COMMONWEALTH OF AUSTRALIA

Patents Act 1952

APPLICATION FOR A STANDARD PATENT

I/WE GERHARD DINGLER of Industriestrasse 20, 7274 Halterbach, German Federal Republic

hereby apply for the grant of a Standard Patent for an invention entitled

LARGE-AREA, BOARD-SHAPED COMPOUND UNITS

which is described in the accompanying complete specification.

This application is made under the provision of Part XVI of the Patents Act 1952 and is based on an application for a patent or similar protection made in German Federal Republic on 16 December 1983 (No. P 33 45 592.9)

My address for service is: F.B. RICE & CO., 28A Montague Street, Balmain, NSW 2041

Dated this 6th day of December 1984.

GERHARD DINGLER

By: Patent Attorney

To: The Commissioner of Patents
COMMONWEALTH OF AUSTRALIA

P.B. RICE & CO., Patent Attorneys, Sydney
Commonwealth of Australia
The Patents Act 1952

DECLARATION IN SUPPORT

In support of the (Convention) Application made by: GERHARD DINGLER

for a patent for an invention entitled: Large-area, Board-shaped compound units

I (we) Gerhard Dingler

of

make this declaration as follows:

a) I am (we are) the applicant(s) for the patent

b) I am (we are) the actual inventor(s) of the invention.

Delete the following if not a Convention Application.

The basic application(s) as defined by section 141 (242) of the Act was (were) made on 16 December 1983 in German Federal Republic

by Gerhard Dingler

The basic application(s) referred to in this paragraph is (are) the first application(s) made in a Convention country with respect of the invention the subject of the application.

a) I am (we are) the actual inventor(s) of the invention.

Signed Applicant/Inventor

Declarant's Name GERHARD DINGLER

Declared at West Germany this 4th day of February 1988

F. B. RICE & CO PATENT ATTORNEYS

This form is suitable for any type of Patent Application. No legalisation required.
Claim

1. A large-area, board-shaped construction element comprising a board plane which reaches predetermined working temperatures when in use and a stiffening device for reducing bending of said board plane, having its main direction of load perpendicular to said board plane, said stiffening device comprising:
   a) a sandwich of at least one layer of a first material, one layer of a second material and one layer of a third material, each of said layers having a main direction of load perpendicular to said board plane, wherein
      b) said third material layer lies between the two other material layers,
      c) said third material layer has a substantially higher coefficient of heat expansion than said two other material layers,
      d) said first and second material layers are made of thermosetting plastic, which sets at a temperature considerably above the maximum working temperature of said construction element, and
      e) said third material layer is under contracting biasing force in said sandwich.
2. A large-area, board-shaped construction element as claimed in claim 1, wherein the first and the second material are the same.

3. A large-area, board-shaped construction element as claimed in claim 1, wherein the first and the second material are made of thermosetting plastic.

4. A large-area, board-shaped construction element as claimed in claim 1, wherein the third material is metal.

5. A large-area, board-shaped construction element as claimed in claim 4, wherein the third material is a sheet metal strip.

6. A large-area, board-shaped construction element as claimed in claim 5, wherein the cross-section of the sheet metal strip is substantially smaller than the cross-section of the two other materials.

7. A large-area, board-shaped construction element as claimed in claim 6, wherein the sheet metal strip is provided with reinforcing beads which run in the longitudinal direction of the sheet metal strip.

8. A large-area, board-shaped construction element as claimed in claim 1, wherein the thermosetting plastic is fiber-reinforced.
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Complete Specification for the invention entitled:

LARGE-AREA, BOARD-SHAPED COMPOUND UNITS

The following statement is a full description of this invention including the best method of performing it known to me:-

- 1 -
LARGE-AREA, BOARD-SHAPED COMPOUND UNITS

The invention relates to a stiffening device for reducing bending in a board-shaped construction element.
The invention relates to a device according to the pre-characterizing clause of the main claim.

