NATIONAL BUREAU OF STANDARDS REPORT

8926

REPORT OF VISIT TO BRITISH FIRE RESEARCH STATION
5 and 6 JULY 1965

By

A. F. Robertson

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

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ABSTRACT

The workers at the Fire Research Station have made significant progress in study of smoke production by diffusion flames and the influence of N_2, CO_2, and H_2O as addatives on the air side. Work on experimental burn out tests has progressed well and preliminary results suggest that the findings may tend to justify rather than discredit the standard time-temperature curve as a basis for fire testing. Elaborate heat flux instrumentation has been involved in these tests with the objective of deriving a heat balance for the fires.

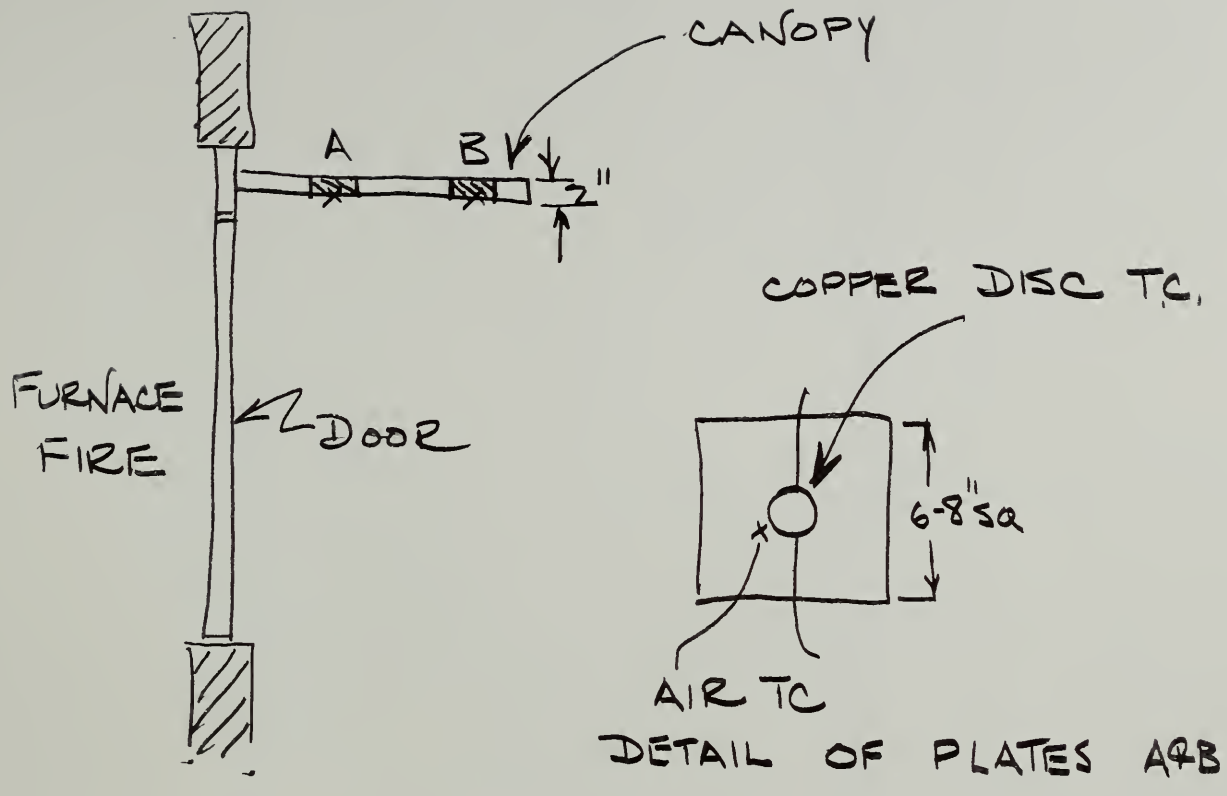
Work on thermal decomposition products has not developed well because of staffing problems. The program for study of fire performance of prestressed concrete beams has been initiated. This includes study of the influence of continuity over supports on the behavior of such structures. I saw one of the first of these tests. It appears unlikely that continuity without axial restraint will provide much benefit with respect to fire endurance.

