

GALVANIZED STEEL DECK AND SYSTEM THEREOF

FIELD OF INVENTION

The present invention relates to galvanized steel deck and a system thereof for use in the construction industry, and in particular but not exclusively, for use in the construction of buildings such as steel frame buildings, concrete frame building and similar building types.

BACKGROUND TO THE INVENTION

The following discussion of the background to the invention is intended to facilitate an understanding of the present invention. However, it should be appreciated that the discussion is not an acknowledgment or admission that any of the material referred to was published, known or part of the common general knowledge in any jurisdiction as at the priority date of the application.

Composite construction is widely used in the construction industry due to the benefits it brings. The benefits include structural stability, an increased speed of construction, and savings in weight and size of the primary structure of a building. The combination of concrete and steel when joined together structurally, due to its strength and stiffness, can give rise to an efficient and lightweight design and material.

Composite slabs comprise reinforced concrete cast on top of profiled steel decking, in which the decking typically acts as formwork during construction and as external reinforcement at the composite stage. Hence, it is essential that such steel decking is carefully designed and constructed. However, during the construction stage in which wet concrete is poured over conventional galvanized steel decking, the steel decks of the decking can easily move apart. Furthermore, temporary propping may also be required during the construction stage.

Therefore, there is an urgent need for effective and efficient galvanized steel decking to address the aforementioned disadvantages. The present invention seeks to provide a galvanised steel deck and a system thereof to overcome at least in part some of the aforementioned disadvantages.

SUMMARY OF THE INVENTION

Throughout this document, unless otherwise indicated to the contrary, the terms “comprising”, “consisting of”, and the like, are to be construed as non-exhaustive, or in other words, as meaning “including, but not limited to”.

- 5 In accordance with a first aspect of the present invention, there is provided a metal deck comprising an elongate member having a first portion shaped for receiving a female connector and a second portion shaped for receiving a male connector. The first portion comprises a male connector and the second portion comprises a female connector. The height of the first and second portions lies between approximately 60 mm and 120 mm.
- 10 The male connector comprises a projection extending outwardly, with a first concave portion connected to a first convex portion and further extends upwardly into a first flange and a second concave portion connected to the base via a second convex portion.

- The female connector comprises a corresponding indentation in relation to the male connector and adapted to receive the male connector, with a first concave portion
- 15 connected to a first convex portion and further extends upwardly into a second flange and a second concave portion connected to the base via a second convex portion.

- The male and female connectors are releasably connectable to corresponding connectors on an adjacent metal deck, thereby enabling a plurality of metal decks to be connected to one another, by engaging the first and second concave portions of the male connector and
- 20 the female connector bearing the corresponding indentation to form positively interlocking metal decking, thereby enabling constant engagement of the male and female connectors and retention of said engagement.

- When a female connector of one metal deck is connected to a corresponding male connector of an adjacent metal deck, they are positively interlocked, hence
- 25 advantageously preventing the connected metal decks from moving apart during the construction stage where wet concrete is poured over the metal decks.

The male connector can take a form of a truncated rectangle with rounded edges and the female connector comprises an indentation that can take the form of a rectangle with rounded edges. The male connector length is shorter than the female connector length.

The male connector length lies between approximately 19 mm and 70 mm. The female connector length lies between approximately 20 mm and 72 mm.

The first and second concave parts, adjoining the connectors and the first and second flanges, comprise curved radius of approximately 2.5 mm. Preferably, the margin error
5 for the measurement is approximately ± 0.2 mm.

The base of the metal deck comprises at least one trough-shaped portion that extends longitudinally, to prevent oil canning. Preferably, the length of the trough-shaped portion is approximately 38 mm.

The first and second flanges extend generally perpendicular from the base. Each of the
10 first and second flanges that extend upwardly from the connectors comprises a first portion and a second portion. The first portion extends inwardly. The second portion comprises a bent edge that points towards the base of the elongate member. The length of the second portion lies between approximately 8 to 9 mm. The lengths of the first and second flanges lie between approximately 43 mm and 54 mm.

15 Preferably, the margin of error for the measurements is approximately ± 5 mm. More preferably, the margin of error for the measurements is approximately ± 1 to 2 mm.

The metal deck comprises a galvanized coating of Zinc. The combination of the metal deck with concrete provides fire resistance properties.

In accordance with a second aspect of the present invention, there is provided a metal
20 decking system. The metal decking system comprises a plurality of metal decks arranged alongside each other, in which each metal deck comprises an elongate member having a first portion shaped for receiving a female connector and a second portion shaped for receiving a male connector. The first portion comprises a male connector and the second portion comprises a female connector, in which the male and female connectors are
25 releasably connectable to corresponding connectors on an adjacent metal deck thereby enabling a plurality of metal decks to be connected to one another to form a metal decking system.

The male connector releasably connects to a female connector bearing a corresponding indentation in relation to the male connector. The male and female connectors are

positively interlocked, thereby enabling constant engagement of the connectors and retention of the engagement.

In accordance with a third aspect of the present invention, there is provided a composite structure comprising a concrete slab and a metal decking, in which the composite
5 structure is clad or embedded in the concrete slab.

In accordance with a fourth aspect of the present invention, there is provided a metal deck substantially as herein described with reference to the accompany drawings as appropriate.

The present invention has at least the following advantages:

- 10 1. The present invention prevents the metal decks from moving during the construction stage where wet concrete is poured over the decks.
2. The present invention provides improved mechanical bonding between the metal decks and concrete which results in improved composite performance.
- 15 3. Metal decks of the present invention have large spanning ability (span longer distance with a lighter steel weight) as compared to conventional metal decks. This advantageously removes the need for any temporary or permanent propping during the construction stage.
4. Metal decks of the present invention have improved fire resistance properties as compared to conventional metal decks, and meet the requirements of both local
20 and International Fire Codes.

Other aspects and advantages of the invention will become apparent to those skilled in the art from a review of the ensuing description, which proceeds with reference to the following illustrative drawings of various embodiments of the invention.

