DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
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FIRE RESISTANCE OF CLAY HOLLOW WALL TILE

Scope of Present Results

The fire tests of hollow tile completed by this Bureau have been of panels 4 feet square. In some of the tests the tile were built within rigid frames giving restraint on all edges, while others were tested under working load as in load bearing wall construction. The test consisted of subjecting the panel to a controlled test fire on one side, with indicated furnace temperature near 832°C (1550°F) at 30 minutes, 927°C (1700°F) at one hour, 1010°C (1850°F) at 2 hours, 1101°C (2000°F) at 4 hours and 1177°C (2150°F) at 8 hours.

The strength and other physical properties of individual tile representative of those subjected to the fire tests have been determined and preliminary results reported in a paper before the American Ceramic Society*.

The walls tested under load were subjected to 120 pounds per square inch of gross bearing area for end construction tile and either 60 or 80 pounds per square inch for side construction tile. These loadings were selected as being those most commonly used in practice.

A further series of fire tests and fire and water tests wherein the test panels will be 11 feet high and 16 feet wide will soon be undertaken, pending the conclusion of which our recommendations should be taken as tentative.

General Fire Test Performance

As indicated by tests of material from 20 sources representative of the typical classes of clay used in tile manufacture, the ability to withstand fire exposure varies widely and is governed by the class of clay, the design of the units, and the method of building the wall. Some 8-inch walls failed under the working load after a fire exposure of one hour and 30 minutes. Other 8-inch walls

*"Strength, Absorption and Freezing Resistance of Hollow Building Tile". Jour. Amer. Ceramic Soc., 7 (3) (1924).

withstood the fire exposure for 6 hours, the limit of the test duration. Except with tile from one clay, all panels built of load bearing tile of standard weight were able to support the full working load throughout the 6-hour test.

The fire damage varies greatly in amount depending mainly on the kind of clay from which the tile is made and the design of the units, some tile showing little or no effects after 6-hour fire exposures, others suffering material damage after relatively short fires. What minerals or mineral combinations in the clay are responsible for the difference in fire effects noted, is not as yet definitely known, although indications are that minor constituents recurring consistently with given types of clays and acting as fluxes are important factors. The extent of the damage and its influence on the strength of the wall is governed in a degree by the number of cells through the thickness of the wall, decreasing as the number of cells is increased, the damage where present being generally confined to the shell or cell on the fire side. With two unit 12-inch walls built of 4-inch and 8-inch tile, the damage is confined to portions of the exposed unit. The susceptibility to damage also decreases with increase in shell thickness. As would be expected, the temperatures on the unexposed face after given fire exposures on the opposite face also are lower where the thicker shells or greater number of cells are present. No difference in fire resistance was noted between end construction and side construction tile having comparable shell thickness and number of cells, this statement also applying to such tile of special design as were tested.

The following table gives the average time required to reach temperatures of 150°C (302°F) and 250°C (482°F) on the unexposed side of unplastered walls. The lower temperature was chosen because of the common use of 300°F as a limit of permissible temperature for the unexposed side of partitions in specifications for fire tests of such construction. While this temperature is below the ignition point of ordinary combustible materials, excepting hazardous materials like celluloid, matches, and a number of chemical compounds, it is probably not too high as a limit for general temperatures on the uncovered surface, considering that higher temperatures are likely to prevail at cracks and open joints and under combustible material that may be piled against the wall. The higher temperature, 250°C, can be taken as the actual border temperature that will produce ignition of ordinary combustible materials under the conditions obtaining in building fires.

Thickness of Wall in inches	Kind of Unit or Construction	Time required to reach given temperatures on the unexposed side	
		150°C (302°F)	250°C (482°F)
8	Partition tile	1 hr., 15 min.	2 hr., 15 min.
8	Load bearing tile of standard weight	1 hr., 45 min.	3 hr., 15 min.
12	Single unit, 12-inch 9-cell load-bearing tile	3 hr., 15 min.	5 hr., 0 min.
12	Two unit 8-inch and 4-inch load-bearing tile	4 hr., 15 min.	Not reached in six hours.

The time required to reach these temperatures varies with the thickness of the wall, the design of the unit, and the method of construction. Gypsum and Portland cement plasters, or mixtures of these plasters with lime plaster, such as will remain in place during the fire test will increase the times required to obtain given temperatures by one-half hour to one hour or over, the greater increments being incident with the heavier walls.

The above time periods should not be taken as the safe fire resistance periods, in deriving which the results of the tests must be discounted to allow for the greater range in quality of material and workmanship obtaining in building construction as compared with that incident with the relatively few duplications of test specimens possible to introduce. As previously indicated the results are also limited by the size of the test panel, walls of a building story in height being subject to greater deflection than the 4-foot test panel, which has a bearing on the ability of the wall to sustain load under fire conditions. Even considering these limitations it appears probable that 8-inch unplastered walls of load bearing hollow tile will satisfactorily hold back fires in intensity and duration equivalent to the first hour of

the fire test exposure and the 12-inch walls, fires equal to the first 2 or 2 1/2 hours. This would make 8-inch walls adequate in residence, office and institutional occupancies where no considerable accumulation of combustible material is present. For the more severe exposures in these occupancies as also for those involving merchandizing and manufacturing with moderate amounts of combustible materials, the 12-inch wall will apparently be adequate. Walls heavier than 12 inches would be needed for the more severe fire conditions incident with mercantile, manufacturing, warehouse and storage establishments. Suitable plaster coatings would add materially to the resistances above outlined.

The above conclusions refer particularly to bearing partitions and party and fire walls in fire resistive buildings. In other buildings and in all cases where combustible or non-fire resistive members are framed into the wall, they should not project more than 3 1/2 inches into the wall for 8 and 12 inch walls, and the ends in the wall should have not less than 4 inches of solid material above, below and between them, if the full fire resistance of the wall is to be developed.

The above conclusions apply particularly to interior exposures. As it refers to exposures from the outside, the fire effects on neighboring detached buildings from the burning of an adjacent building can generally be taken as less severe, due to the shielding effects of the walls of the burning building, and less opportunity for high temperatures to build up in the unconfined space between them.

The above is submitted for your information and is not intended for publication.