analysis of distinct floor/ceiling assemblies, and includes descriptions of the test procedure followed, assemblies tested, and the results obtained. The results presented in this report apply only to the material tested, in the manner tested, and not to any similar materials or material combinations.

2.0 TEST PROCEDURE

The test exposes a floor/ceiling assembly to a standard fire exposure controlled to achieve specified temperatures throughout a specified time period. The assembly is constructed at large scale, and evaluated under pre-determined fire exposure and loading conditions.

2.1 ASTM E 119-00 FIRE EXPOSURE

Southwest Research Institute's® (SwRI®) large-scale horizontal furnace is used to expose large test specimens to the ASTM E 119-00 fire exposure. The furnace is capable of exposing a maximum test specimen of 13 ft 6 in. × 17 ft 6 in. The 80-in. deep furnace is equipped with 14 premixed air/natural gas burners symmetrically placed across the walls. The burners are 18 in. above the furnace floor and controlled by a variable ratio air/gas regulator. Windows are located on all sides of the furnace to allow observation of the surface exposed to the flame.

The fumace exposure is described in the standard, and is used to regulate the furnace environment throughout the duration of the exposure period. Points on the standard time/temperature curve are shown in Table 1 and are used to control the fire exposure.

Table 1. Points On The Time/Temperature Curve.

TIME	TEMPERATURE
0 minutes	Ambient
5 minutes	1000°F (538°C)
10 minutes	1300°F (704°C)
30 minutes	1550°F (843°C)
45 minutes	1638°F (892°C)
60 minutes	1700°F (927°C)
2 hours	1850°F (1010°C)
3 hours	1925°F (1052°C)
4 hours	2000°F (1093°C)

The conduct of the fire test is controlled according to the standard time/temperature curve, as indicated by the average temperature obtained from the readings of nine furnace probe thermocouples (TCs) symmetrically located across the face of the specimen 12 in. below the exposed surface of the specimen. The furnace probe TCs are enclosed in protection tubes of such material and dimensions that the time constant of the TC assembly lies between 5.0 and 7.2 min, as required by the standard. The furnace temperature during a test is controlled such that the area under the time/temperature curve is within 10 percent of the corresponding area under the standard time/temperature curve for tests of 1 hr or less, 7.5 percent for tests less than 2 hr, and 5 percent for those tests 2 hr or more in duration.

The furnace is continually monitored and necessary adjustments of the air/gas ratio are made to ensure that the temperature in the furnace follows the prescribed time/temperature curve. The exhaust damper position is also monitored and adjusted as necessary to maintain the prescribed pressure within the furnace environment relative to ambient air pressure. The furnace pressure is maintained at a slightly negative pressure, measured at 12 in. below the exposed surface of the floorlceiling sample.

2.2 INSTRUMENTATION AND DOCUMENTATION

2.2.1 Unexposed Surface Temperature

The unexposed surface temperature is monitored using a minimum of nine TCs. Temperatures of unexposed surfaces are measured with No. 20 B & S gauge, Type K (Chromel-Alumel) welded TCs, placed under flexible, dry, felted mineral fiber pads. The wire leads of the TC terminate

under the pad and are in contact with the unexposed surface. The pads are attached firmly to the surface to minimize any heat loss from the sides. The reinforcing steel section temperatures are monitored using twenty-four 118-in. grounded junction inconel sheathed TCs peened to the joist reinforcing steel rebar prior to the concrete being cast. Temperature levels are monitored continuously throughout the test and recorded with computer data acquisition equipment for subsequent data reduction. TC placement is shown in Appendix A.

2.2.2 Deflection

The deflection at the approximate center of the floor assembly test sample was measured with a linear voltage displacement transducer. The deflection of the floorlceiling assembly test sample was monitored continuously throughout the test. The deflection measurement location is shown in Appendix A.

2.2.3 Photographic and Video Documentation

Photographic and video documentation of the fire exposure was collected. Photographic documentation is provided in Appendix B and video documentation of the fire tests accompany this report.

2.2.4 Loading

A uniform pressure of 250 lb/ft^2 was applied to the 12 × 15-ft'test exposure area. This was accomplished by utilizing a distributed dead load consisting of nine nominal 1323-lb steel weights, 18 nominal 8-lb, 4 × 4-in. yellow pine wood studs, and 18 Miller "H" series hydraulic jacks [Model No. H84B2N-(200)-(2400)-(100)-N11-0]. The hydraulic jacks used had a bore diameter of 2 in. Please see Figure A-1 in Appendix A, for the load distribution layout.

