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REINFORCED CONCRETE SLAB AND TENSION CONNECTOR THEREFOR

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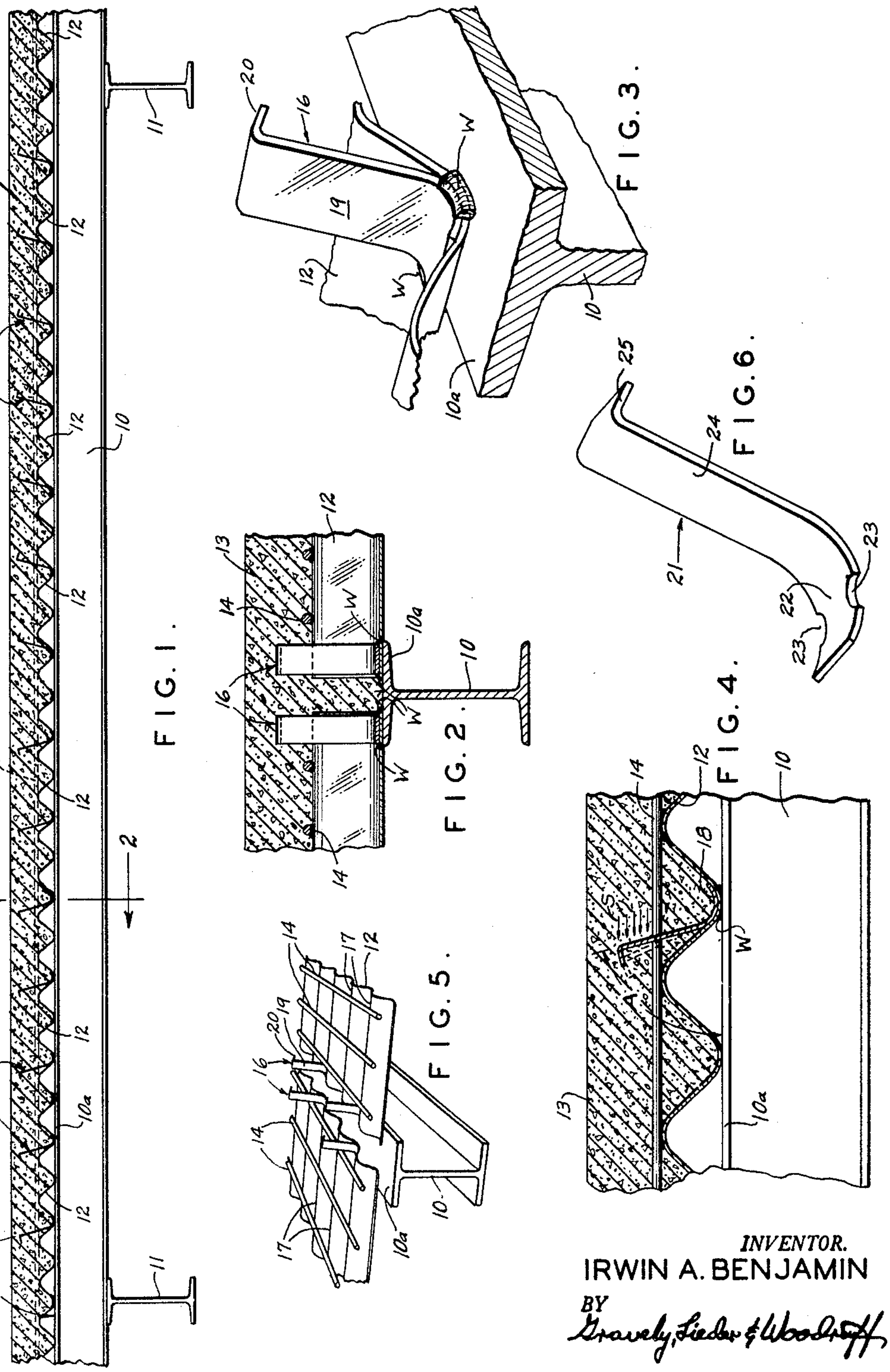

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REINFORCED CONCRETE SLAB AND TENSION CONNECTOR THEREFOR

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This invention relates to improvements in means for connecting reinforced concrete slabs to metallic load bearing members whereby the components are made to act together or compositely.

