

**PRODUCTION OF CLADDING SHEETS**

5       The present invention relates to building structures, such as roofs, from roll-formed steel cladding sheets.

10       In particular, the present invention relates to manufacturing roll-formed steel cladding sheets for building structures, such as roofs.

15       The current standard practice for building a roof from roll-formed steel cladding sheets, such as COLORBOND cladding sheets, includes the following steps:

20       (a) roll-forming steel strip unwound from a coil to form a roll-formed profile and thereafter successively square cutting the ends of the roll-formed strip to form a plurality of rectangular sheets of a standard size that are required to build the roof;

25       (b) marking up and thereafter cutting the ends of a number of the rectangular sheets into required shapes for building the roof; and

30       (c) constructing the roof by attaching the remaining standard-size sheets and the cut sheets to a roof frame.

35       In order to construct a typical roof it is necessary to cut approximately 40% of the initial number of standard-size rectangular cladding sheets that are required to build the roof. The cuts required range from straightforward cuts to produce one or more angled corners to more complex cuts to produce irregular shaped sheets.

      The practice of cutting rectangular cladding sheets results in considerable waste of material and

requires a considerable amount of time.

5 In addition, occasionally it is necessary to lift rectangular cladding sheets onto roofs to mark up the sheets and then lower the sheets to the ground and cut the sheets into the required shapes. This practice is time consuming and introduces a safety risk in terms of lifting the sheets onto roofs and then lowering the sheets from roofs.

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An object of the present invention is to provide a method of producing roll-formed steel cladding sheets for building a roof that is more efficient and cost effective and safer than the above-described current standard practice.

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Another object of the present invention is to provide an apparatus for producing roll-formed steel cladding sheets for building a roof in accordance with the method.

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According to the present invention there is provided a method of producing a plurality of roll-formed cladding sheets for building a structure, such as a roof, which includes the steps of:

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(a) inputting data relating to a design of the structure into a computer program that translates the design data into a series of cutting operations of a cutting assembly for cutting strip having a roll-formed profile into a plurality of separate cladding sheets that have the correct size and shape to be placed directly onto an underlying frame and assembled together to form the structure; and

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(b) cutting the roll-formed strip with the cutting assembly in accordance with the cutting operations

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and forming the plurality of separate cladding sheets.

According to the present invention there is also provided a method of marking a roll-formed strip to define  
5 at least part of the perimeters of a plurality of cladding sheets for building a structure, such as a roof, which includes the steps of:

(a) inputting data relating to a design of the  
10 structure into a computer program that translates the design data into a series of marking operations of a marking assembly for marking at least part of the perimeters of a plurality of cladding sheets onto a roll-formed strip that can be subsequently cut to form separate  
15 cladding sheets that have the correct size and shape to be placed directly onto an underlying frame and thereafter assembled together to form the structure; and

(b) marking the roll-formed strip in accordance  
20 with the marking operations of the marking assembly and defining at least part of the perimeters of the plurality of cladding sheets that can be subsequently cut to form separate cladding sheets that have the correct size and shape to be placed directly onto an underlying frame and  
25 thereafter assembled together to form the structure.

Preferably the method described in the preceding paragraph further includes cutting the roll-formed strip on the marked perimeters to form the plurality of separate  
30 cladding sheets.

Preferably the method includes cutting or marking the roll-formed strip while the strip is being processed on a roll-forming line.

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In this situation, preferably the method includes cutting or marking the roll-formed strip transversely to

the longitudinal direction of the strip and not cutting or marking the strip longitudinally. Consequently, in this situation, the cutting or marking operations control only the shape of the front and rear ends (including the  
5 corners) of the separate cladding sheets and do not change the maximum width of the separate cladding sheets.

Preferably the method includes cutting the roll-formed strip into separate cladding sheets using a cutting  
10 assembly that is supported in relation to the roll-forming line to move in response to the programmed cutting operations.

The cutting assembly may be any suitable cutting  
15 assembly, such as a shear cutter, a plasma cutter, and a laser cutter.

The cutting assembly may include two or more cutters positioned in relation to the roll-forming line  
20 and selectively operable depending on the type of cuts required.