SwRI's hydraulic loading system was calibrated on June 6, 2005, utilizing a Sensotec load cell (Model No. 4110573-02-05), and the linear equation of pressure versus load was formulated. The load cell calibration sheet and pressure versus load graph are located in Appendix E.

After application of the nominal 12,050-lb dead load, the load jacks were pressurized to 575 psig for a nominal load of 32,950 Ib, and a total load of 45,000 lb over the 12 × 15-ft test exposure area. The pressure was manually maintained to ± 5% for the full duration of the fire exposure period.

3.0 TEST ASSEMBLY

The floorlceiling assembly was constructed with a test exposure area of 12 × 15 ft. The Lite-Deck insulating concrete forms (ICF) were mounted on top of SwRI's large horizontal furnace and the test assembly was cast in-place. Ingram Readymix Inc., located in New Braunfels, Texas, provided the concrete used in construction. The mix design and material certifications are located in Appendix D.

The interlocking form assembly consisted of expanded polystyrene (EPS) base panels with 18-gauge C-channel steel studs, two 6-in. thick top hats attached to each 6-in. thick base section, #6 rebar centered 1.5 in. from the bottom of each joist, #3 rebar laid in a 16-in, on-center grid located 1.5 in. above EPS panels to reinforce the 4-in. thick concrete slab. The underside of the floor/ceiling assembly was finished with 518-in. Type X gypsum wallboard attached to the C-channel studs. Details of the Lite-Deck ICF can be found in Appendix D.

4.0 TEST RESULTS

The floor/ceiling assembly was constructed on top of SwRI's large horizontal furnace and was allowed to cure for a minimum of 28 days. Instrumentation connections were verified and the 250-lb/ft^2 load was applied. The wall was tested on August 19,2005 at an ambient and initial temperature of 88°F. At approximately 26 min, the EPS forms ignited and fueled the furnace. The furnace operator set the furnace gas controls to idle at approximately 31 min. Gas flow was increased at approximately 46 min. At approximately 72 min and 15 sec into the test, a temporary power failure occurred and the standard time/temperature curve could not be followed for approximately 4 min. The fire exposure was terminated at 111 min 30 sec, at which time the average unexposed surface temperature was 201°F, representing a 113°F rise above ambient conditions. The maximum unexposed surface temperature reached 211°F, representing a 123°F rise above ambient conditions. The reinforcing steel section temperature did not exceed the maximum temperature allowed (1100°F). At 108 min the assembly began to rapidly lose its structural integrity and at 111 min 30 sec the assembly collapsed. After reviewing the data, it was determined that the power failure did not affect the validity of the test because the area under the actual furnace timeltemperature curve was 1.6% higher than the area under the standard time/temperature curve for a 90-min duration. The standard allows for a 7% difference in the areas under the curves for test durations greater than 1 hr but less than 2 hr. Visual observations of the test are summarized in Table 2.

Table 2. Visual Observations.

TIME (min:sec)	OBSERVATION
0:00	Test started.
9:30	Ceiling gypsum wallboard still attached.
26:00	Ceiling gypsum wallboard still attached. EPS foam melting and dripping through ceiling seams.
31:00	Furnace temperature increase. Furnace gas set to idle.
37:00	Dark grey-black smoke from top edges of sample.
43:00	Deflection at 0.31 in.
44:00	Concrete spalling.
49:00	Spalling continues.
50:00	Smoke from edges.
62:00	Deflection at 0.49 in.
98:30	Deflection at 1.13 in.
109:15	Deflection at 2.08 in.
111:45	Test terminated. Load-induced failure.

5.0 CONCLUSIONS

SwRI's Department of Fire Technology, located in San Antonio Texas, conducted a fire performance evaluation for Lite-Form Technologies' Lite-Deck Floor/Ceiling Insulating Concrete Form System in accordance with ASTM E 119-00, *Standard Test Methods for Fire Tests of Building Construction and Materials*. Testing was conducted on August 19,2005. The floor/ceiling assembly was exposed to the temperature conditions specified in the standard under load-bearing conditions for an unrestrained assembly.

Lite-Form Technologies' unrestrained floor/ceiling system did not exceed the temperature rise limits. At 108 min the assembly began to rapidly lose its structural integrity and, shortly thereafter, failure occurred. As a result, the unrestrained floor/ceiling assembly with a load of 250-lb/ft^2 obtained a 1-½ hr fire resistance rating according to ASTM E 119-00.