Nov. 3, 1936. G. S. NELSON 2,059,477

WIDE SPAN ROOF CONSTRUCTION

Filed Feb. 11, 1931

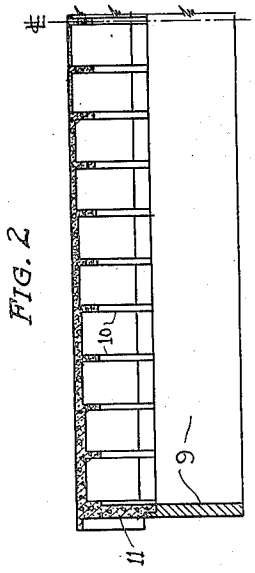


FIG. 2

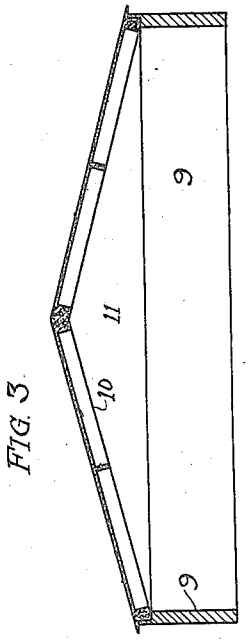


FIG. 3

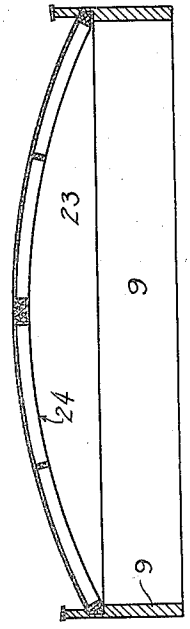


FIG. 5

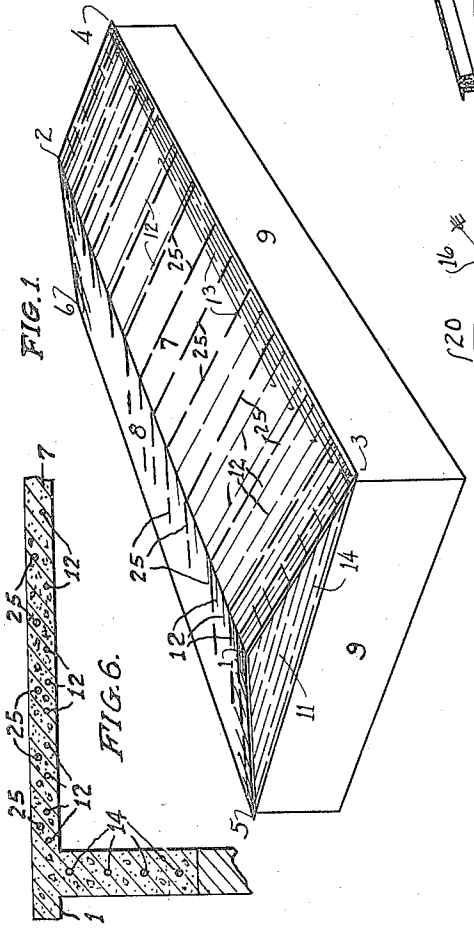


FIG. 1

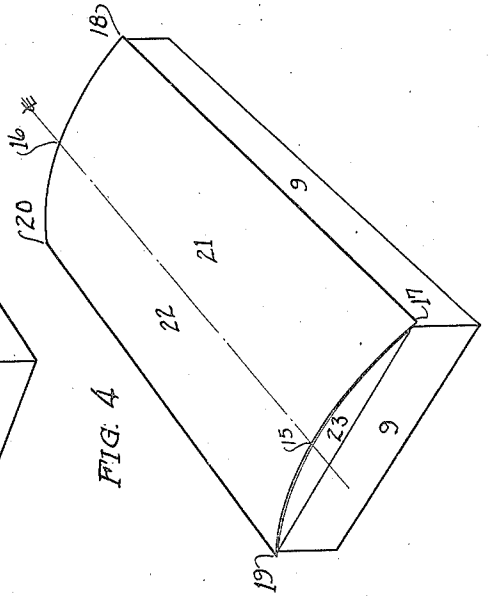


FIG. 4

FIG. 6.

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Patented Nov. 3, 1936

2,059,477

UNITED STATES PATENT OFFICE

2,059,477

WIDE SPAN ROOF CONSTRUCTION

George S. Nelson, Salt Lake City, Utah

Application February 11, 1931, Serial No. 515,055

5 Claims. (Cl. 108—1)

My invention relates to improvements in wide span roof construction and has for its object the production of unusually wide roof spans, made with materials such as reinforced concrete, with parts so arranged and attached together as to produce wide-span roofs at a small cost, while requiring but a small amount of space or head room, and without requiring unsightly tie rods in the interior of the building.