Preferably the cutting assembly includes a cutting head that is able to move in the direction of  
25 travel of the roll-formed strip being processed on the roll-forming line and/or transversely to the direction of travel.

Preferably the cutting head is able to move  
30 normal to the general plane of the roll-formed strip being processed on the roll-forming line to maintain a constant gap between the strip and the cutting head.

Preferably the cutting head is able to rotate to  
35 maintain a constant gap between the roll-formed strip being processed on the roll-forming line and the cutting head.

Preferably the method includes marking the roll-formed strip to define at least part of the perimeters of the smaller separate cladding sheets using a marking assembly that is supported in relation to the roll-forming line to move in response to the programmed marking operations.

The marking assembly may be any suitable marking assembly.

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One such suitable marking assembly includes an array of downwardly directed paint/ink injectors, for example in the form of single shot valves, positioned above a section of the roll-forming line, with the paint/ink injectors being selectively operable in response to the programmed marking operations to discharge paint/ink onto the strip to mark at least part of the perimeters of the separate cladding sheets while the strip is being processed on the line.

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Preferably the method includes controlling the operation of the cutting assembly in response to the operation of the roll-forming line.

25 Preferably the method includes controlling the operation of the marking assembly in response to the operation of the roll-forming line.

30 Preferably the method includes marking or otherwise branding each cut or marked cladding sheet to identify the sheet so that it can be differentiated by the marked identification from the other cladding sheets that are required to build the structure.

35 By way of example, the cladding sheets may be marked with consecutive numbers.

Preferably the same identification marking system, such as consecutive numbers, is used to identify the cladding sheets and to mark the location of each cladding sheet onto a plan of the structure.

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Preferably the method further includes packing the separate cladding sheets in a predetermined order to facilitate subsequent assembling of the sheets to build the structure.

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Preferably the method includes packing the cut separate cladding sheets in a stack in reverse order so that the top cladding sheet in the stack is the first sheet in the stack that is required for building the structure and each underlying sheet is the next sheet in the stack that is required for building the structure.

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Preferably the roll-formed strip is a steel strip.

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The roll-formed cladding sheets may be any suitable profile. For example, the cladding sheets may be corrugated sheets having successive crests and the troughs when viewed in transverse section and one underlap side edge and one overlap side edge. The cladding sheets may also include one or more ribs separated by pans and one underlap side edge and one overlap side edge.

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There is a wide range of possible options for the computer program. The form of the computer program may take into account different factors or prioritise the factors differently depending on whether the overall objective of the program is to:

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(a) minimise material waste (and therefore optimise the cutting/marking operations to minimise material waste);

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(b) maximise production rate (and therefore optimise the time required for the cutting and/or marking operations on the roll-formed strip);

5                   (c) provide the best layout of cladding sheets for the structure (and therefore optimise the cutting/marking operations to optimise the layout of the cladding sheets for the structure); or

10                   (d) a hybrid of two or more of the above options.

The factors include, by way of example:

15                   (a) the possible combinations of shapes of cladding sheets that can build a structure of a particular design;

20                   (b) the possible arrangements of the cladding sheet shapes along the length of a roll-formed strip being processed on a roll-former line, and more particularly the interrelationship of different shapes of cladding sheets along the length of the strip being processed on the line;

25                   (c) the roll-form profile and the dimensions of the roll-formed strip being processed on the roll-former line;

30                   (d) the interrelationship of (a), (b), and (c), and the actual design of the structure and the impact of the direction of the prevailing weather on the selection process;

                    (e) the operating capacity of the roll-forming line;

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                    (f) the operating capacity of the cutting/marking assemblies, and more particularly the capacity of the

assemblies to cut/mark different shapes of cladding sheets and

(g) transportation and materials handling factors  
5 (such as maximum length/width that can be packed and transported).

With regard to factor (d) above, it is relevant to note that in any given situation the best possible  
10 layout of cladding sheets for a particular structure is influenced by (a) the roll-form profile and the dimensions of the roll-formed strip being processed on the roll-former line, (b) how the design of the cladding sheet "fits" in relation to the features of the structure  
15 design, and (c) the prevailing weather direction in relation to the structure and the effect of weather on the cladding sheet.