If such devices are used for concrete formwork, they are known as formwork panels. They are reusable and serve for supporting the concrete until it has set. They are used for the fabrication of masonry walls. In this case, two generally parallel formwork panels delimit the thickness of the later wall. Such formwork panels are also used, however, for ceiling boarding, the formwork of joists, the formwork of piers etc. In service, they have to meet numerous demands which are very contradictory. For example, they must be light. The reason for this is that, as individual formwork panels, they have to be handled if possible by a single man or if possible by two men.

But, even if the formwork panels are to be lifted by a crane, they should be light because in this case several formwork panels are joined together. The normally used formwork panels are heavy, since the formwork board consists of a thick sandwich board with wood as the principal constituent. The frame and the webs supporting the...
formwork board from behind are made of steel. The disadvantages of these formwork panels are as follows:

a) Due to the high weight, the formwork panels are difficult to handle.

b) Due to the high weight, only a certain number of them can be transported on trucks.

c) The formwork panel must fit in the frame. Special production techniques have to be used here as only the frame is made of dead material, while the formwork board is made of live material.

d) The peripheral lines of the formwork board stand out in many places on the finished concrete since the frame protrudes at least with one rib up to the concrete. With two formwork boards next to each other, there are thus three parallel, closely adjacent ribs protruding out of the finished wall.

e) The formwork board absorbs water. As long as it is new, this is not very much. However, when it later separates into fibers, it absorbs more and more water. This means that the concrete has too little water during setting on the site and it then gets the familiar air voids.

f) A loss of water can also take place in the narrow gaps between the edge of the formwork board and the frame. This is all the more so as the hydrostatic pressure on a, for example, 2.50 m high formwork panel with filled concrete is, after all, quite considerable.
The formwork board determines by its surface quality the surface quality of the later concrete. The smoother it is, the smoother will also be the masonry wall or the ceiling or similar. Even with very high-grade formwork boards, the surface quality deteriorates over time due to separation into fibers. If the surface quality were very high, this would also have the advantage that a very thin layer of cement separates out directly next to the formwork board surface, which is desirable both for aesthetic reasons and for reasons of subsequent aftertreatment. In the case of the known devices, the formwork board is either very rough from the outset or it becomes very rough during use.

When the concrete has been poured between formwork panels, it is, as is known, compacted by vibrators. In this operation, the concrete moves down very slightly. In the region of the surface of the formwork board, the concrete, of course, moves down all the more readily the smoother it is.

The laitance is anything but a chemically neutral substance. Rather, it attacks metal. This means that the retaining edge of the frame legs of the formwork panel corrodes over time.

For reason of equitable work distribution, building is also to take place as far as possible
during the winter. During setting of the concrete, a small amount of heating occurs. Over wide temperature ranges, this is immaterial. As from a temperature of, for example, \(-10^\circ C\), the formwork panels dissipate so much heat that the concrete no longer sets. The heat is dissipated in particular in the region of the formwork board mounts as they, after all, come into contact with the concrete directly. Wherever the, in themselves, high-grade formwork boards have been used in sandwich design, they have a poor heat insulation. They lean heavily against the crossmembers of the formwork panel frame, and these crossmembers then act practically as cooling ribs for the area behind them. Thus, it can happen that the metal parts of the formwork panels stand out on the concrete like a grid. This makes a structure either totally or partially worthless.

Merely for the sake of weight reduction, in recent years attention has turned to formwork panels made of aluminum. However, aluminum is very expensive and can only be welded by special weldings, is attacked even more by the laitance and is dented much earlier than the formwork panels of the structure mentioned above. In aluminum formwork, the formwork board is frequently also made of aluminum. On aluminum, however, the concrete begins to cake after only the second or third formwork application, so that demolding presents problems.
The object of the invention is to provide compound units of the type mentioned at the start which are much lighter than the lightest metal formwork, which are easily producible and which, despite the low weight, are both capable of withstanding for a long time the customary rough treatment on site and, above all, are capable of absorbing the hydrostatic pressures occurring in concreting. It should be possible to deform better than has so far been the case with aluminum formwork and it should also be achieved that the surface quality of the formwork board is and remains excellent.