BRIEF DESCRIPTION OF DRAWINGS

- 25 The present invention will now be described, by way of illustrative example only, with reference to the accompanying drawings, of which:

Figure 1 shows a profile of a galvanized steel deck in accordance with an embodiment of the present invention;

Figure 2 shows a sectional profile of galvanized steel decks in accordance with an embodiment of the present invention;

- 5 **Figure 3** shows a profile of a galvanized steel deck in accordance with an embodiment of the present invention and its corresponding preliminary load/span results when a theoretical load is applied to the galvanized steel deck;

Figure 4 shows (A) the profile of the galvanized steel deck of Figure 3; and (B) a profile of a plurality of the galvanized steel decks when connected to one another;

- 10 **Figure 5** shows a profile of a galvanized steel deck in accordance with another embodiment of the present invention and its corresponding preliminary load/span results when a theoretical load is applied to the galvanized steel deck;

Figure 6 shows (A) the profile of the galvanized steel deck of Figure 5; and (B) a profile of a plurality of the galvanized steel decks when connected to one another;

- 15 **Figure 7** shows a profile of a galvanized steel deck in accordance with yet another embodiment of the present invention and its corresponding preliminary load/span results when a theoretical load is applied to the galvanized steel deck;

Figure 8 shows (A) the profile of the galvanized steel deck of Figure 7; and (B) a profile of a plurality of the galvanized steel decks when connected to one another;

- 20 **Figure 9** shows a profile of a galvanized steel deck in accordance with yet another embodiment of the present invention and its corresponding preliminary load/span results when a theoretical load is applied to the galvanized steel deck; and

Figure 10 shows (A) the profile of the galvanized steel deck of Figure 9; and (B) a profile of a plurality of the galvanized steel decks when connected to one another.

25 **DETAILED DESCRIPTION**

Particular embodiments of the present invention will now be described with reference to the accompanying drawings. The terminology used herein is for the purpose of

describing particular embodiments only and is not intended to limit the scope of the present invention. Additionally, unless defined otherwise, all technical and scientific terms used herein have the same meanings as commonly understood by one of ordinary skill in the art to which this invention belongs.

- 5 The use of the singular forms “a”, “an”, and “the” include both singular and plural referents unless the context clearly indicates otherwise.

The use of “or”, “/” means “and/or” unless stated otherwise. Furthermore, the use of the terms “including” and “having” as well as other forms of those terms, such as “includes”, “included”, “has”, and “have” are not limiting.

- 10 The use of “metal decking” as used herein refers to steel decking, galvanized steel decks or any permanent formwork to concrete for providing structural stability.

With reference to Figures 1 and 2, there is described hereinafter a galvanized steel deck **10** in accordance with an embodiment of the present invention. The galvanized steel deck **10** is for use in the construction of buildings such as steel frame buildings, concrete
15 frame building and the like.

The galvanized steel deck or metal deck **10** comprises an elongate member having a base **11** extending to a first portion and a second portion, the first portion comprises a male connector **12** and the second portion comprises a female connector **13**. The galvanized steel deck **10** is one of a plurality of steel decks arranged alongside one another to form
20 steel decking **30**. The steel decking **30** is designed for use with concrete topping and to be embedded herein.

The male connector **12** of the galvanized steel deck **10** and the female connector **13** are positively interlocked, enabling constant engagement of the male **12** and female connectors **13** and retention of said engagement. The connectors are releasably
25 connectable to adjacent galvanized steel deck **10**. Advantageously, this eliminates the use of securing means to secure the adjacent steel deck **10** together.

The male connector **12** comprises a projection extending outwardly, with a first concave portion **14** connected to a first convex portion **15** and further extends upwardly into a first

flange **16** and a second concave portion **17** connected to the base **11** via a second convex portion **18**.

The female connector **13** comprises a corresponding indentation in relation to the male connector **12**, wherein this inwardly directed portion receives the male connector **12**,
5 with a first concave portion **14** connected to a first convex portion **15** and further extends upwardly into a second flange **16** and a second concave portion **17** connected to the base **11** via a second convex portion **18**.

The first and second flanges **16** extend generally perpendicular from the base **11**. Each of the first and second flanges **16** that extend upwardly from the connectors comprises a
10 first portion **19** and a second portion **20**. The first portion **19** extends inwardly. The second portion **20** comprises a bent edge **19** that points towards the base **11** of the elongate member.

Example 1

With reference to Figures 3 and 4, there is described hereinafter a galvanized steel deck
15 **10** in accordance with an embodiment of the present invention.

The galvanized steel deck **10** comprises an elongate member having a first portion shaped for receiving a female connector **13** and a second portion shaped for receiving a male connector **12**. The first portion comprises a male connector **12** and the second portion comprises a female connector **13**, in which the male and female connectors are
20 releasably connectable to corresponding connectors on an adjacent steel deck thereby enabling a plurality of steel decks **10** to be connected to one another to form a galvanized steel decking system **30** (see Figure 4). When a female connector **13** of one galvanized steel deck **10** is connected to a corresponding male connector **12** of an adjacent galvanized steel deck **10**, they are positively interlocked, hence advantageously
25 preventing the connected galvanized steel decks **30** from moving apart during the construction stage where wet concrete is poured over the galvanized steel decks **30**.

The dimensions of the galvanized steel deck **10** are collectively chosen to take into account the load to be carried by the steel deck **10**. The height of the galvanized steel deck **10** is about 60 mm and the width of the galvanized steel deck **10** is about 300 mm.
30 In other embodiments of the present invention, the height of the galvanized steel deck **10**

ranges from about 60 mm to about 120 mm. It would be appreciated that the height and the width of the galvanized steel deck **10** can be lesser than or greater than the measurements or range of measurements mentioned above to suit the needs of the desired composite. Preferably, the margin of error for the measurements is approximately ± 5 mm. More preferably, the margin of error for the measurements is approximately ± 1 to 2 mm.

Preferred Properties of Galvanized Steel Deck

The preferred properties of the galvanized steel deck **10** comprise the following:

1. Grade of steel used for the galvanized steel deck **10** has high tensile strength that ranges from about 450 to about 550 MPa yield strength.
2. The galvanized steel deck **10** has a base metal thickness that ranges from about 0.75 mm base metal thickness to about 1.50 mm. Preferably, the base metal thickness is about 0.75 mm, about 0.90 mm, about 1.00 mm, about 1.20 mm or about 1.50 mm.
3. The galvanized coating of the steel deck **10** is Z275 min. (275 g/m²) in accordance with AS1397:2011 Australian Standard.
4. The galvanized steel deck **10** meets the requirements of both local, the Singapore Fire Code and International Fire Codes, which includes the European Fire Code. The galvanized steel deck **10** is embossed on the rib and at the bottom side of the deck for improved diaphragm action.

The galvanized steel deck **10** is subjected to a preliminary load/span testing, which shows the performance of the deck. During the testing, a theoretical load is applied to a galvanized steel deck **10** of a pre-determined steel thickness and a pre-determined slab thickness, and the corresponding span (in mm) is measured (see results table of Figure 3).

