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The effect of fire on the strength of geosynthetic reinforcement in reinforced concrete facing panels of soil retaining walls

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ABSTRACT: Concern is often expressed about the performance of reinforced soil structures using polymeric materials when the facing is subject to the effects of fire. This paper describes the construction of an instrumented concrete facing material containing lengths of geosynthetic reinforcement and the subsequent application of a ½ hour fire to the panel face. Following application of the fire, its limited effect on the reinforcement was established by subjecting the geogrid to pull-out testing and comparing its pull-out strength with that for unheated control specimens.

1 INTRODUCTION

The use of polymeric materials for reinforced soil retaining wall construction is now commonplace. For certain applications however, designers are cautious about using polymeric reinforcement materials where there is a possibility of the finished structure being subjected to accidental fire damage. To investigate the effect of fire on the strength of

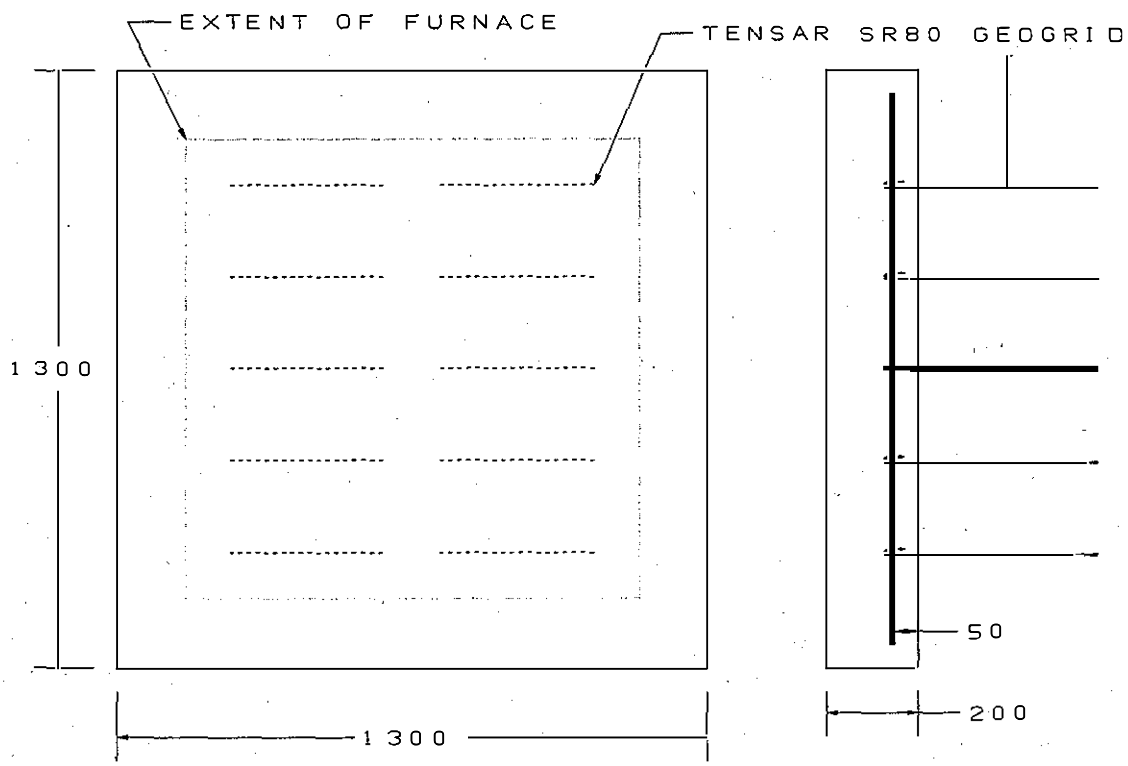

Fig. 1. Panel layout showing location of geogrids.

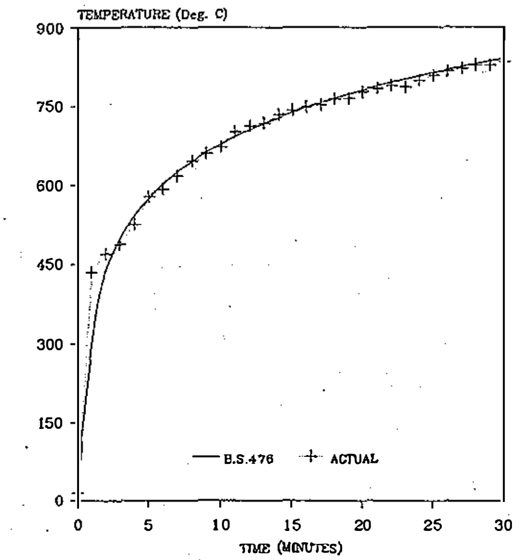

Fig. 2. Furnace temperature curve for half hour fire test.