This object is achieved according to the invention by the features evident from the characterizing part of the main claim.

Such a device can also be used as a board for winter construction, it can be used as a roof for huts etc. The invention provides for prestressing the compound unit. The two outer materials would actually be overstrained. However, by prestressing in precisely the opposed direction to the straining direction, the load which the plastic has to withstand is reduced. If the setting temperature is considerably above the working temperature, which can be, for example, at 130 to 150°C, the state of prestressing is frozen-in in such high temperature ranges that they are never again reached in service.

By the features of claim 2, production and calculation is facilitated and it is easier to arrive at
One aspect of the invention relates to a large-area, board-shaped construction element comprising a board plane which reaches predetermined working temperatures when in use and a stiffening device for reducing bending of said board plane, having its main direction of load perpendicular to said board plane, said stiffening device comprising:

a) a sandwich of at least one layer of a first material, one layer of a second material and one layer of a third material, each of said layers having a main direction of load perpendicular to said board plane, wherein

b) said third material layer lies between the two other material layers,

c) said third material layer has a substantially higher coefficient of heat expansion than said two other material layers,

d) said first and second material layers are made of thermosetting plastic, which sets at a temperature considerably above the maximum working temperature of said construction element, and

e) said third material layer is under contracting biasing force in said sandwich.

Such a device can also be used as a board for winter construction, it can be used as a roof for huts etc. The invention provides for prestressing the compound unit. The two outer materials would actually be overstrained. However, by prestressing in precisely the opposed direction to the straining direction, the load which the plastic has to withstand is reduced. If the setting temperature is considerably above the working temperature, which can be, for example, at 130 to 150°C, the state of prestressing is frozen-in in such high temperature ranges that they are never again reached in service.
By the features of claim 24, it is easy to join the compound units together or sling them on cranes.

By the features of claim 25, it is possible to heat the device to a certain degree. In application of the device for concrete formwork, this would have the advantage that concreting could continue even in severe frost and the concrete still sets. In using the compound units as hut roofs, the snow load or ice load can be prevented from becoming too high. It is namely adequate here if the heating output per unit area is very low.

The invention is particularly suitable for applications according to claims 26 and 27.

By the features of claim 26, the sheet metal strips interlink and they can run between the same spatial planes. It is therefore not necessary to make the compound units higher because sheet metal strips have to run in them.

The invention will now be explained with reference to a preferred exemplary embodiment. In the drawing,

Fig. 1 shows the rear view of a 2640 mm long and 750 mm wide formwork board,

Fig. 2 shows a cross-section along the line 2-2 in Fig. 1, enlarged four times the natural size,

Fig. 3 shows the side view of a sheet metal strip,

Fig. 4 shows the perspective view of the intersection region of two sheet metal strips,

Fig. 5 shows a first electrical connection possibility of
the sheet metal strips.

Fig. 6 shows a second possibility for electrical connection of the sheet metal strips.

Fig. 7 shows the stress diagram of an inside bay web without sheet metal strips.

Fig. 8 shows the stress diagram produced by the prestressing.

Fig. 9 shows the stress diagram resulting from the superimposition of Figs. 7 and 8.

A formwork panel 11 has a formwork board 12, four perimeter webs 13, 14, 16, 17 and, parallel with the perimeter webs 14, 16, a relatively large number of inside bay webs 18, which are about 22 cm distant from one another. As shown by the broken lines 19, other webs of the same form as the inside bay webs 18 can be provided at equal distance and parallel with the perimeter webs 16, 13. The perimeter webs 13 to 17 have a width of 2.3 cm and are thus quite substantially narrower than the previously existing perimeter webs made of steel or aluminum. The inside bay webs 18 have a width of 6 mm, which likewise is quite substantially less than the previous inside bay webs had. The perimeter webs 13 to 17 and the inside bay webs 18 and also the webs which may exist as shown by the broken lines 19 are to a slight extent conical out of the plane of the drawing of Fig. 1, with the exception of the perimeter areas 21 of the perimeter webs 13, 14, 16, 17, which perimeter areas 21 stand upright relative to the plane of the drawing of Fig. 1. Such a formwork panel
11 weighs approximately 30 to 32 kg, which means a considerable saving in relation to an aluminum formwork of 39 kg or even a steel frame formwork of 68 kg.