Example 2

With reference to Figures 5 and 6, there is described hereinafter a galvanized steel deck **10** in accordance with another embodiment of the present invention. The structure and design of the galvanized steel deck **10** in this embodiment is similar to the galvanized

steel deck **10** described in Example 1 and similarly comprises the preferred properties mentioned above (see Figure 6). However, in this embodiment, the height of the galvanized steel deck **10** is about 80 mm.

The galvanized steel deck **10** is similarly subjected to a preliminary load/span testing.

- 5 During the testing, a theoretical load is applied to a galvanized steel deck **10** of a pre-determined steel thickness and a pre-determined slab thickness, and the corresponding span (in mm) is measured (see results table of Figure 5).

Example 3

- 10 With reference to Figures 7 and 8, there is described hereinafter a galvanized steel deck **10** in accordance with yet another embodiment of the present invention. The structure and design of the galvanized steel deck **10** in this embodiment is similar to the galvanized steel deck **10** described in Example 1 and similarly comprises the preferred properties mentioned above (see Figure 8). However, in this embodiment, the height of the galvanized steel deck **10** is about 100 mm.

- 15 The galvanized steel deck **10** is similarly subjected to a preliminary load/span testing. During the testing, a theoretical load is applied to a galvanized steel deck **10** of a pre-determined steel thickness and a pre-determined slab thickness, and the corresponding span (in mm) is measured (see results table of Figure 7).

Example 4

- 20 With reference to Figures 9 and 10, there is described hereinafter a galvanized steel deck **10** in accordance with yet another embodiment of the present invention. The structure and design of the galvanized steel deck **10** in this embodiment is similar to the galvanized steel deck **10** described in Example 1 and similarly comprises the preferred properties mentioned above (see Figure 10). However, in this embodiment, the height of the
25 galvanized steel deck **10** is about 120 mm.

The galvanized steel deck **10** is similarly subjected to a preliminary load/span testing. During the testing, a theoretical load is applied to a galvanized steel deck **10** of a pre-determined steel thickness and a pre-determined slab thickness, and the corresponding span (in mm) is measured (see results table of Figure 9).

In each of Examples 1 to 4 described above, the load/span testing and results table are based on the following assumptions:

1. The concrete density being about 2400 kg/m^3 .
2. There are end supports across the full width of a panel. The panel comprises the total number of galvanized steel decks **10** that is required to cover a desired open space.
3. The bearing area to be about 70 mm. The bearing or “end bearing” is the end support that sits in the steel beam at both ends of a steel sheet.
4. The construction loads being:
 - a. Point load to be about 100 kg/m^2 .
 - b. Imposed construction load to be about 1.5 KPa (or 4.5/Load for Length>3m).
5. The spans are based on maximum allowable deflection of about Load/250.
6. The cantilevered portion of a composite slab to be less than $5 \times H$, where H = height of slab thickness.

In accordance with another aspect of the present invention, there is described hereinafter a galvanized steel decking system **30** for use in the construction of buildings such as steel frame buildings, concrete frame building and similar building types.

The system comprises a plurality of galvanized steel decks **10** connected to one another. Each of the galvanized steel deck **10** comprises an elongate member having a first portion shaped for receiving a female connector **13** and a second portion shaped for receiving a male connector **12**. The first portion comprises a male connector **12** and the second portion comprises a female connector **13**, in which the male and female connectors are releasably connectable to corresponding connectors on an adjacent steel deck **10** thereby enabling a plurality of steel decks to be connected to one another to form a galvanized steel decking system **30**. When a female connector **13** of one galvanized steel deck **10** is connected to a corresponding male connector **12** of an adjacent galvanized steel deck **10**, they are positively interlocked, hence advantageously

preventing the connected galvanized steel decks **10** from moving apart during the construction stage where wet concrete is poured over the galvanized steel decks **10**. Each of Figures 4B, 6B, 8B and 10B shows a galvanized steel decking system **30** in accordance with an embodiment of the present invention.

- 5 Advantageously, the present invention possesses a positive interlocking system which advantageously prevents galvanized steel decks **10** from moving apart during the construction stage where wet concrete is poured over the galvanized steel decks **10**. The present invention also provides an improved bonding between a galvanized steel deck **10** and concrete which results in improved composite performance, improved spanning ability
10 and improved fire resistance properties.

It is to be understood that the above embodiments have been provided only by way of exemplification of this invention, and that further modifications and improvements thereto, as would be apparent to persons skilled in the relevant art, are deemed to fall within the broad scope and ambit of the present invention described herein. It is further to
15 be understood that features from one or more of the described embodiments may be combined to form further embodiments.

CLAIMS

1. A metal deck, comprising:

an elongate member comprising a base extending to a first portion and a second portion;
the first portion comprises a male connector; the second portion comprises a female
5 connector;

the male connector is formed as a truncated rectangle with rounded edges, and
comprises a flat-fronted projection extending outwardly, the projection comprising:

a first male connector convex portion connected to a first male connector
concave portion and further extending upwardly into a first flange and

10 a second male connector convex portion connected to the base via a second male
connector concave portion;

the female connector comprises a corresponding indentation in relation to the male
connector and is adapted to receive the male connector, the indentation comprising:

15 a first female connector concave portion connected to a first female connector
convex portion and further extending upwardly into a second flange, and

a second female connector concave portion connected to the base via a second
female connector convex portion;

wherein in engagement, the first and second concave portions of the male connector engage
with the first and second convex portions of the female connector and the first and second
20 convex portions of the male connector engage with the first and second concave portions
of the female connector to releasably connect the metal deck to an adjacent metal deck and
to form positively interlocking metal decking, thereby enabling constant engagement of
the male and female connectors and retention of said engagement.

2. The metal deck according to claim 1, wherein the female connector comprises the
25 indentation that can take the form of a rectangle with rounded edges.

3. The metal deck according to any of the preceding claims, wherein the male connector
length is shorter than the female connector length.