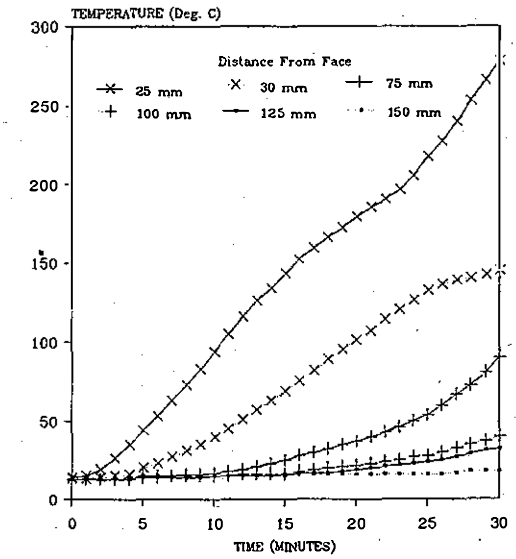

Fig. 3. Recorded temperatures in 150 mm thick panel.

such reinforcement a concrete facing panel containing short lengths of Tensar SR80 geogrid was constructed and subjected to a ½ hour fire to BS 476 Part 20 At the end of which the face of the panel had attained a temperature of 836°c.

The embedded grids were subsequently subjected to pull-out testing to establish any change in short-term strength of the grid due to exposure to the elevated temperatures caused by the fire. The panels were cast and exposed to the fire at Warrington Fire Research with the subsequent pullout testing being carried out at Bolton Institute of Higher Education.

2 CASTING

The concrete test panels were cast 1.3m x 1.3m to provide a 1.0m² face to the test furnace. The test panels were 150mm and 200mm thick with the control panel being 150 mm thick. Steel reinforcement was included at 200mm spacing vertically and 150mm horizontally, a typical configuration for a facing panel. The panel was cast such that 50mm cover was provided to the rear face of the steel from the rear face of the panel. Each panel contained 5 samples of Tensar SR80 geogrid 4 bars long and 17 ribs wide, looped around and wired to the steel bars, Figure 1.

Thermocouples were cast into both of test panels to permit monitoring of in-panel temperatures during the test. The panels were cast using a C30 mix (30 N/mm²) and left to cure for 7 weeks.

3 FIRE TESTING

The face of the test panel was bolted onto a gas fired furnace. A 300mm wide box was fixed onto the back face of the panel and filled with compacted damp sand, to replicate the in-service condition for the panel and Tensar SR80 geogrids.

At the start of the test the ambient temperature was 14°C. The furnace was lit and the temperature curve of BS 476 Part 20, Figure 2, was followed for 30 minutes at which point the furnace was extinguished. After 30 minutes heating the furnace temperature had reached 836°C and the maximum temperature on the rear face of the panel was 18°C.

Figure 3 shows the temperature distribution through the 150mm of panel throughout the test period. Figures 4 and 5 show how temperature decayed with distance from the exposed face at three different times during the test, for each panel thickness. The Tensar SR80 geogrid was located 88mm from the front face in the 150mm thick panel and 138mm from the front face in the 200m thick panel. A thermocouple attached to a reinforcing bar to which the embedded geogrid was secured indicated a maximum temperature

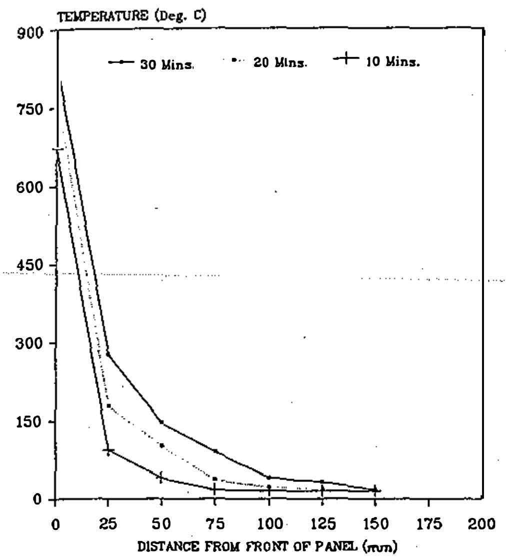

Fig. 4. Temperature variation with time through 150 mm thick panel.