At the present wide-span roofs are generally supported upon beams or trusses, or by means of arches having their lower ends tied together. In each of these cases considerable depth between the roof and the ceiling is required, or it is necessary to expose tie bars or bottom chords of beams or trusses in such a manner as to detract from the good appearance of the interiors of buildings.

In contrast to this the wide span roof of my invention saves material, dead load and head room because it uses the materials of which it is built more efficiently than do the types of construction now in use.

To illustrate, in my construction the material in the slab near the ridge is utilized as the compression material in a beam spanning from gable to gable and used for carrying most of the roof load to the end walls, whereas in ordinary construction this material would be used only to carry the load between joists which in turn would carry the loads to the side walls only. With practically the same amount of material as would ordinarily be required if tie bars were used between eaves, my construction makes possible the same span without unsightly tie rods.

I attained the objects of this invention by assembling the constituent parts as illustrated in the accompanying drawing, in which,

Fig. 1 shows a perspective view of a reinforced concrete gabled end roof with the system of placing the reinforcing bars shown on one roof slope and one gable. The reinforcing is to be placed symmetrically in the entire roof.

Fig. 2 shows a section through the roof, taken parallel to the ridge.

Fig. 3 shows a roof section taken perpendicular to the ridge.

Fig. 4 shows a perspective view of an arched roof.

Fig. 5 is a section through the arched roof.

Similar numerals and letters refer to similar parts throughout the several views.

In Fig. 1 each roof slope is preferably constructed with a capacity to span between the ridge and the wall. On narrow roof spans a slab might be used for this purpose but on wide roof spans it will be most advantageous to reduce dead loads by using the joist and slab type of construction shown on the drawing submitted herewith. The joist and slab combination provides great strength in diagonal tension and shear with extreme economy of material, because the joists themselves contribute to the strength of sides 7, 8, 21, and 22 in the manner described as follows.

Ordinarily failures due to diagonal tension occur approximately at forty five degree angles with the axis of the beam. Therefore when each side of the roof is called upon to function as a beam, a forty five degree failure cannot occur without disrupting several reinforced joists. The most probable lines of failure for either shear or diagonal tension therefore would be confined to lines lying between pairs of joists, which lines would have to be nearly perpendicular to the axis of the beam. This shifting of the critical section will add greatly to the strength of the beam in shear and diagonal tension.

The reinforcing for the slabs spanning between joists 10; and for the slab, or joists, or arches, as the case may be, spanning between the ridge and the walls, will be placed in the usual manner for reinforcing these respective members. Since these methods of reinforcing are in common use and are not claimed as a part of this invention, they have not been shown on the drawing.

Negative reinforcing bars 25 placed in the top-sides of the joists, or slabs, over the ridge enable the designer to utilize the advantages of partially continuous, or cantilevered, joists, or slabs. That is, the advantages contributed to a beam, composed of a system of slabs, by the longitudinally spaced transverse stiffening means afforded by said negative reinforcing bars acting either alone or in conjunction with the ordinary reinforcing in the joists, or the slabs. The longitudinally spaced transverse joists shown in Figures 2, 3, and 4 of the drawing, acting in conjunction with the slab will, of course, provide a greater transverse stiffening effect than the slab will when acting alone. The particular circumstances involved in each roof design will determine whether the slab reinforced only with the longitudinally spaced transverse stiffening rods may be used to best advantage, or if it is more desirable to use supplementary joists. This is an important advantage made use of by this invention, since ordinarily the roof structure must be designed as a simple span from wall to wall; whereas by the use of this invention the joists, or slabs, canti-

lever only half the distance from wall to wall at the most, because they are restrained at one end.

The thrust that each slope exerts upon the other may be resolved into a force equivalent to a uniform load acting at the ridge, in the direction of the roof slope. Each slope therefore will be designed as a beam that spans from gable to gable, as from support 1—3 to 2—4. Then each slope 7 and 8 must be designed as a beam spanning the length of the building and carrying loads that act in a direction parallel to the slope. It is necessary, therefore, to reinforce the tension sides 3—4 and 5—6 of the respective beams 7 and 8 with steel bars 13 to withstand the tensile stress; and to provide sufficient compression material at the ridge 1—2 to withstand any compression stress in excess of that which the slab is capable of resisting alone.

Clearly any part, or all, of side walls 9 may be omitted as desired, in buildings utilizing the present invention, because the roof body may be designed to span from gable to gable as has been set forth.

By slightly lowering the joist forms successively, as they approach the gables, as shown in Fig. 2, the slab thickness may be gradually increased toward the ends of beams 7 and 8 so as to resist the shear stresses which constantly increase toward the support.