4. The metal deck according to claim 1, wherein the first and second concave parts of the male and female connectors comprise curved radius of approximately 2.5 mm.
5. The metal deck according to claim 5, wherein the curve radius comprise margin error for the measurement of approximately ± 0.2 mm.
- 5 6. The metal deck according to any of the preceding claims, further comprises at least one trough-shaped portion extending longitudinally along the base of the metal deck.
7. The metal deck according to claim 1, wherein the first and second flanges extending upwardly from each of the male and female connectors, each flange further comprises a first portion that extends inwardly.
- 10 8. The metal deck according to claim 1, wherein the first and second flanges extending upwardly from each of the male and female connectors, each flange further comprises a second portion having a bent edge that points towards the base of the elongate member.
9. The metal deck according to any of the preceding claims, wherein the first and second
15 flanges extend generally perpendicular from the base.
10. The metal deck according to any of the preceding claims, wherein the height of the first and second portions lies between approximately 60 mm and 120 mm.
11. The metal deck according to any of the preceding claims, wherein the lengths of the first and second flanges lies between approximately 43 mm and 54 mm.
- 20 12. The metal deck according to any of the preceding claims, wherein the male connector length lies between approximately 19 mm and 70 mm.
13. The metal deck according to any of the preceding claims, wherein the female connector length lies between approximately 20 mm and 72 mm.
14. The metal deck according to any of the preceding claims, wherein the margin of error
25 of the measurements is approximately ± 5 mm, and preferably, approximately ± 1 to 2 mm.
15. The metal deck according to any of the preceding claims, wherein the metal deck comprises a galvanised coating of Zinc.

16. The metal deck according to claim 16, wherein the galvanised coating comprises fire resistance properties.
17. A metal decking system, comprising a plurality of metal decks according to any of the preceding claims, wherein the metal decks are arranged alongside each other, wherein
5 a male connector releasably connects to a female connector bearing a corresponding indentation in relation to the male connector and positively interlocking, thereby enabling constant engagement of the male and female connectors and retention of said engagement.
18. A composite structure comprising a concrete slab and metal decking as defined in any
10 of the preceding claims, wherein the metal decking is clad or embedded in said slab.



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(71) Applicant: **M METAL PTE. LTD.** [SG/SG]; 5 Kian Teck Drive, Singapore 628822 (SG).

(72) Inventor: **KONG, John Wai Meng**; 2 Hillview Crescent, Singapore 669427 (SG).

(74) Agent: **RHT I-ASSETS ADVISORY PTE. LTD.**; 6 Battery Road #10-01, Singapore 049909 (SG).

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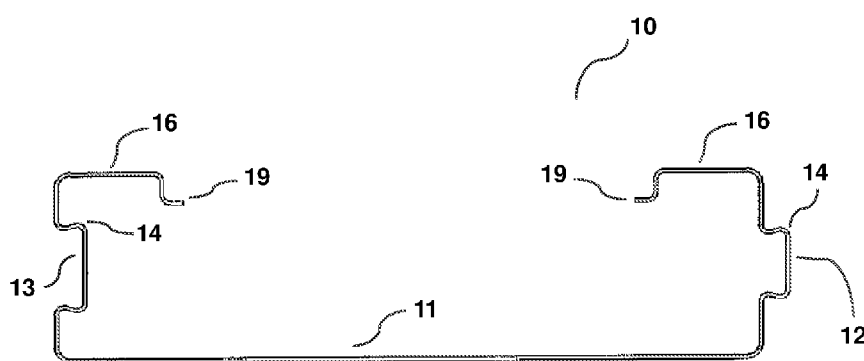


Figure 1

(57) Abstract: The present invention relates to galvanized steel deck and a system thereof for use in the construction industry of buildings such as steel frame buildings, concrete frame building and similar building types. The galvanized steel deck comprises an elongate member having a first portion shaped for receiving a female connector and a second portion shaped for receiving a male connector. The first portion comprises a male connector and the second portion comprises a female connector, in which the male and female connectors are releasably connectable to corresponding connectors on an adjacent steel deck thereby enabling a plurality of steel decks to be connected to one another.



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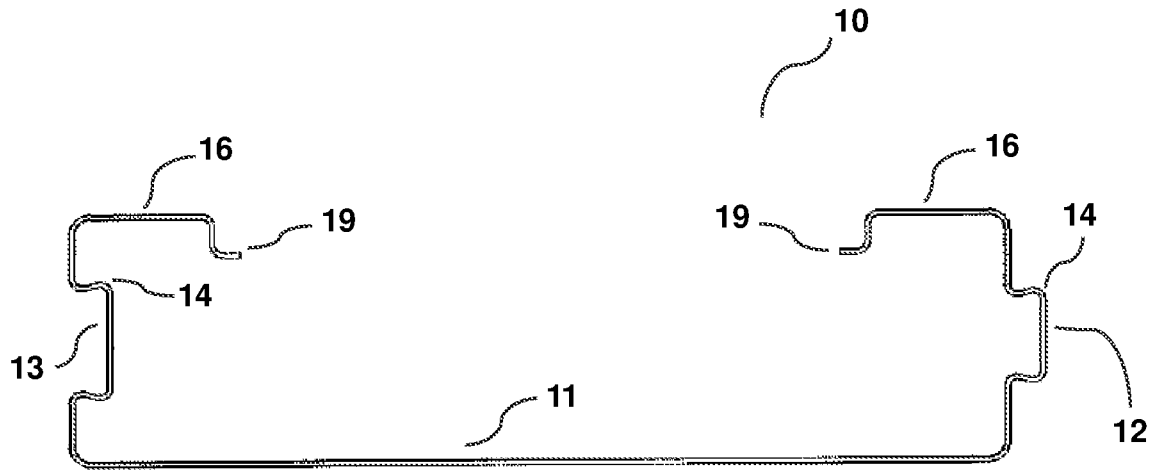


