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(54) IMPROVEMENTS IN OR RELATING TO COMPOSITE DECKS

(71) We, REDPATH DORMAN LONG LIMITED, a British Company of 53 Goldington Road, Bedford, Bedfordshire, England, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a ribbed sheet for composite decks and to composite decks incorporating such a sheet.

To form a composite deck it is possible to lay out a ribbed sheet of steel or the like, and then pour concrete over this sheet. When the concrete is set the composite deck so formed may be used, for instance as a floor, with its concrete part uppermost. If the composite deck is supported along the ends of the ribs, so that the ribs lie across a gap, the action of a down-load on the deck is to compress the concrete, and to tension the sheet.

The expression ribbed sheet as used in this specification is intended to mean a sheet having a plurality of upstanding ribs arranged in spaced parallel relationship.

While it is generally advantageous for the sheet to be of steel, on account of the strength and weight characteristics of that material, and its low cost and ready availability; there may be particular cases where other materials could be more appropriate. For instance, the sheet may be of stainless iron, aluminium, or even fibre reinforced plastics in very special circumstances.

When an excessive load is applied it is possible for the concrete nearest to the interface to pull away from the sheet at the centre of the gap, and for the concrete to slip outwardly relative to the sheet at the edges of the gap.

When delamination occurs near the middle of the gap, the concrete round the ribs tends either to pull away from the ribs (if a welsh hat section is used for the ribs), or to crush the ribs together (if the ribs have a dovetail configuration). To resist the crushing action of the concrete on the portion

of the rib furthest from the plane of the sheet (and on the sides of the rib) in the latter case, the present invention is concerned with projections formed from that portion, and extending transversely across that portion.

The projections are intended, inter alia, to strengthen that portion against buckling.

In as much as some of the concrete flows over the projections when it is poured, there is also some advantage to be gained from a keying effect which resists the sliding of the concrete relative to the sheet which is apparent at the ends of the deck.

Accordingly the invention provides a ribbed sheet, for use as part of a composite deck, having a generally planar soffit surface, and a plurality of ribs bent upwardly from this surface such that the ribs are wider at a distance away from the surface than they are close to the surface, in which a plurality of spaced projections are formed on the face of that portion of at least one of the ribs furthest from the surface, said projections facing away from said soffit surface and being formed as indentations pressed upwardly in the lower face of that rib portion, and in which the width of said portions is less than the width of the soffit surfaces between the ribs.

Conveniently there may be projections on these portions of all the ribs.

Preferably the projections face away from said soffit surface and are formed as indentations pressed in the lower faces of said rib portions.

The projections may on the same sheet face both towards and away from the said surface.

Advantageously there are keying stiffeners formed on the soffit surface itself.

It is preferred that the keying stiffeners formed on the soffit surface lie parallel to the axis of the ribs.

The invention includes a composite deck comprising a sheet as described above, with concrete or the like poured on the face of the sheet from which the ribs project.

A specific embodiment of the invention and some variants thereof will now be described by way of example with reference to the accompanying drawings, in which:—

Figure 1 is a sectioned perspective view through a composite deck,

Figure 2 is a side view of the deck after it has been loaded to failure,

Figures 3a, 3b, and 3c, show a rib as it is deformed during successive stages in the failure of the deck,

Figure 4 shows a rib in accordance with the invention, and

Figure 5 shows a perspective view of a sheet having a number of different projections and stiffeners formed thereon.

As shown in Figure 1 a composite deck has a ribbed sheet 11 and a concrete slab 12. The sheet 11 has upwardly directed reinforcing ribs 14 which are hollow, and extend into the concrete 12 in the manner of dovetails. The ribs 14 run lengthwise throughout the beam which is effectively formed by a length of the composite deck.

Figure 2 shows a side view of the beam disposed over a gap between two supports 15 and 16. The beam has been subjected to a downward, and has failed by delamination of the concrete and the sheet. At the centre of the gap (e.g. at 17) the concrete has pulled away from the steel sheet leaving a space 18. At the edges of the gap (e.g. at 19) the ends of the concrete have slipped outwardly relative to the sheet by a distance shown as 21. In this manner the composite action of the deck has broken down and the deck will no longer sustain its design load.