By way of example, in the case of a structure in  
20 the form of a hip roof, there are a number of different arrangements of standard size cladding sheets and cut cladding sheets that can be assembled together to form the hip. One possible consideration for selecting one of the arrangements is the wastage associated with cutting or  
25 marking and then cutting the cladding sheets on a roll-former line. Another possible consideration is the direction of the prevailing weather - and more particularly selecting the arrangements in which the cladding sheets are positioned so that the overlap side  
30 edges face away from the prevailing weather direction.

Preferably the computer program is capable of generating quotations to supply cladding sheets to build a structure.

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According to the present invention there is also provided an apparatus for producing a plurality of

cladding sheets for building a structure, which apparatus includes:

5 (a) a roll-forming line for roll-forming a flat strip, for example wrapped in a coil, into a roll-formed profile;

10 (b) a cutting assembly for cutting the roll-formed strip into a plurality of separate cladding sheets; and

15 (c) a control means for controlling the operation of the cutting assembly in response to a computer program and cutting the roll-formed strip into a plurality of separate cladding sheets, the computer program providing a series of cutting operations of the cutting assembly that is derived from data relating to the design of the structure for producing separate cladding that have a correct size and shape to be placed directly  
20 onto an underlying frame and thereafter assembled together to form the structure.

The cladding sheets may be any suitable profile. For example, the cladding sheets may be corrugated sheets  
25 having successive crests and the troughs when viewed in transverse section and one underlap side edge and one overlap side edge. The cladding sheets may also include one or more ribs separated by pans and one underlap side edge and one overlap side edge.

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Preferably the roll-forming line includes an uncoiler for a coil of strip and a series of roll-forming stands for successively roll-forming strip unwound from the uncoiler into a roll-formed profile.

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As indicated above, the cutting assembly may be any suitable cutting assembly, such as a shear cutter, a

plasma cutter, and a laser cutter.

5 The cutting assembly may include two or more cutters positioned in relation to the roll-forming line and selectively operable depending on the type of cuts required.

10 Preferably the cutting assembly includes a cutting head that is able to move in the direction of travel of the roll-formed strip being processed on the roll-forming line and/or transversely to the direction of travel.

15 Preferably the cutting head is able to move normal to the general plane of the roll-formed strip being processed on the roll-forming line to maintain a constant gap between the strip and the cutting head.

20 Preferably the cutting head is able to rotate to maintain a constant gap between the roll-formed strip being processed on the roll-forming line and the cutting head.

25 According to the present invention there is also provided an apparatus for marking a roll-formed cladding sheet to define the perimeters of a plurality of smaller cladding sheets for building a structure, which apparatus includes:

30 (a) a roll-forming line for roll-forming a flat strip, for example wrapped in a coil, into a roll-formed profile;

35 (b) a marking assembly for marking the roll-formed strip to define at least part of the perimeters of a plurality of separate cladding sheets that can be subsequently cut from the roll-formed strip that have the

correct size and shape to be placed directly onto an underlying frame and thereafter assembled together to form the structure; and

5                   (c) a control means for controlling the operation of the marking assembly in response to a computer program that provides a series of marking operations of the marking assembly that is derived from data relating to the design of the structure for  
10                   facilitating production of separate cladding sheets that have a correct size and shape to be placed directly onto an underlying frame and thereafter assembled together to form the structure.

15                   The roll-formed cladding sheets may be any suitable profile. For example, the cladding sheets may be corrugated sheets having successive crests and the troughs when viewed in transverse section and one underlap side edge and one overlap side edge. The cladding sheets may  
20                   also include one or more ribs separated by pans and one underlap side edge and one overlap side edge.

                  The applicant has found in trials carried out with an embodiment of the method of the present invention  
25                   that it is possible to reduce the labor time required to build roofs by between 20% and 50% and substantially reduce material waste.

                  The present invention is described further by way  
30                   of example with reference to the accompanying drawing which is a diagram that illustrates one embodiment of an apparatus for producing a plurality of cladding sheets in accordance with the invention.

35                   The apparatus shown in the Figure comprises a standard roll-forming line that has been modified to include marking and/or cutting assemblies for marking

and/or cutting a roll-formed cladding sheet.

