FIREPROOF BUILDING STRUCTURE

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This invention relates to a fireproof building structure.

The invention has for one object to produce a novel and fully fireproof building structure embodying primary steel load supporting members, fireproofed by a relatively thin cementitious covering layer applied over metal lath secured to said load supporting member or members.

A further and more specific object of the invention is to provide a novel and highly efficient fireproof building structure embodying steel load supporting members fireproofed by a relatively thin layer of plaster applied over metal lath and in a layer thickness of the order of one inch from the face of the lath, which is further characterized by its lightness in weight, not exceeding six pounds per square foot, and by an ability to remain in a substantially unaltered condition, and to maintain the temperature of the steel load supporting members below the temperatures required to cause failure of the members under full load when the fireproof building structure is subjected to a standard fire test conducted in accordance with the Standard Specifications for Fire Tests of Building Construction and Materials (American Society for Testing Materials and the American Standards Association).

With these objects in view and such others as may hereinafter appear, the invention consists in the fireproof building structure and in the various combinations and arrangements of parts hereinafter described and particularly defined in the claims at the end of this specification.

In the drawing, Fig. 1 is a cross-sectional end view of a portion of a fully fireproofed ceiling embodying the present invention; and Fig. 2 is a perspective view of a fully fireproofed structural column, shown in cross section and embodying the present invention.

In the building industry, the use of plasters and similar cementitious materials applied as plaster over lath, has not fulfilled the requirements of the building codes throughout the country as satisfactory fireproofing for primary steel load supporting members in order to produce a fully fireproofed structure. The natural limitation in thickness of plaster which may be applied successfully over metal lath and the degree of fire resistance developed by single lath and plaster applications has restricted the general use of such protection to so-called fire-resistant structures. In attempting to solve the problem of increasing the fire-resisting characteristics of gypsum and other plaster, to the end that a single application of lath and plaster might be rendered capable of providing the desired fireproofing for satisfactory protection of primary steel load supporting members, various forms of fillers including fibrous materials of various sorts have been tried. The effect of these filler materials, while influencing the behavior of the plaster under fire exposure conditions, has been small in increasing the fireproofing efficiency of lath and plaster systems and has not been sufficient to gain acceptance for such as adequate fire protection for primary steel members in fully protected structures. The fire-resistant rating claimed is that measured in a standard fire test conducted in accordance with the Standard Specifications for Fire Tests of Building Construction and Materials (American Society for Testing Materials and the American Standards Association).

We have found that exfoliated vermiculite when incorporated into the plaster, either gypsum, Portland cement or other equivalent plaster, in a substantial amount, produces a composition which, when applied in a single application of lath and plaster to a steel structural member, produces a fireproofed structure which, when exposed to the tests and fire conditions requested by the building codes complies completely with the requirements for fully fireproof structures embodying primary load supporting members. Repeated tests have conclusively demonstrated that vermiculite plaster containing a substantial quantity of exfoliated vermiculite applied over metal lath in layers not exceeding one inch in thickness from the lath and which may be successfully applied in accordance with standard plastering practice, cooperates with a primary load supporting member to form a fully fireproofed structure capable of satisfactorily withstanding the exposure to the fire conditions required by the standard fire test above referred to. The particular reasons underlying these remarkable characteristics of vermiculite plaster are not entirely understood and the remarkable results were totally unexpected and unpredictable from any of the prior literature involving the introduction of various fillers into gypsum and other plasters.

It is recognized that others, prior to the present invention, have experimented with, and in some instances used, vermiculite plaster compositions as ordinary plaster over wood and equivalent structures but in no instance, however, as far as we can learn has this remarkable characteristic of such vermiculite plaster composi-
tions been recognized and utilized in producing a fully fireproofed structure embodying primary steel load supporting members. The present invention contemplates a fully fireproofed building structure embodying steel load supporting members fireproofed by a relatively thin layer of vermiculite plaster applied over metal lath and in a layer of a thickness not exceeding an inch from the face of the lath and which cooperates with the steel load supporting members to fully fireproof the same and provide a structure in which the thin layer of plaster, when subjected to fire conditions specified by the standard fire tests above referred to, operates to maintain the temperature of the steel load supporting members below those required to cause failure of the members under full load and to remain in a substantially unaltered condition when exposed to the fire conditions.