It will be seen in Figure 1 that the width (y) of the top portion of the dovetail ribs is substantially less than the width (x) of the intermediate soffit surfaces. If this were not so there would be a risk that the steel sheet 11 might, under load, sag away from the concrete slab 12 between the ribs 14, thus increasing the possibility of slip occurring between steel and concrete.

The successive stages in the failure at 18 are shown in Figures 3a, 3b, and 3c. In Figure 3a the steel rib 14 fits snugly in the concrete. In Figure 3b the concrete is just beginning to lift off the soffit face of the steel sheet, leaving a small space 18a. At this stage the ribs 14 resist the lifting off action partly by holding apart the upper edges of the concrete surrounding the top portion 22 of the dovetail. As the portion 22 is loaded, the faces of the concrete at 23 and 24 tend to push the walls of the steel rib together.

As shown in Figure 3c the rib has failed leaving the gap 18 as shown in Figure 2, and it can be seen that the walls of the rib have been crushed towards one another at 25 and the upper portion of the rib has buckled upwardly at 26.

If the upper portion of the rib had an initial downward curvature it would quite possibly buckle downwardly instead.

In order to resist the buckling of the top portion of the ribs the present invention provides a series of projections 27 shown more particularly in Figures 4 and 5. The projections are repeated along the length of the rib at a convenient distance apart, and by protruding from the portion 22 of the ribs give the ribs increased rigidity to resist buckling. The projections 27 are shown as protruding downwardly but would equally well protrude upwardly.

The projection, have an added advantage in that concrete flows into them when it is poured, and so helps to resist sliding of the concrete relative to the sheet apparent at the ends of the deck by creating a keying effect. Accordingly the projections may be formed alternately downward and upward from the portion 22 as shown for instance at 27 & 28.

While the projections described so far are designed to resist the mode of failure shown in Figure 2 it will be appreciated that stiffeners generally have considerably advantages in the forming of composite decks.

While the main feature of the invention is to provide projections on the upper portions of the ribs further stiffeners may be formed in the same rolling operation on the internal face of the soffit as at 30. The ribs 30 further increase the keying effect which resists sliding between steel and concrete and also assist in enabling a plasterer to obtain some bite when applying plaster to a ceiling below the soffit surface.

The projections 27 and 28 may be formed as swaged stiffeners, or by rolling into the sheet when the ribs are formed, or by any other convenient manufacturing process.

WHAT WE CLAIM IS:—

1. A ribbed sheet, for use as part of a composite deck, having a generally planar soffit surface, and a plurality of ribs bent upwardly from this surface such that the ribs are wider at a distance away from the surface than they are close to the surface, in which a plurality of spaced projections are formed on the face of that portion of at least one of the ribs furthest from the surface, said projections facing away from said soffit surface and being formed as indentations pressed upwardly in the lower face of that rib portion, and in which the width of said portions is less than the width of the soffit surfaces between the ribs.

2. A sheet as claimed in claim 1 in which there are projections on those portions of all of the ribs.

3. A sheet as claimed in claim 1 in which the projections face both towards and away from the said surface.

4. A sheet as claimed in any one of the preceding claims in which there are keying



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A specific embodiment of the invention and some variants thereof will now be described by way of example with reference to the accompanying drawings, in which:—

5 Figure 1 is a sectioned perspective view through a composite deck,

Figure 2 is a side view of the deck after it has been loaded to failure,

10 Figures 3a, 3b, and 3c, show a rib as it is deformed during successive stages in the failure of the deck,

Figure 4 shows a rib in accordance with the invention, and

15 Figure 5 shows a perspective view of a sheet having a number of different projections and stiffeners formed thereon.

As shown in Figure 1 a composite deck has a ribbed sheet 11 and a concrete slab 12. The sheet 11 has upwardly directed reinforcing ribs 14 which are hollow, and extend into the concrete 12 in the manner of dovetails. The ribs 14 run lengthwise throughout the beam which is effectively formed by a length of the composite deck.