Shear bars, or stirrups 12 are added to withstand shear stresses in the slabs in excess of the safe working strength of the concrete. These bars may be placed either perpendicular to the axis of the beam as shown, or inclined at an angle with the axis. Obviously bars 12 serve as web reinforcing for the beam comprising the whole roof structure acting as a unit.

At the gables 11 means such as tie bars 14 must be used to resist the outward thrust of the two roof slopes.

With this construction it is apparent that with joists spanning only one half the total roof span, and capable of being made continuous on one end; and with but a small proportionate addition of concrete in the slab; and with the addition of web reinforcing, and longitudinal tension reinforcing bars; long inexpensive roof spans are obtainable, having but a small thickness, and comparatively light weight; and requiring no unsightly tie bars inside of the building. The joists and slabs may be inexpensively formed with steel forms. In the gables, which form rigid attachments for the sloping ends of the slabs, the only extra expense will be for the reinforcing steel, since the gables are likely to be composed of masonry or concrete in any case.

The action in the arched roof shown in Fig. 4 is similar to that shown for corresponding parts in Fig. 1 except that the joists arch between lines 15—16 and 17—18, or 15—16 and 19—20 instead of between lines 1—2 and 3—4 or 1—2 and 5—6.

The end thrust in each transverse interior segment of the arched body is transferred to the next outer segment (by means of the shear and diagonal tension resisting qualities of the body) and finally all of said end thrusts are transferred to the rigid ends, where means are provided for counterpoising their combined thrusts from opposite roof slopes against one another. The above described action is similar in both the arched and gabled types of roof structures of the present invention.

Sides 21 and 22 now become beams equivalent to beams 7 and 8 and therefore require reinforcing similar to beams 7 and 8. End 23 has the same function as gable 11 and is to be reinforced similarly. Arched ribs 24 carry the loads between the ridge and the side walls, when side walls are used, similar to joists 10 in Fig. 1.

This type of construction will require less reinforcing steel than the first mentioned type, but it will make more expensive form work necessary.

It will be noted that in the construction herewith claimed as my invention, walls 9 may be loaded more uniformly than ordinarily, since by it, part or all of the load generally carried by the side walls may be transferred to the end walls.

In this specification the invention is described as it would apply to a concrete structure, but it is not intended to limit its use to concrete since it may well be adapted for use with other materials.

Having now described my invention, what I now claim as new and desire to secure by Letters Patent of the United States is as follows;

1. A roof comprising a plurality of slabs, each disposed in angular relationship to the adjacent slab, rigid means attached to the sloping ends of the slabs whereby the angular relationship is maintained at the ends, negative reinforcing bars positioned in the slabs in the direction of their slopes and adapted to counteract the deformation of the angular relationship of the slabs, web reinforcing bars disposed in the slab, tie bars whereby the horizontal thrust from opposite roof slopes may be counterpoised and longitudinal reinforcing tension members positioned along the longitudinal edges of the slabs whereby the slabs function as beams spanning longitudinally of the body.

2. A roof, comprising a plurality of slabs each disposed in angular relationship to the adjacent slab, rigid means attached to the sloping ends of the slabs whereby the angular relationship is maintained at the ends; stiffening means in said slabs transversely thereof to counteract the deformation of the angular relationship of the slabs; tie bars whereby the horizontal thrust from opposite roof slopes may be counterpoised; and longitudinal reinforcing tension members positioned along the longitudinal edges of the slabs whereby the slabs function as beams spanning longitudinally of the body.

3. A roof, comprising a plurality of slabs each disposed in angular relationship to the adjacent slab, rigid means attached to the slabs at widely spaced intervals whereby the angular relationship is maintained at said intervals; stiffening means in said slabs transversely thereof to counteract the deformation of the angular relationship of the slabs; tie bars whereby the horizontal thrust from opposite roof slopes may be counterpoised; and longitudinal reinforcing tension members positioned along the longitudinal edges of the slabs whereby the slabs function as beams spanning longitudinally of the body.

4. A roof, comprising a plurality of curved slabs in abutting relationship, rigid means attached to the sloping ends of the slab whereby the curved shape is maintained at the ends; stiffening means in said slabs transversely thereof to counteract the deformation of the curved shape of the slabs; tie bars whereby the horizontal thrust from opposite roof slopes may be counterpoised; and longitudinal reinforcing tension members positioned along the longitudinal edges of the slabs whereby the slabs function as beams spanning longitudinally of the body.

5. A roof, comprising a plurality of curved slabs in abutting relationship, rigid means attached to the slab at widely spaced intervals whereby the curved shape is maintained at said intervals; stiffening means in said slab transversely thereof to counteract the deformation of the curved shape of the slabs; tie bars whereby the horizontal thrust from opposite roof slopes may be counterpoised; and longitudinal reinforcing tension members positioned along the longitudinal edges of the slabs whereby the slabs function as beams spanning longitudinally of the body.

GEORGE S. NELSON.