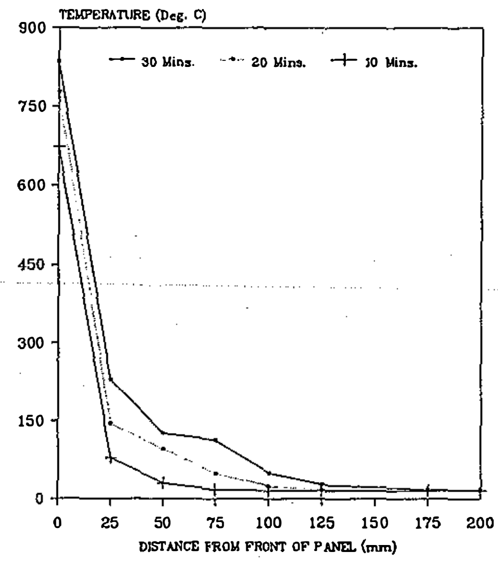

Fig. 5. temperature variation with time through 200 mm thick panel.

of 32°C by the end of the heating period. Maximum temperatures experienced by the grid at the rear face of the panel were 18°C in the 150mm thick section and 17°C in the 200mm thick section. During the fire test limited spalling of the heated face occurred, as expected.

On removal from the furnace the sand was removed and the geogrid tails inspected. No visible signs of damage were apparent. Plate 1.

4 PULL-OUT TESTING

After the fire test, pull-out testing was carried out to establish the short-term pull-out resistance of both the heated and control specimens. To facilitate testing, each panel was cut into a number of test specimens each containing a single Tensar SR80 geogrid tail 17 ribs wide. The outer two ribs were cut and the grid tested over 15 ribs. The specimens were clamped to the bed of a tensile test machine and a load applied to the grid at strain rate of 2% per minute of the exposed grid length. The average failure load from the 5 specimens of each panel type were :

Sample	Failure load kN
150mm heated samples	22.3
200mm heated samples	21.7
150mm control samples	22.0

The above results confirm that no significant change in short-term strength occurred as a result of exposure to the ½ hour fire.

5 DISCUSSION

The controlled heating in the gas fire furnace initially raised the temperature of the panels exposed face slightly quicker than the rate specified in BS 476, but after the first 60 seconds as the temperature increased from 450°C to 836°C the temperature profile closely followed that specified in BS 476. Within the face panels there was good agreement between the temperature profiles of 25 to 125mm measurements in the 150mm and 200mm thick panels. Whilst the temperatures of the exposed face rose to 836°C during the test the maximum temperature experienced by the grid was 32°C.

The heating regime of BS 476 is intended to represent a fire in an enclosed environment, where as a geogrid facing panel system will be used externally. Consequently the rate of heat transfer into the test panel is likely to have been significantly greater than would occur for an external fire of the same duration. Hence the temperatures experienced by geosynthetic reinforcement cast into a panel exposed to a ½ hour fire in an external application are likely to be less than those recorded.

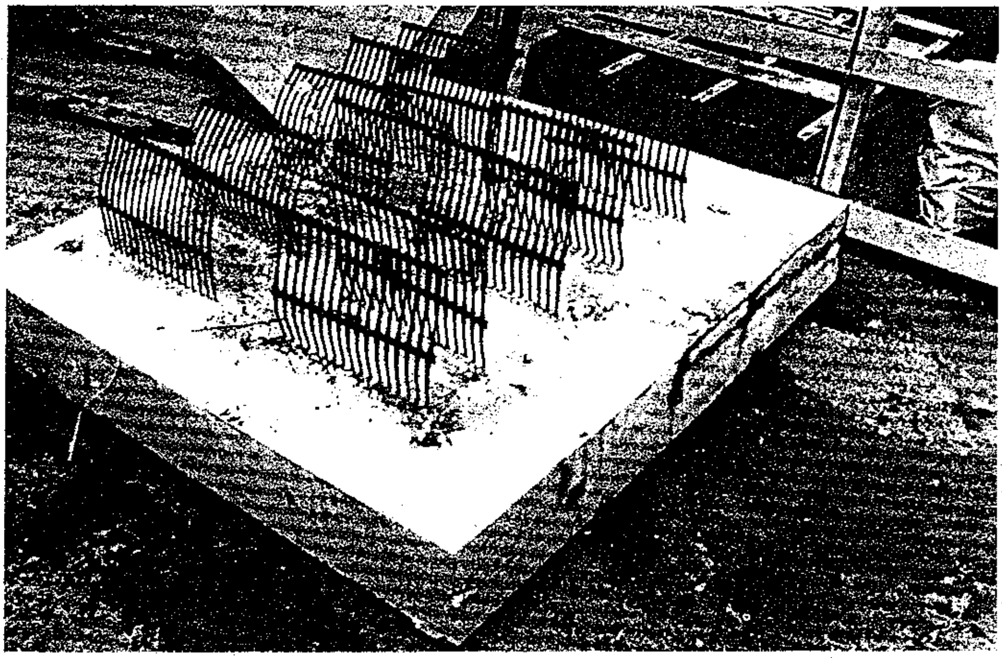

Plate 1. rear face of panel after fire test.

6 CONCLUSION

From the results obtained a 150mm thick panel is sufficiently thick to protect geosynthetic reinforcement from the effects of a ½ hour fire to BS 476.