The inside bay webs 18 are 96 mm high. In them, a metal sheet strip 22 is provided, as shown in Fig. 2, in the center plane or meandering about this plane. Its bottom end 23, as shown in Fig. 2, has a small distance from face 24 of the associated inside bay web 18. The top end 26 protrudes so far into the formwork board 12 that it is essentially in the neutral zone of the formwork board 12. Because the formwork board 12 is, after all, still joined to the perimeter webs 13 to 17 and the inside bay webs 18, the neutral zone of the formwork board 12 is not for instance in its center, but offset further down, as shown in Fig. 2. The formwork board 12 has on its top surface 27, as shown in Fig. 2, a roughness which is negligible in this trade.

The sheet metal strip 22 is 1 mm thick and is made of steel of type St 37. It is corrugated with waves 28 like corrugated sheet. With the exception of the sheet metal strip 22, the material of the formwork board 12 and of the inside bay web 18 is made of glassfiber-reinforced thermosetting plastic having an $\alpha_T$ value of $14 \times 10^{-6}$. The sheet metal strip 22 has a higher $\alpha_T$ value of $21 \times 10^{-6}$.

Fig. 7 shows the stress diagram for the inside bay web 18 in the zero state with applied service load. The minus sign refers to compressive force and the plus...
sign to tensile force. Where the two fields meet is the neutral zone. In the example there are 5326.33 N/cm². An SMC glassfiber-reinforced plastic based on DSM 730, for example, would withstand this load. However, the deflection of inside bay web 18 would then be much too great, i.e. area 27 would bulge.

Fig. 8 shows how the sheet metal strip 22 then exerts a precisely opposed prestress of 4174 N/cm². If one then observes the complete inside bay web 18 (in the manner of speech of the main claim "compound unit"), superimposition produces the stress diagram shown in Fig. 9, i.e. the difference between Figure 7 and Figure 8, and the deflection has become correspondingly smaller by this difference, i.e. acceptable in practice.

The prestressing is produced by introducing the glassfiber-reinforced plastic and the sheet metal strips 22 into a mold. The glassfiber-reinforced plastic then reacts chemically and, since this process is exothermic, heat in the range of 130°C is generated. This heat is also transmitted to the thermically quick-reacting sheet metal strip 22, which then expands relative to the materials surrounding it. At this temperature of 130°C, the thermosetting material then becomes hard and bonds with the sheet metal strip 22. Although the complete element then cools, the sheet metal strip 22 remains bonded with the material and at this stage shrinks relative to the set plastic. This causes the prestressing as shown in Figure 8 of 4174 N/cm² in the region of the highest
compression or of the highest tension. The plastics do not have any cold creep characteristics. These would also be prevented by the use of fibers. The plastic used can be nailed with steel nails.

It is water repellent and does not accept concrete. The materials are commercially freely available. For example, the companies Bayer and Hoechst supply the material DSM 730. The glassfiber-reinforced plastic SMC can be made up by yourself or bought ready-to-use, so that it only has to be mixed with an activator before introduction into the mold. Plastic and glassfibrers are available everywhere, they are by no means rare materials. If needs be, they can be patched in the way in which boat hulls, gliders or the like are patched.

In Figure 3, the sheet metal plate has holes, through which the plastic material can bond, so that a positive connection also takes place and the plastic does not adhere to the surface of the sheet metal plate 22.