Standard practices heretofore have involved placement of reinforced concrete slabs on steel beams such that the slabs and beams do not coact as a unitary assembly, but the beams alone carried all of the vertical loads transferred thereto by the slabs. Attempts have been made to prevent movement between the slabs and beams by the use of shear devices disposed in the body of concrete and secured to the reinforcing means or to the beams. Such devices act in flexure to develop very high stresses and usually result in failures by crushing of the concrete at the face of the devices. The high flexural stresses in these devices are generally developed close to the junction of the beam and decrease at a very rapid rate farther from the beam such that reverse bearing stresses are imposed in the slab, demonstrating that these devices act in bending and are inefficient.

It is an object of the present invention to provide a more efficient and more economical tie-in or connector between a reinforced concrete slab and its supporting beam and to form a connection to the beam at the same time for erection security during the pouring of the concrete.

It is also an object of the present invention to provide an improved connector for a reinforced concrete slab such that the stresses are taken in tension in the connector or in shear at the attachment to the beam, thereby eliminating the need for developing flexural resistance in the connector.

A further object of this invention is to provide an improved tension connector for reinforced concrete slabs and supporting beams such that stresses may be accurately controlled to react in tension in the connectors or shear at the zone of attachment, and so that a balanced distribution between tension and shear can be obtained as will be more particularly set forth.

Other objects and advantages of the present invention will appear as the description of preferred forms of the invention proceeds. It is a preference to form the tension connector of sheet material having a base portion to fit in the concrete reinforcement and a tension arm extending angularly into the body of the concrete to control the stresses for tension in the arm. The tension connector base, while formed to fit the reinforcement, provides means to control the shear stresses such that the shear stresses at the base may be balanced with tension stresses in the arm, whereby failure of the connector may be predicted for either tension in the arm or shear in the attachment of the base. The preferred embodiments of this invention have been illustrated in the accompanying drawings, wherein:

FIG. 1 is a sectional elevational view of a beam supported concrete slab of reinforced character illustrating one form for the improved tension connectors;

FIG. 2 is a sectional elevational view seen at line 2—2 in FIG. 1;

FIG. 3 is an enlarged and fragmentary perspective view of a tension connector and reinforcing means for the concrete slab;

FIG. 4 is a greatly enlarged and fragmentary sectional view through the reinforced concrete slab to show the action of the tension connector;

FIG. 5 is a fragmentary perspective view of a portion of the assembly prior to pouring the concrete; and

FIG. 6 is a fragmentary view of a modification of the present connector means.

In FIG. 1 the reinforced concrete slab assembly is seen to comprise a beam **10** of any suitable shape, such as an I beam, the beam **10** being carried by spaced primary load bearing members **11**. The beam **10** carries the end portions of a series of metallic corrugated sheets **12** having the longitudinal sides in overlapped relation to provide a complete form for the concrete material **13** which is placed thereon in plastic condition in the usual manner. Each of the sheets **12** is provided with spaced reinforcing bars **14** directed transversely of the crests of the corrugations and secured to each such crest by welding the bars thereto.

The end margins of the corrugated sheets **12** are placed on the flange **10***a* of the supporting beam **10** to provide a desired bearing contact therewith, as shown in FIGS. 2 and 3. After a series of sheets **12** have been placed spanning two adjacent beams **10** they are secured to the beam flanges **10***a* by welding the end portions. The welding is accomplished at the time the tension connectors **16** are placed so that the concrete **13** after pouring and setting will be made to act compositely with the beams **10**. Each connector **16** is formed from strip material to provide a base end **18** which seats in the valley between two crests **15**. The connector includes an arm **19** which extends upwardly from the base **18** at an angle A from a horizontal and varying from about 60° to 90°, it being determined that the preferred angle A should be about 75° such that stresses experienced by the connector shall be substantially in tension. It is a further characteristic of the connector **16** to provide an angular element **20** at its outer end with such element **20** being substantially at 90° to the arm **19**. It has been found that the angular orientation of arm **19** of each tension connector **16** effectively develops tension stress, while the angular element **20** develops vertical resistance. Since the arm **19** is designed flexurally weak and therefore tends to rotate from the base **18** (see broken line position of FIG. 4), tension is maintained.