The development of fireproof structures in this country has mainly followed along the line of combining steel load-bearing members with heavy coverings and fillings of masonry, tile, concrete or other combustible materials which have little functional value other than in respect to fireproofing. The enormous dead load factor introduced by these materials, and the absence of a suitable substitute for them, has been a major deterrent to the development of efficient and economical steel frame buildings in the fireproof classification and has long been a problem in the building industry. Metal lath and plaster covering offers distinct advantages from the standpoint of weight added and of ease and cost of application in comparison with accepted fire-resistive coverings but the degree of fire-resistance heretofore obtained with single lath and plaster applications has limited their use for the protection of steel members in buildings of secondary fire-resistive types.

In illustration of present practices and as an example of the protection heretofore obtained with metal lath and plaster, model building codes prescribed a rating of one and one half hours to steel joist floor construction consisting of a two inch or more thick concrete or gypsum top slab and at least seven-eighths inch gypsum or Portland cement plaster ceiling on expanded metal lath. The rating limits the use of this relatively economical system of protection to buildings in relatively low risk fire-resistive classifications.

The Building Code Committee of the United States Department of Commerce give an estimated rating of two and one half hours to steel joist floor construction when used with two inches or more top slab of cinder concrete and with ceiling of at least one and one half inches of Portland cement mortar on metal lath furred out to furnish one inch air space between bottom flanges of joists and ceiling. A very few municipalities, requiring the minimum two and one half hour resistive rating for floors also permit the use of this thickness of gypsum plaster in similar construction but its absence from the Building Code Committee listing indicates that there is no official test data in support of the rating.

Steel joist construction similar to the above, but with ceiling of two inch thick reinforced gypsum ceiling tile plus one half inch of gypsum plaster is commonly accepted as meeting the requirements of fully protected construction. A four hour rating is generally extended similar protection for structural beams, girders and trusses.

The above examples, representing the most efficient fire-resistive coverings for steel members available (at least from the standpoint of weight) are indicative of the performance of materials heretofore available. It is noted here that gypsum plaster as specified in the example of the one and one half hour rating for floors refers to a standard mix of neat gypsum and sand developed for the building industry and of proven ability to withstand fire exposure in an efficient manner within the limits of ratings established for it by fire test. It is also noted that the minimum thickness of seven-eighths inch gypsum plaster required under steel construction for a one and one half hour rating represents about the practical maximum thickness of such plaster as limited by cost of application and the ability of the plaster to stay in place without an additional layer of metal lath as reinforcement.

From the foregoing it will be observed that the field of use of ordinary gypsum plaster over metal lath as a fireproofing has been greatly restricted because of the fact that the maximum thickness of plaster which could be applied successfully and stay in place over metal lath is only one inch over the lath. Such a thickness of plaster did not afford the fireproofing required by law for the fireproofing of primary load supporting members and for a great many years many attempts have been made to improve the characteristics of gypsum plasters by modifying the compositions thereof and by introduction therein of various fillers. None of these, however, has solved the problem. The procedure of applying a double lath and plaster covering has been suggested but the expense involved entirely precludes this procedure for general application and as a result the usual commonly accepted fully fireproof structure for primary load supporting members is typified by a two-inch thick reinforced gypsum tile with at least one half inch of gypsum plaster thereover and such a structure is given a four hour rating under the law.

The present invention is based upon the unusual performance of cementitious plaster compositions, preferably gypsum plaster compositions, embodying substantial amounts of completely exfoliated vermiculite filler. Under test, a building structure having steel load supporting members fireproofed with metal lath and a one inch thick vermiculite plaster ceiling successfully withstood standard test fire conditions after referred to upwards of five and three-quarter hours, whereas ordinary gypsum plaster under similar conditions rates only one and one half hours.