Figure 4 shows how the sheet metal plate 22 can be shaped if it crosses another sheet metal plate 31. The sheet metal plate 22 is then provided with a notch 32, which extends somewhat more than to half of the sheet metal plate 22 and is wider than the sheet metal plate 31 is thick. Conversely, a notch 33 is made in sheet metal strip 31, so that by fitting the sheet metal strips 22, 31 into each other, an intersection can form. A small excess in the notches 32, 33 is adequate to allow the sheet metal strips 22, 31 to stretch slightly at the temperature of
If materials are used, the coefficients of thermal expansion of which have an even higher differential, the prestressing is even higher. The same is achieved if plastics are used which react and solidify at even higher temperatures, because then the sheet metal strip 22, and where applicable 31 as well, expand(s) even more and is frozen-in in this even greater expansion.

Simply for the sake of simplicity, it was assumed in the above description that only the inside bay webs 18 have such sheet metal strips 22. It goes without saying that sheet metal strips can also be provided analogously in the perimeter webs 13, 14, 16, 17. If webs are also provided as shown by the broken lines 19, they also contain sheet metal strips.

The invention can also be supplemented to the effect that sheet metal material is also provided in the formwork board 12, either inserted as a strip or better as a sheet metal plate, which is not solid however but has holes as per the holes 29 from Fig. 3.

Fig. 1 shows that screws (sic) 34 are cast-in at the corner regions of the formwork panel 11. A screw can be screwed into these in the viewing direction of Fig. 1. Furthermore, a bubble level 36 and, perpendicular to it, a bubble level 37 can be formed in one of the bays visible in Fig. 1, so that it is later possible to see whether the formwork panel 11 also stands true.

It is easy to connect the abovementioned system
of sheet metal strips electrically. This is shown by Fig. 5 for an exemplary embodiment. There, the left-hand top corner region is connected to a terminal 38 and the right-hand bottom region to a terminal 39. It is readily possible, without altering the mechanical prestressed characteristic, to heat up the formwork board 12 to such an extent that it does not become colder than \(-10^\circ\text{C}\), for example. The thermal load of the entire device is low in that case.

In a circuit arrangement as shown in Fig. 5, the sheet metal strips must be electrically connected to one another at the intersections or the abutting points, which can be readily achieved by means of wires simply serving for the electrical connection.

Fig. 4 shows that the sheet metal strips can also be heated in another way, namely by connecting up in series.

The device according to the invention has a substantially higher service life than all known devices.

The number of the devices according to the invention used is likewise substantially higher than the known devices. Since the material coming into contact with the concrete is dead plastic material, this material is insensitive to concrete. In rough treatment on site, the device is much less susceptible to damage. For example, steel and in particular, aluminum are left with dents if a stack of devices collapses, is hit or such like. The device according to the invention absorbs such forces resiliently and
returns to its initial position. In the event that cracks actually do occur, they can be repaired just as well by the unskilled as cracks in leisure objects can be repaired by the unskilled.
THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A large-area, board-shaped construction element comprising a board plane which reaches predetermined working temperatures when in use and a stiffening device for reducing bending of said board plane, having its main direction of load perpendicular to said board plane, said stiffening device comprising:
   a) a sandwich of at least one layer of a first material, one layer of a second material and one layer of a third material, each of said layers having a main direction of load perpendicular to said board plane, wherein
   b) said third material layer lies between the two other material layers,
   c) said third material layer has a substantially higher coefficient of heat expansion than said two other material layers,
   d) said first and second material layers are made of thermosetting plastic, which sets at a temperature considerably above the maximum working temperature of said construction element, and
   e) said third material layer is under contracting biasing force in said sandwich.

2. A device as claimed in claim 1, wherein the first and the second material are the same.

3. A device as claimed in claim 1, wherein the first and the second material are made of thermosetting plastic.

4. A device as claimed in claim 1, wherein the third material is metal.

5. A device as claimed in claim 4, wherein the third
2. A large-area, board-shaped construction element as claimed in claim 1, wherein the first and the second material are the same.