Introduction

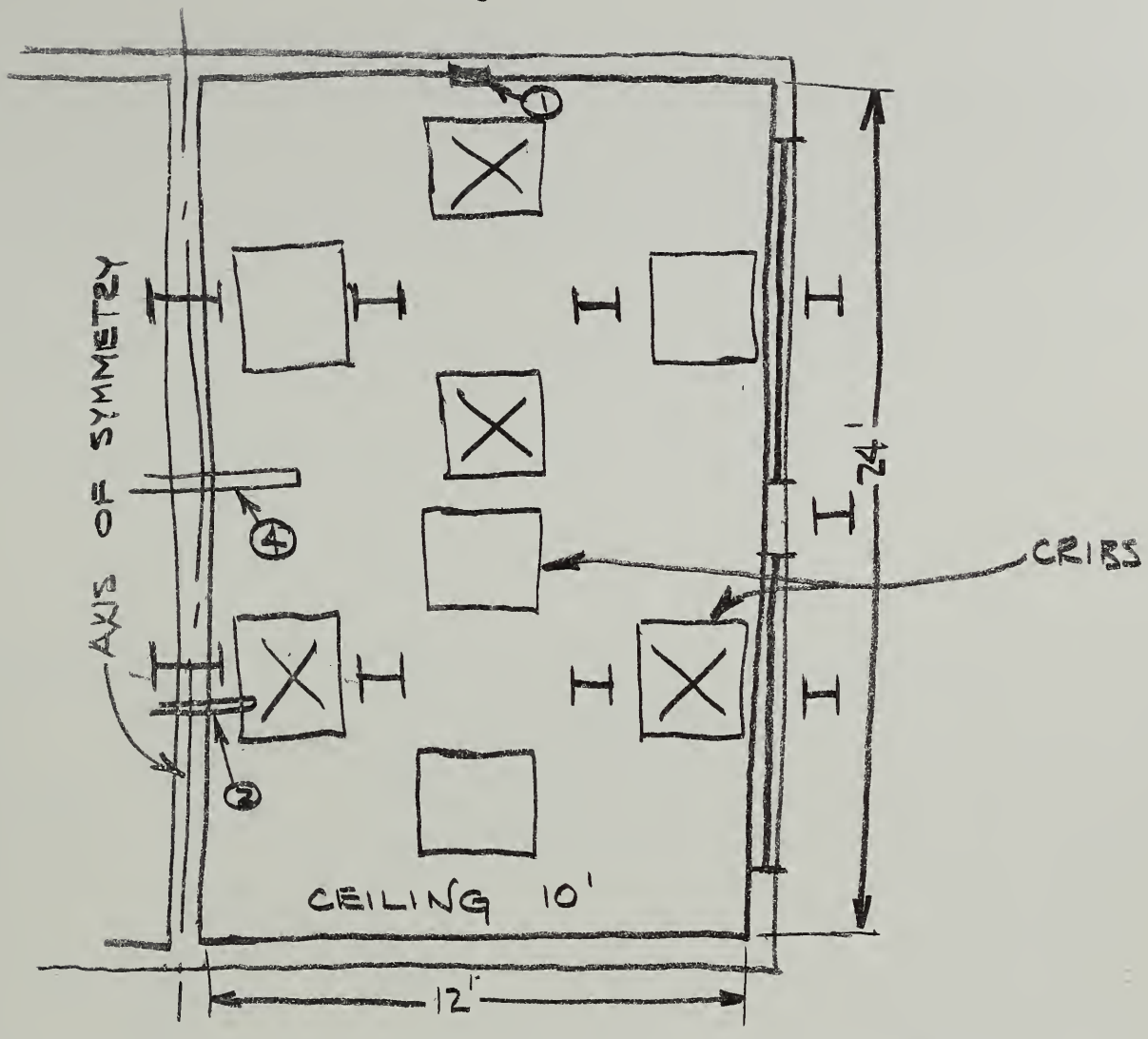
Advantage was taken of the need to be in London in connection with a meeting of the IMCO group concerned with fire tests for marine constructions to visit the Fire Research Station for two days. This report summarizes the observations made during this visit and describes some work of special interest to us in connection with our current program plans.