Referring now to the drawing, the invention has been illustrated as embodied in a fully fireproofed structure embodying primary steel load supporting members such as the I-beams 10. The I-beams 10 have attached to the lower flanges thereof metal lath 12 in any usual or preferred manner and a layer of metal lath covering the four sides thereof and attached thereto according to the methods. The metal lath has applied to it vermiculite plaster of the order of thickness of one inch, the whole comprising a fully fireproofed structure. It is preferred to utilize vermiculite plaster...
comprising a mixture of one part by weight of a standard vermiculite filler to three parts by weight of neat gypsum plaster. Such proportions represent a practical balance of such properties as plaster workability, density, hardness, drying time, thermal resistivity, resistance to shrinkage and disintegration in fire, and the like. Mixes containing appreciably larger percentages of vermiculite filler are lighter in weight, provide greater thermal insulation, are more resistant to shrinkage, but are more workable, give harder plaster surfaces, but have a greater tendency to shrink and crack when exposed to fire. Mixes containing more vermiculite filler are lighter in weight, provide greater thermal insulation, are more resistant to shrinkage, but are less workable, give greatly increased abrasion resistance normally required of a plaster surface. Satisfactory fire test performance has been demonstrated by tests, however, with compositions varying in proportions of filler and cementitious binder from the order of one to five parts by weight of neat gypsum plaster to one part by weight of expanded vermiculite.

The expanded vermiculite filler most successfully employed was well graded from fine to coarse granules, not materially different in size from neat gypsum plaster. Such proportions of vermiculite, based on volumetric analysis, showed 96% passing through a No. 14 screen, 56% through No. 28, 21% through No. 65 and less than 5% through No. 100. Average loose volume weight was 12 pounds per cubic foot. It was further characterized by the absence of unexpanded material capable of expansion at temperatures up to 1800°F. It is not intended that the invention be limited to this particular grade of expanded vermiculite as efficient fireproofing qualities have been demonstrated with materials from other sources and of widely different particle size and range of particle size. The material employed does, however, represent the general order of particle size which has been found to be most efficient from the standpoint of plaster workability and ease of application which are prime factors in determining the practicability of the plaster.

The weight of the preferred vermiculite plaster applied over metal lath to a thickness governed by one inch ground and in accordance with standard plastering practice was found to be of the order of five and one-quarter pounds per square foot of ceiling area. The same thickness of standard gypsum plaster rated at less than two and one half hours protection would weigh around 15 pounds. Gypsum tile protection required for fully protected construction of similar type would weigh around 15 pounds per square foot and from these comparative figures it will be observed that the present fully fireproofed structure has the further desirable characteristic of reducing to a minimum the dead load factor of the cementitious fireproofing.

While the preferred embodiment of the invention has been herein illustrated and described, it will be understood that the invention may be embodied in other forms within the scope of the following claims.

Having thus described the invention, what is claimed is:

1. In a building structure, in combination, a steel load bearing member, and a fireproof membrane mounted adjacent said member and between the same and the source of fire, said membrane comprising metal lath and a relatively thin cementitious layer containing exfoliated vermiculite and gypsum in proportion by weight of one part of vermiculite to from two to five parts of gypsum, said vermiculite having a particle size of ordinary plastering sand applied over the lath to a thickness not exceeding one inch, said membrane cooperating with the steel load supporting member to form a fully fireproofed structure.

2. In a steel building structure embodying primary steel load supporting members, the combination with said primary steel load supporting members of a membrane carried by said members and disposed to fireproof them against a source of fire and comprising metal lath and gypsum vermiculite plaster embodying vermiculite having a particle size of ordinary plastering sand and in proportion by weight of one part of vermiculite to from two to five parts of gypsum, the thickness of said plaster not exceeding one inch and its weight not exceeding six pounds per square foot, said membrane being capable of fully fireproofing said primary load supporting members when the fireproof structure is tested under the conditions prescribed by the Standard Specifications for Fire Tests of Building Construction and Materials (American Society for Testing Materials and the American Standards Association).

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