Figure 1

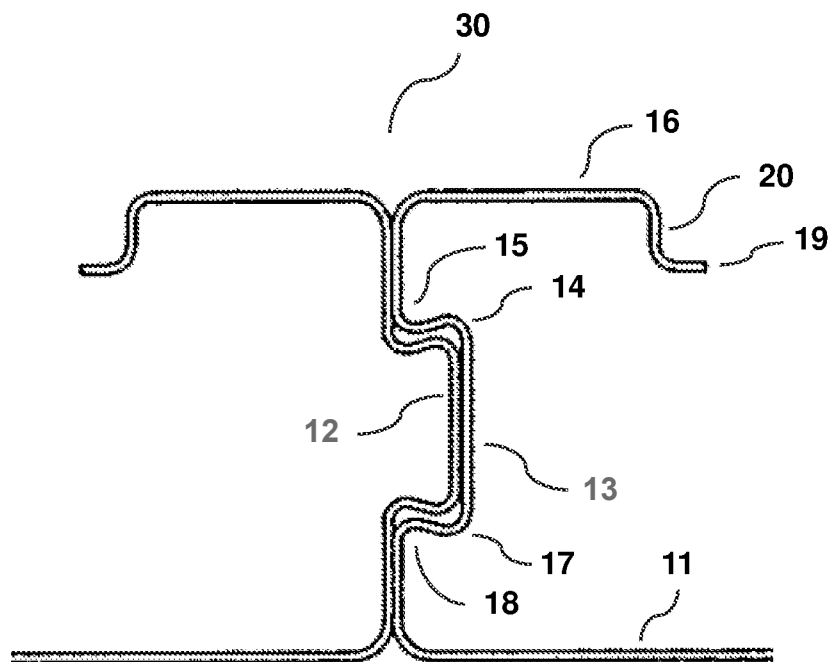


Figure 2

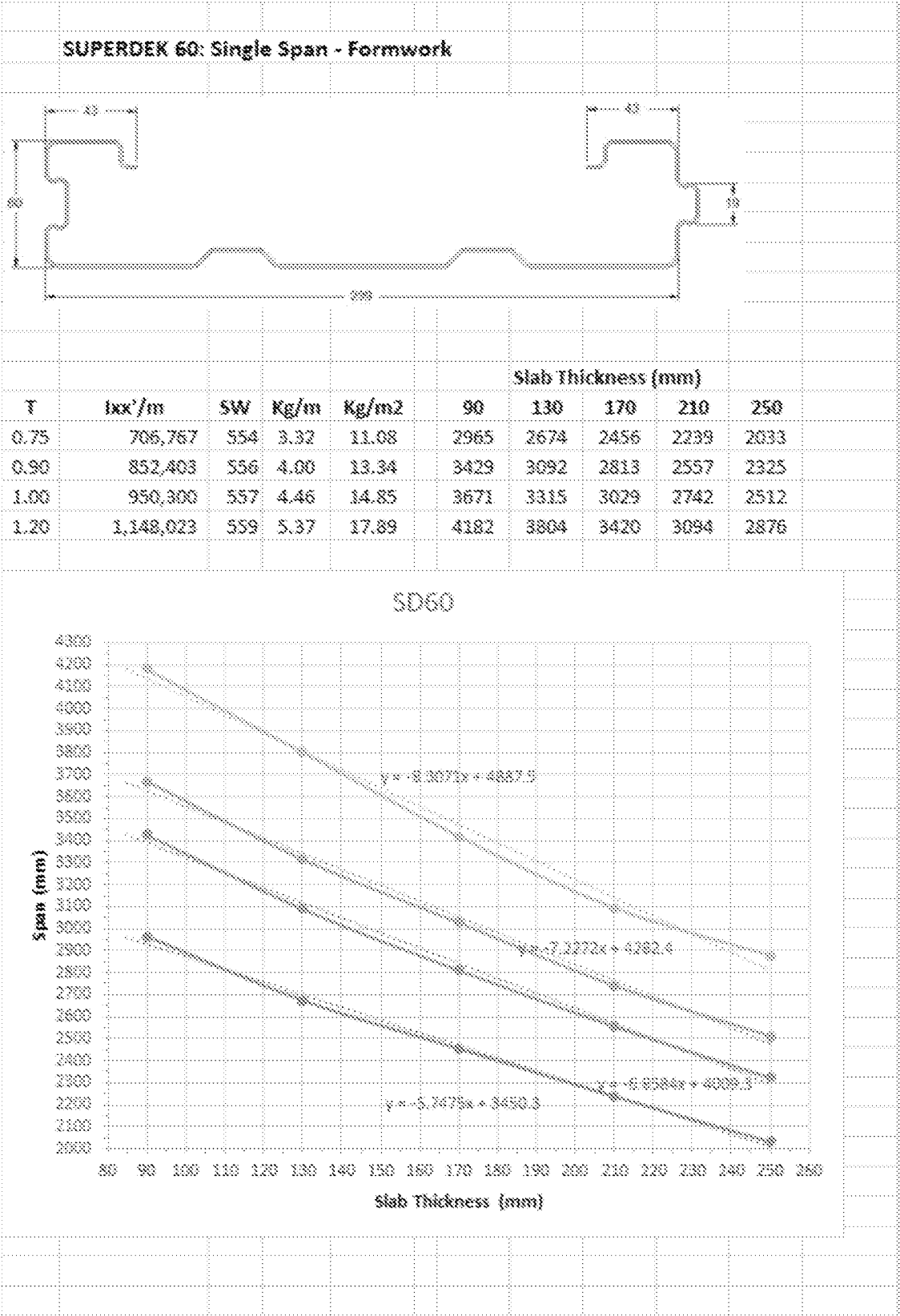


Figure 3

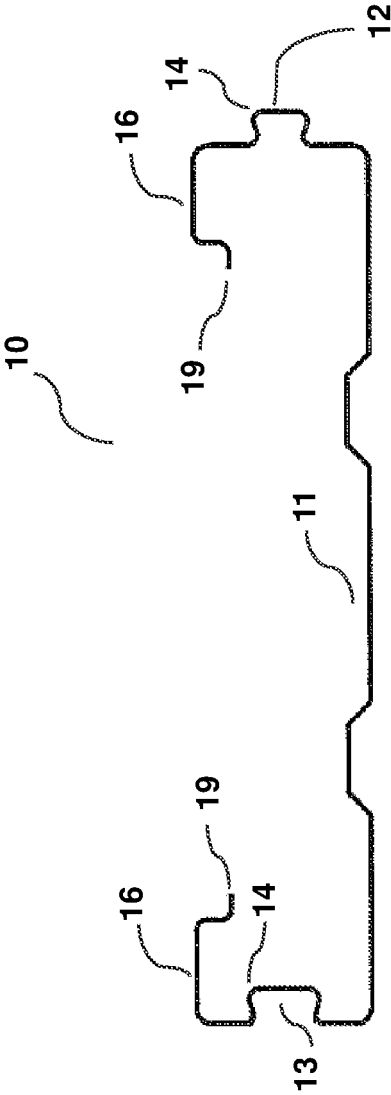


Figure 4A