* * * *

I visited Messrs. Ashton and Malhotra to discuss their work on doors and burn-out tests. Their work on doors is being done primarily for ISO and they are exploring ways of measuring hot gas passage through doors by use of a flat canopy over the unexposed surface as shown. They had set alumina plates into the canopy; these were fitted with both copper disc thermocouples as well as an adjacent thermocouple to measure air or gas temperature. Malhotra had considered the incorporation of a photometer, but this has not been done yet. They find that temperature measured at point B tends to be higher than at point A. They, like we, are inclined to favor a radiation measurement of heat transfer through the door.



The work on the British Iron and Steel Federation burn-out tests has been assigned to another group under Mr. Butcher who was ill during my visit. His assistant, Mr. Chitty, showed me some of their results. The tests are being conducted in a specially built structure as shown in the sketch. The position of cribs is shown for the usual test in which 1/3 of the floor area is covered. A few tests are also planned in which the fuel will be distributed over 2/3 of the floor area. The cribs are built up of nominal 2 in. x 2 in. x 3-1/2 ft sticks without fastening or gluing. They are arranged with single stick spacing and built to a height sufficient to provide the required fire load which has included 1-1/2, 3, 6, and 12 lb/ft^2 of gross floor area. The cribs marked with an X are supported on three ring dynanometers which are located in a tube set into the floor. The cribs are all lit with kerosene-soaked fiberboard strips to start all together. Tests have been conducted with two ventilation arrangements, the windows wide open or half closed. The window area is equal to one half that of the wall in which they are set. Their height is 6 feet. They are unglazed and open from the start of the test.



Thomas and Hesselden have installed various special instrumentation as follows:

1. Vermiculite plaster heat flux meter on end wall. Thermocouples are located at the surface and 1/4 and 1/2 in. below.

2. A special copper constantan heat flux meter within and near one pile at four elevations. These are mounted on the surface of a water-cooled copper pipe.

3. In addition to the thermocouples located 3 in. below the ceiling, they have introduced additional couples at about 2 and 6 feet down.

4. An aspirating thermocouple is placed through the back wall.

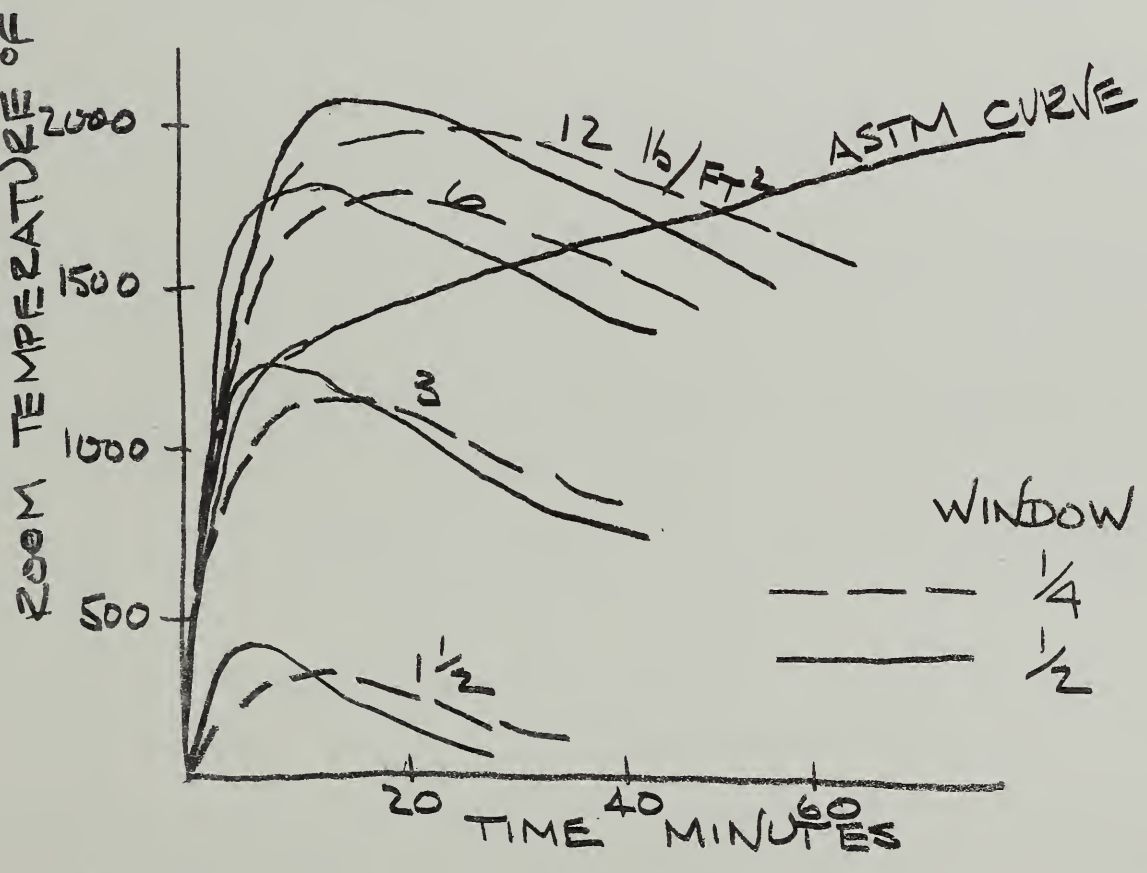
5. Both a McGuire radiometer and a radiation pyrometer are set to view the flames through the window.