In placing the tension connectors **16** (FIG. 1) the angular elements **20** of one series thereof are oriented or turned to face away from the center or midspan of beam **10**, while the other series are oppositely oriented or turned. This orientation causes the connector arms **19** to tend to rotate downwardly (FIG. 4) as bending occurs in the beam **10** under loading, with the result that the concrete bearing sets up stresses in the direction of arrows S. Since the angular element **20** is substantially locked against movement in the concrete **13** the resultant stress in the connector arm **19** is taken in tension, and shear stress is created in the welds W at the base **18**.

It is seen in FIG. 3 that the connector base **18** is seated in a valley of the corrugated sheet **12** and welds W are made along the opposite edges of the base **18**. Moreover, at least one weld W is made through the corrugated sheet **12** to the beam flange **10***a* (FIG. 2) so that the sheet is secured to the beam flange **10***a* at the same time. The welds W are in the form of fillets and sufficient weld material is deposited to provide a shear connection having shear stress resistance at least balanced with the tension stress loading expected in the connector arm **19**, but the weld fillet shear stress resistance may be made greater so that any failure of the connector **16** shall be in tension to avoid crushing the concrete **13**.

A modified tension connector **21** is illustrated in FIG. 6, wherein the base **22** thereof has recesses **23** in one edge or both of its opposite edges to increase the length of the welds W and thereby increase the shear stress resistance. In referring to recesses **23** it is intended that the term shall also include aperture type openings between the edges for receiving weld fillets. The arm **24** and outer angular end element **25** of the modified connector are substantially like those described for the tension connector **16**, and the manner of its use is the same.

It has been found from tests that the connectors **16** or **21** may be made from 12 gage sheet metal having a width of 1½", with the arms **19** or **24** approximately 3" long and the angular elements **20** or **25** at the outer end about ½" long and turned to lie at about 90° to the axis of the arms. The size of the base portions **18** or **22** is governed by the dimensional configuration of the corrugated sheets **12**. A tension connector of the form shown at either **16** or **21** has the advantage that the stress loading in tension can be varied by increasing or decreasing the gage of the sheet metal, and the shear stress resistance can be correlated with the tension stress by providing one or more straight welds W as in FIG. 3 or one or more elongated welds as in FIG. 6. Tests have further shown that the present tension connectors are more efficient than the presently known connectors in preventing damage to the concrete, in effecting composite action and coaction between the reinforced concrete slab and the supporting beams, and in controlling the stress patterns within the assembly.

The foregoing disclosure has been given in connection with certain preferred embodiments of tension connectors for reinforced concrete slabs, but it is understood that the embodiments herein may be altered in size, proportion and location without in any way departing from the broad principle of its action and effect in composite reinforced concrete slab construction. While the present disclosure has included one example of a corrugated shut and reinforcing rod type of form for the plastic concrete which later becomes the reinforcement for the solidified concrete, it is understood that other forms and reinforcement components may be employed without departing from the improvements herein shown. It is, therefore, the aim to include all possible forms and equivalent embodiments in the appended claim.

What is claimed is:

In a reinforced concrete floor slab assembly, principal support means in spaced parallel relation, beam members carried by said support means in spaced horizontal relation spanning the distance between support means, a plurality of form and reinforcing corrugated sheets having end portions resting on said beam members with the corrugation crests and valleys directed transversely to said beam members, a plurality of individual connector elements each formed of flat strip material with a base end turned to seat in a corrugation valley and an arm extending angularly from the base end to an outer end bent at right angles to said arm and oppositely to said turned base end, said connector elements being placed in corrugation valleys adjacent the end portions of said sheets and across the length of said beam span between said support means, the angularly extending arms of said connector elements on each side of the mid span of said beam members being oppositely oriented and extending above the corrugation crests, and each base end of said connector elements being formed with recessed edges of non-linear form to receive weldments, weldments connecting said recessed edges of said base end of said connector elements to the adjacent end portion of said corrugated sheets and to said beam members, said weldments forming tensile load and shear stress connections with said beam members and fixing said base ends of the connector elements in position, and a body of concrete material carried by said corrugated sheets filling said valleys and extending to a height above said crests to fully cover and surround said angularly extending arms and outer bent ends thereof, the angularity of each said arm of said connector elements being from 60 to 80 degrees to the horizontal direction of said beam members to transmit tension stresses into said weldments and connect said body of concrete to said sheets and beam members.

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