With reference to the Figure, flat steel strip is unwound from a coil 5 and passed successively through a series of roll-formers 7 that progressively roll a required profile in the strip. By way of example, the profile may comprise a series of lengthwise extending flat pans separated by upstanding ribs with side edge formations to allow adjacent subsequently formed cladding sheets to be positioned in side by side overlapping relationship. The roll-formed strip emerging from the last of the roll-formers is moved past a position sensor 17 for sensing the position of the strip, a marking assembly 9, a first cutting assembly 11, and a second cutting assembly 13 in the form of an exit shear. These assemblies 9, 11, 13 are selectively operable to mark and/or cut the roll-formed strip to produce cladding sheets having required shapes. The cladding sheets emerging from the end shear 13 are passed to a sheet handling station 15 and are stacked or otherwise handled as required.

The marking assembly 9 is operable to mark the roll-formed strip to define the ends of non-squared cladding sheets. The marked roll-formed strip is subsequently square cut, typically by the end shear 13, outboard of the marked ends of the strip. The marked ends of the cladding sheets can be subsequently cut, for example at a building site, to form cladding sheets with the required shape.

The marking assembly 9 is also operable to brand the roll-formed strip to uniquely identify each subsequently cut cladding sheet.

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The above-described apparatus is controlled by software that:

(a) translates design data for a structure, such as a roof of a house, into a series of marking and/or cutting operations of the marking and/or cutting assemblies 9, 11, 13 for marking and/or cutting roll-formed strip to form the cladding sheets; and

(b) drives the roll-forming line;

(c) drives the marking and/or cutting assemblies 9, 11, 13 and marks and/or cuts the roll-formed strip to form cladding sheets having the required shapes.

The operation of the marking and/or cutting assemblies 9, 11, 13 is responsive to the requirements of the programmed series of marking and/or cutting operations and the actual operation of the roll forming line at any given point in time, as monitored by the sensor 17.

Depending on the type of end profile required for a cladding sheet, one or both of the cutting assemblies 11, 13 may be operated. For example, in a number of situations it may only be necessary to square cut the ends of the roll-formed strip. In these situations operation of the exit shear 13 may only be required. In other situations it may be necessary to form angled straight cuts on the ends of the roll-formed strip. In these situations operation of the cutting assembly 11 may be appropriate. In particular, the cutting assembly 11 may be a shear cutter that is operable to move along the length of the roll-former line with the roll-formed strip and form the angled cut during the course of such movement. In other situations it may be necessary to form more complex cuts on the ends of the roll-formed strip. In such situations, operation of both cutting assemblies 11, 13 may be appropriate to complete the cuts.

Many modifications may be made to the preferred embodiment of the present invention described above without departing from the spirit and scope of the present invention.

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By way of example, the embodiment of the apparatus shown in the Figure may further comprise a means for dispensing tap or other suitable material along the underside of cut ends of cladding sheets so that any burrs or other projections that are formed in the cutting operation do no damage underlying stacked cladding sheets.

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**CLAIMS:**

1. A method of producing a plurality of roll-formed cladding sheets for building a structure, such as a roof,  
5 which includes the steps of:

(a) inputting data relating to a design of the structure into a computer program that translates the design data into a series of cutting operations of a  
10 cutting assembly for cutting strip having a roll-formed profile into a plurality of separate cladding sheets that have the correct size and shape to be placed directly onto an underlying frame and assembled together to form the structure; and

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(b) cutting the roll-formed strip with the cutting assembly in accordance with the cutting operations and forming the plurality of separate cladding sheets.

20 2. A method of marking a roll-formed cladding sheet to define at least part of the perimeters of a plurality of cladding sheets for building a structure, such as a roof, which includes the steps of:

25 (a) inputting data relating to a design of the structure into a computer program that translates the design data into a series of marking operations of a marking assembly for marking at least part of the perimeters of a plurality of cladding sheets onto a strip  
30 having a roll-formed profile that can be subsequently cut to form separate cladding sheets that have the correct size and shape to be placed directly onto an underlying frame and thereafter assembled together to form the structure; and

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(b) marking the roll-formed strip in accordance with the marking operations of the marking assembly and

defining at least part of the perimeters of the plurality of cladding sheets that can be subsequently cut to form separate cladding sheets that have the correct size and shape to be placed directly onto an underlying frame and  
5 thereafter assembled together to form the structure.