Results are still in process of being analyzed, but the following summary seems to be indicated:

1. In general, the damage to protective covering for steel seems more severe than that produced by a fire test of similar duration in a furnace.

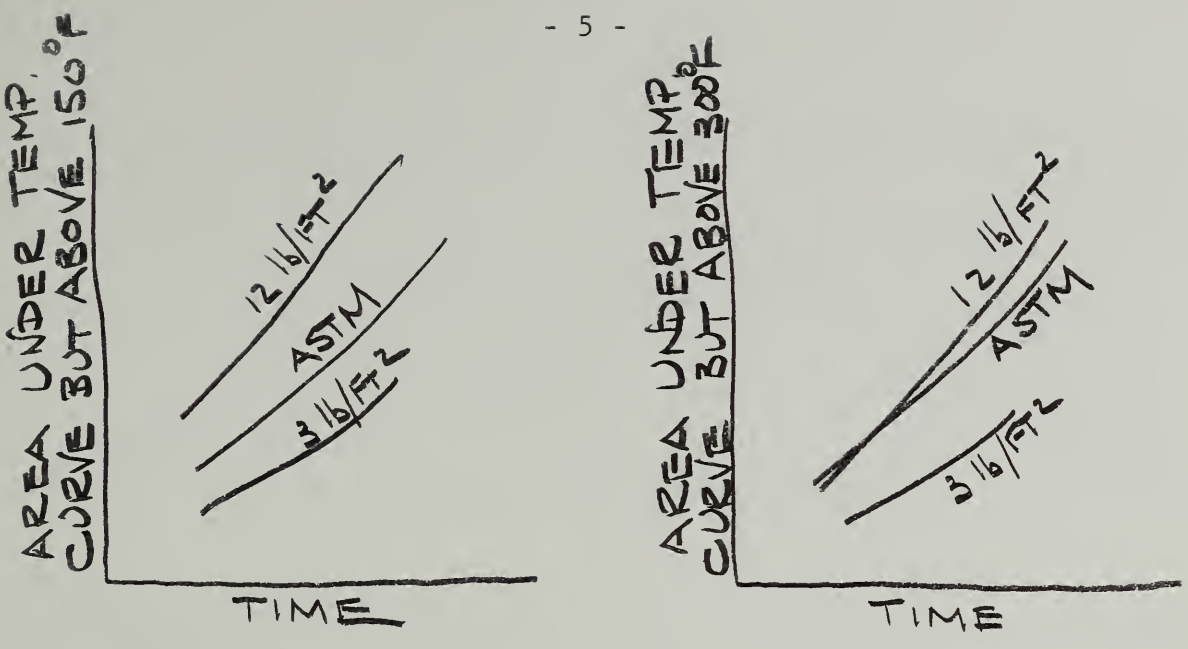
2. The six-pound fire load exposure provides a severe fire and will require good protection for structural steel.

3. As sketched from memory after study of a collection of time-temperature curves, the data were about as follows:



In general, the tests with 1/4 window area seemed to provide the most severe exposure although peak temperatures were somewhat less.

4. Measurements had been made following Ingberg's suggestion that the severity could be assessed by measuring the area below the curve above base temperatures of 150 and 300°F. The following plots show, roughly, the results obtained and apparently justify the use of the standard time-temperature curve.