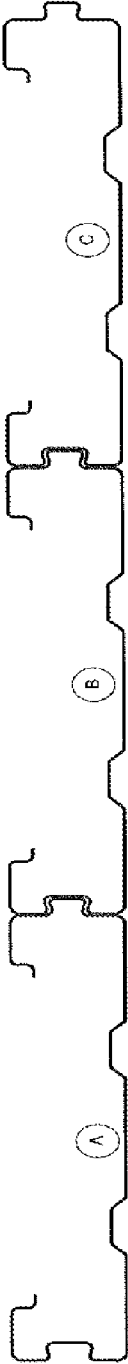


Figure 4B

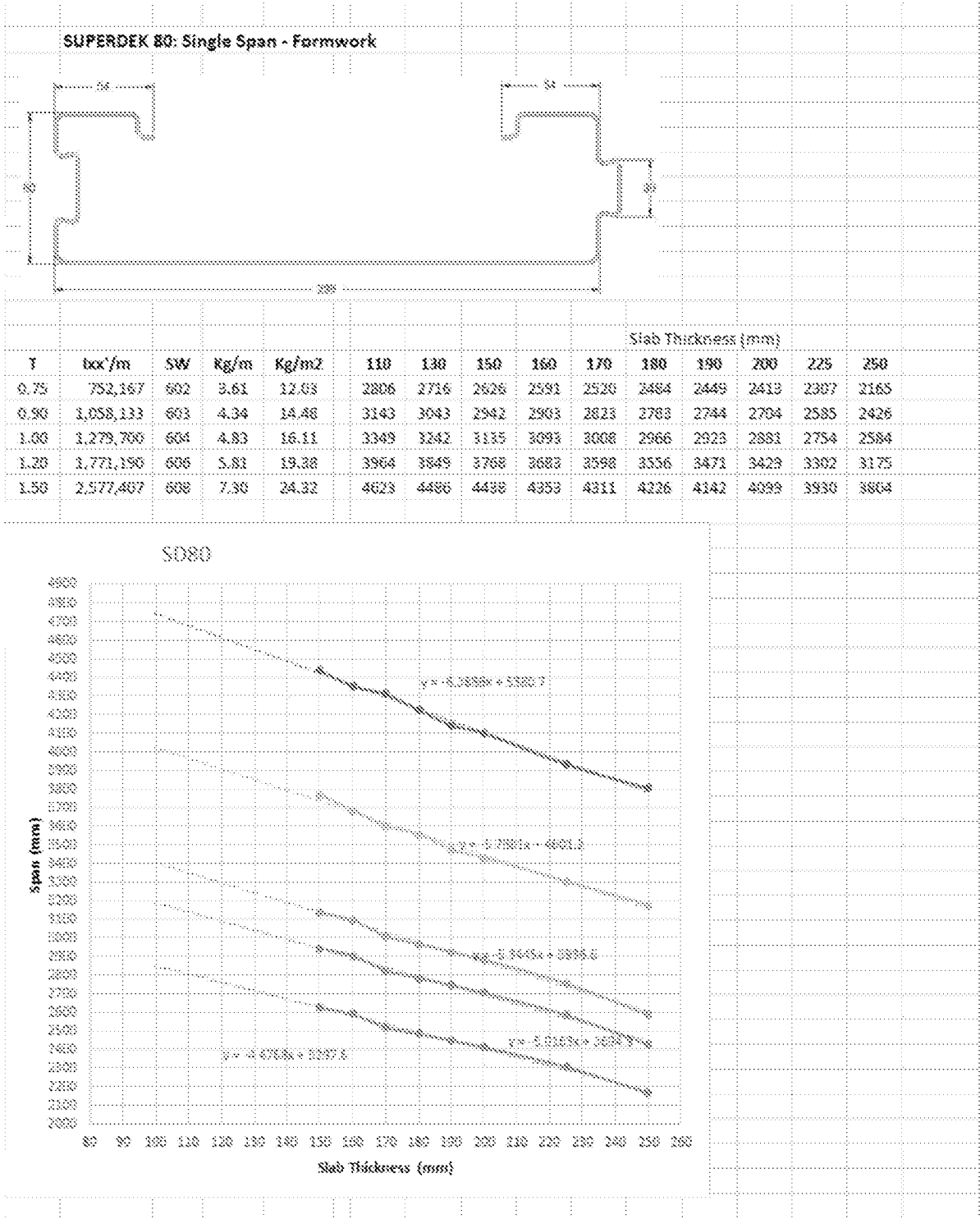


Figure 5

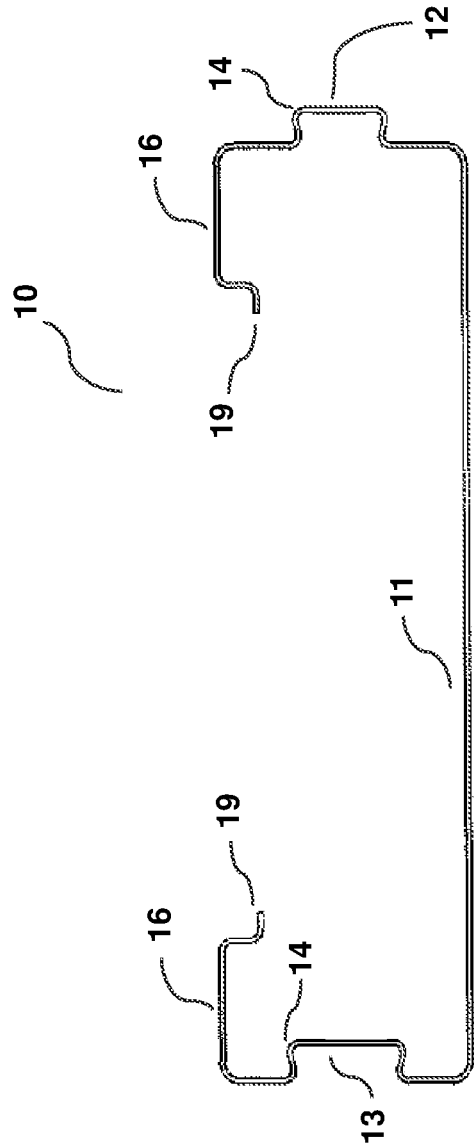


Figure 6A

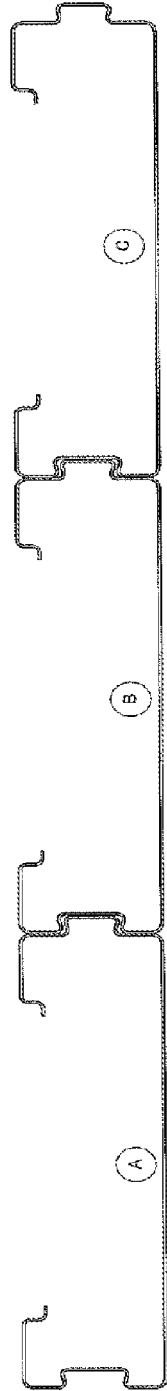