3. The method defined in claim 2 further includes cutting the roll-formed strip on the marked perimeters to form the plurality of separate cladding sheets.

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4. The method defined in any one of the preceding claims includes cutting or marking the roll-formed strip while the strip is being processed on a roll-forming line.

15 5. The method defined in claim 4 includes cutting or marking the roll-formed strip transversely to the longitudinal direction of the strip and not cutting or marking the cladding sheet longitudinally.

20 6. The method defined in any one of the preceding claims includes cutting the roll-formed strip into separate cladding sheets using a cutting assembly that is supported in relation to the roll-forming line to move in response to the programmed cutting operations.

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7. The method defined in claim 2 and any one of the preceding claims when dependent directly or indirectly on claim 2 includes marking the roll-formed strip to define the perimeters of the separate cladding sheets using a  
30 marking assembly that is supported in relation to the roll-forming line to move in response to the programmed marking operations.

8. The method defined in any one of the preceding  
35 claims includes controlling the operation of the cutting assembly in response to the operation of the roll-forming line.

9. The method defined in claim 2 and any one of the preceding claims when dependent directly or indirectly on claim 2 includes controlling the operation of the marking assembly in response to the operation of the roll-forming line.

10. The method defined in claim 2 and any one of the preceding claims when dependent directly or indirectly on claim 2 includes marking each cut or marked cladding sheet to identify the sheet so that it can be differentiated by the marked identification from the other cladding sheets that are required to build the structure.

11. The method defined in any one of the preceding claims includes packing the smaller separate cladding sheets in a predetermined order to facilitate subsequent assembling of the sheets to build the structure.

12. The method defined in any one of the preceding claims includes packing the cut smaller separate cladding sheets in a stack in reverse order so that the top cladding sheet in the stack is the first sheet in the stack that is required for building the structure and each underlying sheet is the next sheet in the stack that is required for building the structure.

13. An apparatus for producing a plurality of cladding sheets for building a structure, which apparatus includes:

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(a) a roll-forming line for roll-forming a flat strip, for example wrapped in a coil, into a roll-formed profile;

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(b) a cutting assembly for cutting the roll-formed strip into a plurality of separate cladding sheets;

(c) a control means for controlling the operation of the cutting assembly in response to a computer program and cutting the roll-formed strip into a plurality of separate cladding sheets, the computer  
5 program providing a series of cutting operations of the cutting assembly that is derived from data relating to the design of the structure for producing separate cladding that have a correct size and shape to be placed directly onto an underlying frame and thereafter assembled together  
10 to form the structure.

14. The apparatus defined in claim 13 wherein the cutting assembly includes a cutting head that is able to move in the direction of travel of the roll-formed strip  
15 being processed on the roll-forming line and/or transversely to the direction of travel.

15. The apparatus defined in claim 14 wherein the cutting head is able to move normal to the general plane  
20 of the roll-formed strip being processed on the roll-forming line to maintain a constant gap between the strip and the cutting head.

16. The apparatus defined in claim 14 or claim 15  
25 wherein the cutting head is able to rotate to maintain a constant gap between the roll-formed strip being processed on the roll-forming line and the cutting head.

17. An apparatus for marking a roll-formed strip to  
30 define at least part of the perimeters of a plurality of smaller cladding sheets for building a structure, which apparatus includes:

(a) a roll-forming line for roll-forming a flat  
35 strip, for example wrapped in a coil, into a roll-formed profile;

(b) a marking assembly for marking the roll-formed strip to define at least part of the perimeters of a plurality of cladding sheets that can be subsequently cut from the roll-formed strip that have the correct size and shape to be placed directly onto an underlying frame and thereafter assembled together to form the structure; and

(c) a control means for controlling the operation of the marking assembly in response to a computer program that provides a series of marking operations of the marking assembly that is derived from data relating to the design of the structure for facilitating production of separate cladding sheets from the roll-formed strip that have the correct size and shape to be placed directly onto an underlying frame and thereafter assembled together to form the structure.