5. Winds had caused trouble during a few tests resulting in unusual circulation of air in the room during which one or more cribs did not burn with the others.

6. Although data were not well analyzed, it appeared that there would not be wide (> ± 20%) variations in crib burning rate except for the situation of unuaual wind effects.

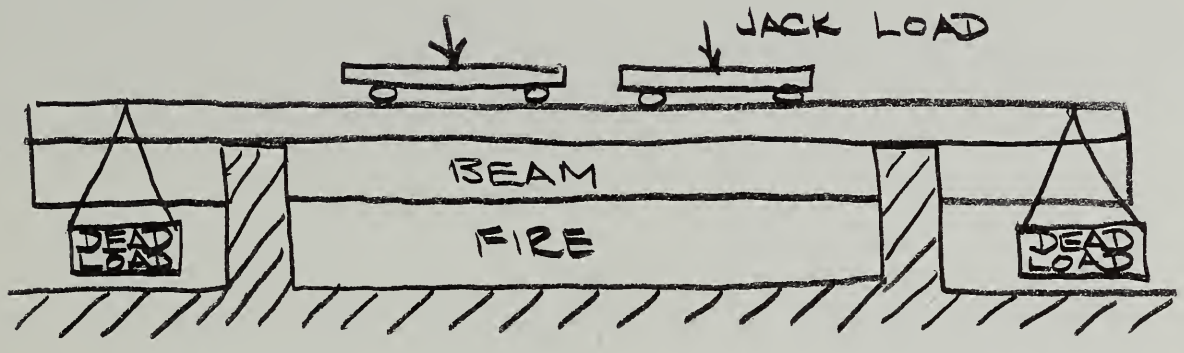
7. The aspirating thermocouple did not appear to be too useful. Results were quite similar to those with bare thermocouples except for the period after flaming had ceased.

8. The objective of Thomas and Hesselden was to develop a heat balance for the system. Anenometer measurements were not too successful and window air flow would be based on geometry and room temperatures.

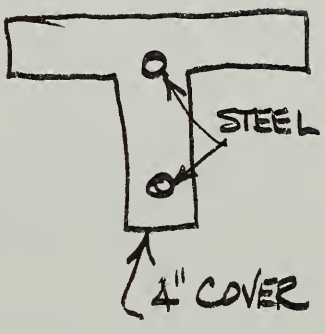
9. The basic series to explore fire load and ventilation had been completed, but additional tests were planned to study the influence of thermal properties of wall lining on severity.

10. Difficulty had been encountered in properly burning the cribs involved in the 1-1/2 lb/sq ft floor area. Probably because of the poor height to width ratio of the cribs.

Mr. Ashton and Malhotra had a test of a prestressed concrete beam in progress during our visit:



Two prestress cables were used, one for positive moments and the other for negative moments. I saw the specimen at about 3 hours after the start of test. It was nearly straight at that time, but cracks had developed across the top slab over the supports, probably a result of expansion of the web. The specimen failed apparently in compression over one of the supports at about 4-3/4 hr. A somewhat similar construction, but simply supported at the ends without continuity had failed at just over 4 hours. Apparently, performance was not significantly increased by continuity. These tests were being conducted for the Building Research Station. The specimens had aged for about 2 years indoors prior to test.



I visited Dr. Rashbash and Mr. Stark, his assistant. The work on study of smoke production from diffusion flames by Dr. McClintock had started off very well and is covered in his reports FR Note 570, 582 and 592. He found that soot formation of ethylene diffusion flames could be reduced by dilution of the air by N_2, H_2O, and CO_2. The latter two gases apparently being most effective. These results seem to confirm the findings we have made on smoke production of cellulosic materials with N_2 as diluent. McClintock's work has been terminated by his resignation.

Dr. Rashbash called my attention to the report, "Recirculation and Fuel Air Mixing as Related to Oil Burner Design" by Cooper, Kamo, Marek and Salbing, API Pub 1723, also, "Atmosphere from Fires in Rooms with Little Ventilating" by A. J. Kelly, FR Note No. 494.

Mr. Stark's work on smoke and decomposition product production from cellulosic and plastic materials in enclosures has also suffered by resignations. Apparently, work on cellulosic materials is nearing completion. The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