3. A large-area, board-shaped construction element as claimed in claim 1, wherein the first and the second material are made of thermosetting plastic.

4. A large-area, board-shaped construction element as claimed in claim 1, wherein the third material is metal.

5. A large-area, board-shaped construction element as claimed in claim 4, wherein the third material is a sheet metal strip.

6. A large-area, board-shaped construction element as claimed in claim 5, wherein the cross-section of the sheet metal strip is substantially smaller than the cross-section of the two other materials.

7. A large-area, board-shaped construction element as claimed in claim 6, wherein the sheet metal strip is provided with reinforcing beads which run in the longitudinal direction of the sheet metal strip.

8. A large-area, board-shaped construction element as claimed in claim 1, wherein the thermosetting plastic is fiber-reinforced.

9. A large-area, board-shaped construction element as claimed in claim 8, wherein the fiber reinforcement is in the form of fabric.

10. A large-area, board-shaped construction element as claimed in claim 8, wherein the fiber reinforcement is in the form of added fibers.

11. A large-area, board-shaped construction element as claimed in claim 8, wherein the fiber reinforcement comprises glass fibers.

12. A large-area, board-shaped construction element as claimed in claim 1, wherein the third material lies in the one neutral zone of the two other materials.

13. A large-area, board-shaped construction element as
claimed in claim 1, wherein the outside surfaces of the outer materials have a demold-draft.

14. A large-area, board-shaped construction element as claimed in claim 1, wherein, in the case of several construction elements positioned angularly to one another and joined together as a single piece, the end of the third material is located in the region of the neutral zone of the other device.

15. A large-area, board-shaped construction element as claimed in claim 1, wherein the construction element is the reinforcing webs on the rear of a formwork panel.

16. A large-area, board-shaped construction element as claimed in claim 15, wherein the formwork board of the formwork panel is of a unitary structure with the reinforcing webs.

17. A large-area, board-shaped construction element as claimed in claim 15, wherein the reinforcing webs are the perimeter webs.

18. A large-area, board-shaped construction element as claimed in claim 15, wherein the reinforcing webs are the inside bay webs.

19. A large-area, board-shaped construction element as claimed in claim 1, wherein the parameters of the materials, their dimensions and position are selected such that the tension/compression stress diagram is only partially compensated.

20. A large-area, board-shaped construction element as claimed in claim 1, wherein the third material has, transverse to its longitudinal extension, recesses which are crossed by the two other materials.

21. A large-area, board-shaped construction element as claimed in one or more of the preceding claims wherein, the sheet metal strip is made of steel of grade St 37/St 52.

22. A large-area, board-shaped construction element as claimed in one or more of the preceding claims, wherein
the plastic is of the grade SMC (base DSM 730) glassfiber-reinforced plastic.
23. A large-area, board-shaped construction element as claimed in one or more of the preceding claims, wherein at least one bubble level is cast-in into the construction element.
24. A large-area, board-shaped construction element as claimed in one or more of the preceding claims, wherein nuts are cast-in into the construction element.
25. A large-area, board-shaped construction element as claimed in claim 4, wherein the third material serves as a heating element and is connected to an electrical terminal-plug connection.
26. A large-area, board-shaped construction element as claimed in claim 1, wherein the construction element is a board-shaped element of a temporary construction, such as wall element of a winter construction, roof element of a hut or the like.
27. A large-area, board-shaped construction element as claimed in claim 1, wherein the construction element is the formwork board.
28. A large-area, board-shaped construction element as claimed in one or more of the preceding claims, wherein, at intersections of the sheet metal strips, the latter have edge-open recesses for the respective other sheet metal strip.
29. A large-area, board-shaped construction element substantially as herein described with reference to the accompanying drawings.
DATED this 28th day of June 1988

GERHARD DINGLER
Patent Attorneys for the
Applicant:

F.B. RICE & CO.
FIG. 3

FIG. 4

FIG. 5

FIG. 6