Figure 6B

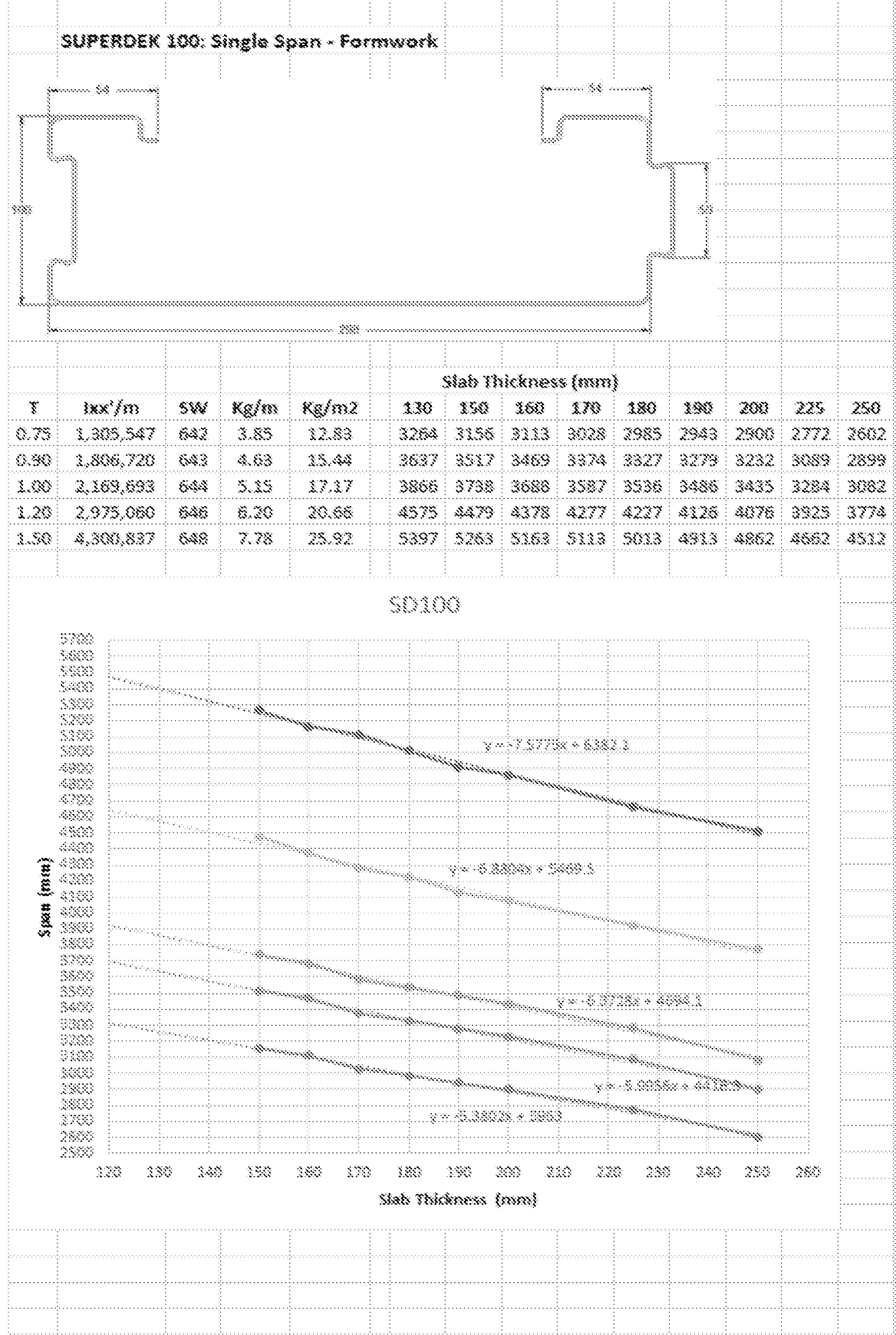


Figure 7

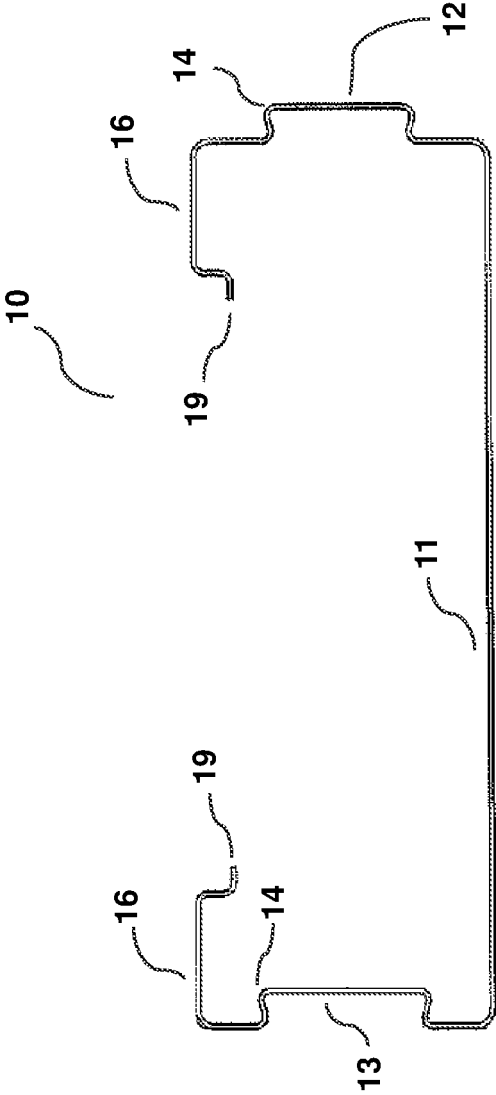


Figure 8A

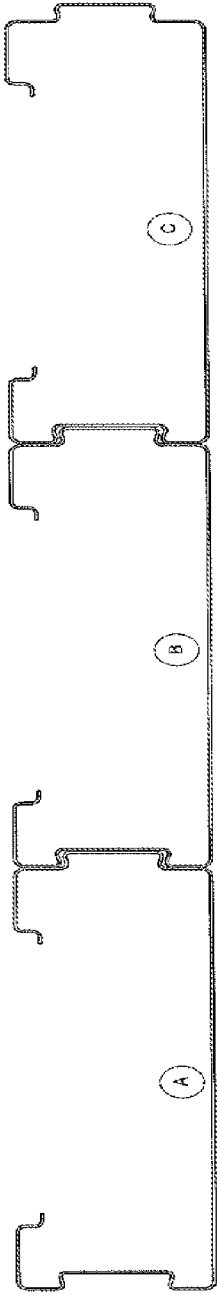