25 Figure 2 shows a side view of the beam disposed over a gap between two supports 15 and 16. The beam has been subjected to a downward, and has failed by delamination of the concrete and the sheet. At the centre of the gap (e.g. at 17) the concrete has pulled away from the steel sheet leaving a space 18. At the edges of the gap (e.g. at 19) the ends of the concrete have slipped outwardly relative to the sheet by a distance shown as 21. In this manner the composite action of the deck has broken down and the deck will no longer sustain its design load.

35 It will be seen in Figure 1 that the width (y) of the top portion of the dovetail ribs is substantially less than the width (x) of the intermediate soffit surfaces. If this were not so there would be a risk that the steel sheet 11 might, under load, sag away from the concrete slab 12 between the ribs 14, thus increasing the possibility of slip occurring between steel and concrete.

40 The successive stages in the failure at 18 are shown in Figures 3a, 3b, and 3c. In Figure 3a the steel rib 14 fits snugly in the concrete. In Figure 3b the concrete is just beginning to lift off the soffit face of the steel sheet, leaving a small space 18a. At this stage the ribs 14 resist the lifting off action partly by holding apart the upper edges of the concrete surrounding the top portion 22 of the dovetail. As the portion 22 is loaded, the faces of the concrete at 23 and 24 tend to push the walls of the steel rib together.

50 As shown in Figure 3c the rib has failed leaving the gap 18 as shown in Figure 2, and it can be seen that the walls of the rib have been crushed towards one another at 25 and the upper portion of the rib has buckled upwardly at 26.

If the upper portion of the rib had an initial downward curvature it would quite possibly buckle downwardly instead.

70 In order to resist the buckling of the top portion of the ribs the present invention provides a series of projections 27 shown more particularly in Figures 4 and 5. The projections are repeated along the length of the rib at a convenient distance apart, and by protruding from the portion 22 of the ribs give the ribs increased rigidity to resist buckling. The projections 27 are shown as protruding downwardly but would equally well protrude upwardly.

80 The projection, have an added advantage in that concrete flows into them when it is poured, and so helps to resist sliding of the concrete relative to the sheet apparent at the ends of the deck by creating a keying effect. Accordingly the projections may be formed alternately downward and upward from the portion 22 as shown for instance at 27 & 28.

85 While the projections described so far are designed to resist the mode of failure shown in Figure 2 it will be appreciated that stiffeners generally have considerably advantages in the forming of composite decks.

90 While the main feature of the invention is to provide projections on the upper portions of the ribs further stiffeners may be formed in the same rolling operation on the internal face of the soffit as at 30. The ribs 30 further increase the keying effect which resists sliding between steel and concrete and also assist in enabling a plasterer to obtain some bite when applying plaster to a ceiling below the soffit surface.

95 The projections 27 and 28 may be formed as swaged stiffeners, or by rolling into the sheet when the ribs are formed, or by any other convenient manufacturing process.

WHAT WE CLAIM IS:—

1. A ribbed sheet, for use as part of a composite deck, having a generally planar soffit surface, and a plurality of ribs bent upwardly from this surface such that the ribs are wider at a distance away from the surface than they are close to the surface, in which a plurality of spaced projections are formed on the face of that portion of at least one of the ribs furthest from the surface, said projections facing away from said soffit surface and being formed as indentations pressed upwardly in the lower face of that rib portion, and in which the width of said portions is less than the width of the soffit surfaces between the ribs.

100 2. A sheet as claimed in claim 1 in which there are projections on those portions of all of the ribs.

105 3. A sheet as claimed in claim 1 in which the projections face both towards and away from the said surface.

110 4. A sheet as claimed in any one of the preceding claims in which there are keying

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stiffeners formed on the soffit surface itself.

5 5. A sheet as claimed in claim 6 in which the keying stiffeners formed on the soffit surface lie parallel to the axis of the ribs.

6. A sheet substantially as hereinbefore described with reference to and as shown in Figures 4 and 5 of the accompanying drawings.

7. A composite deck comprising a sheet 10 as claimed in any one of the preceding claims, with concrete or the like poured on the face of the sheet from which the ribs project.

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