Figure 8B

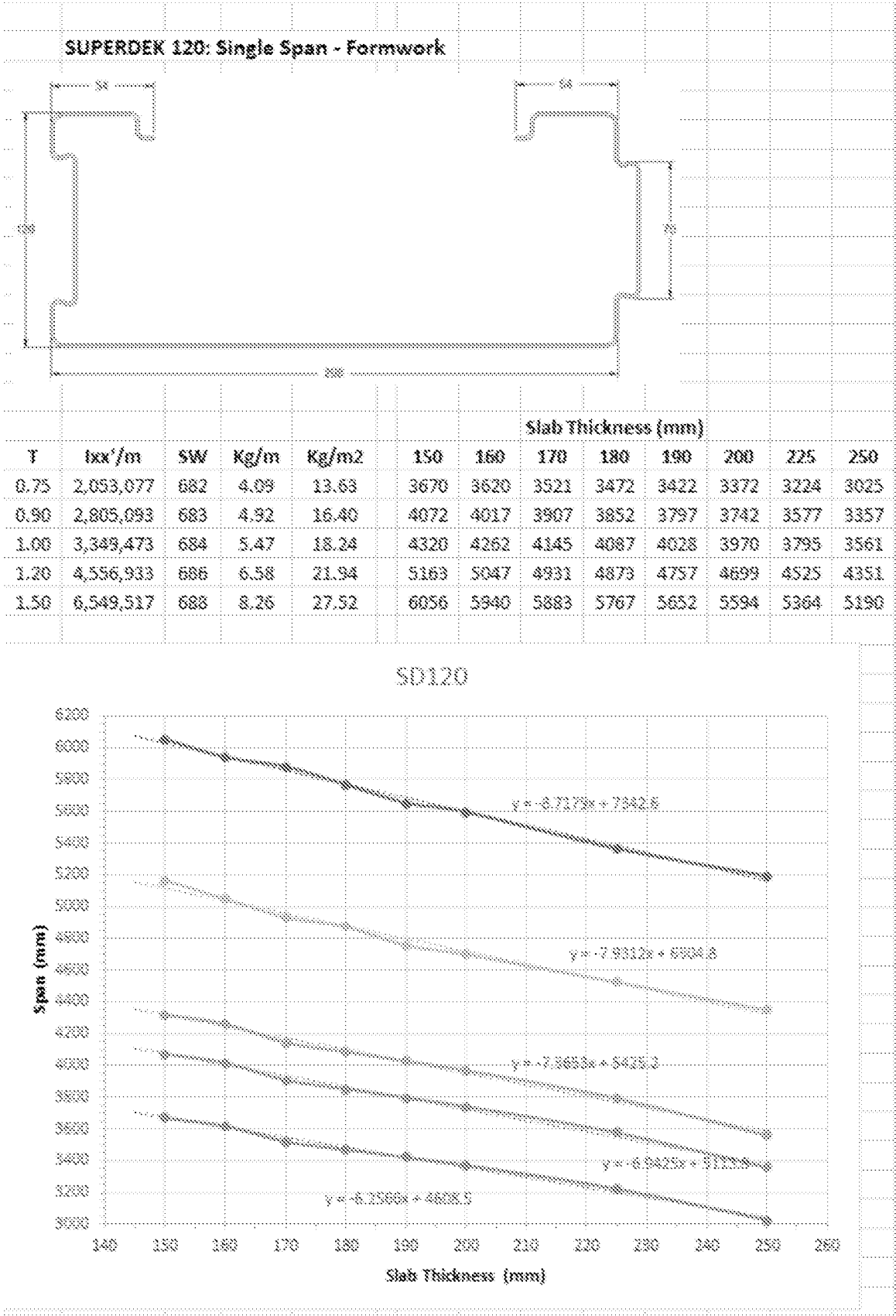


Figure 9

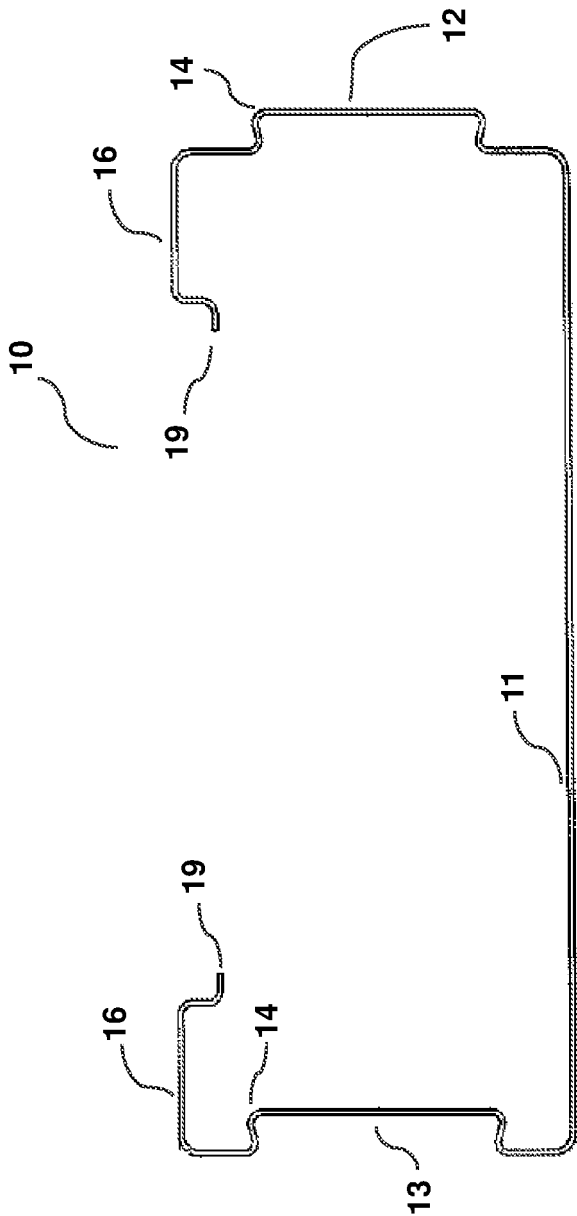


Figure 10A

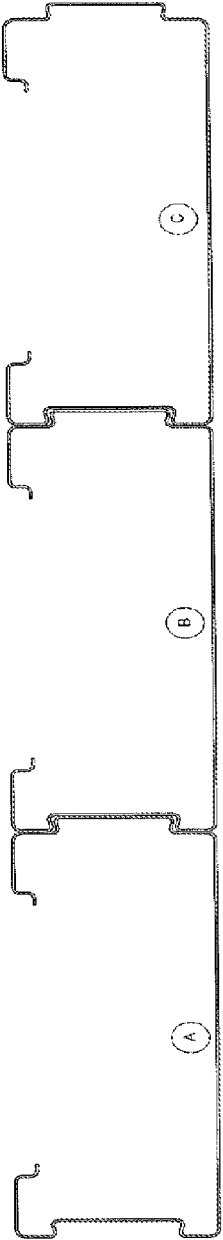


Figure 10B