

"Metal Strip for use in stabilised
earth structures"

This invention relates to a metal strip for use in stabilised earth structures, for example of the type disclosed in GB-A-1069361.-

A preferred type of strip for use in such structures
5 is a rolled steel strip, and particularly a strip provided with transverse ribs as disclosed in GB-A-1563317. In use, the ends of the strips are attached to facing units such as those disclosed in GB-A-1324686. These facing units are interlocked to provide a generally
10 vertical surface. The connection between a strip and a facing unit is usually formed by a fastening element such as a bolt which passes through an aperture in the strip.

In order to ensure that the aperture does not
15 unduly reduce the tensile strength of the strip, it has been proposed in GB-A-1563317 to reinforce the end of a strip by means of welding one or more plates to the end of the strip and to form the aperture in the reinforced region. This presents a number
20 of problems in practice, however. The general use of high tensile strength carbon steel means that welding can be difficult and the high heat required can produce crystallization having a corrosive effect. This can result in hairline cracks not visible to
25 the naked eye. Furthermore, it is common to galvanize the steel strips but this can be difficult with welded reinforcement plates. Prior to galvanizing, the strip passes through an acid bath and it is difficult to remove all of the acid from between the welded
30 plate and the strip. The presence of residual acid is undesirable and may damage the galvanization, leading to corrosion problems.

It has also been proposed in GB-A-1563317 to hot forge the end of the strip to a required configuration. However, this is a relatively expensive process and the forging may change the property of high strength steels in particular, leading to e.g. brittleness.

To deal with these problems, the invention provides a rolled metal strip for use in stabilised earth structures, which has at periodic intervals along its length thickened reinforcement regions formed during the rolling operation and each being between 40 mm and 100 mm in length, the strip being cut to a desired length with one of said reinforcement regions being located at or near an end of the strip, an aperture being formed through the end reinforcement region and being suitable to receive fastening means to locate the strip in a stabilised earth structure.

Thus, the strip will have reinforcement regions provided along its entire length, spaced apart by no more than the distance corresponding to one full revolution of the forming rolls. Typically, the maximum spacing would be about 1400 mm for a roll of this nominal circumference but preferably two or more reinforcement regions are provided for each revolution, thus giving spacings of e.g. 700 mm or 350 mm. Another possibility is to provide a roll of 1000 mm circumference with spacings of 500 mm between pads. Greater spacing results in lesser increase of weight per metre of the strip, and thus less use of material, but increases wastage when the strip is cut to length for use.

The result of providing a reinforcement region at or near the end of the strip length with an aperture formed therethrough is that there need be no separate forming steps after rolling.

It will be appreciated that to avoid cutting wastage in the event that reinforcement regions are required at both ends of the strip, each reinforcement

region might have a longitudinal extent at least twice that required for use at one end of a strip length. In this way, a single cut through the middle of a region would ensure that each severed strip
5 length will terminate in a suitable reinforcement region. However, since the number of reinforcement regions intermediate the ends of a strip length will not be used, it may be preferable to reduce the amount of material and have reinforcement regions
10 of a size suitable for use at one end only. Thus, the cut would not be through the centre of the region, but would instead be made at or near one longitudinal end of the region, e.g. through the reinforcement region, or through its junction with the unthickened
15 strip, or through the unthickened strip at a short longitudinal spacing from the reinforcement region.

The length of each reinforcement region of about 40 mm to 100 mm can be compared with preferred strip cross-sectional dimensions of about 60 x 5
20 mm, 50 x 5 mm or 40 x 4 mm. Thus, the length of the reinforcement region is many times the thickness of the strip, for example of the order of 8 to 25 times the thickness of the strip. This can be contrasted with the dimensions of preferred transverse ribs
25 as disclosed in GB-A-1563317 whose dimension in the longitudinal direction of the strip is of the same order as the thickness of the strip.

It is, in fact, preferable that the strip with reinforcement regions incorporate the transverse
30 ribs also. For the 50 x 5 mm strip mentioned above, there may be ribs of, say, 3mm high and 5mm in the longitudinal direction of the strip. These may be provided at 50 mm intervals on both faces of the strip, with the ribs on one side offset by 25mm
35 with respect to those on the other. The ribs need not be provided continuously, and for ease of production will preferably not be formed in the reinforcement regions. Apart from that, the ribs could be provided

in groups of say four - two on each face of the strip - spaced apart by a larger distance of 100mm or more.

The thickness of the reinforcement region will depend on the stress to be experienced in use, but for typical applications the thickness could be about 8mm for the 5mm thick strip. In general, the increase in thickness will be of the same order as that of the thickness of the strip. e.g. a 1.5 to 3.5 mm increase for a 4 or 5mm thick strip.

- Where ribs are used, the reinforcement regions will generally give a similar increase in strip thickness to that provided by the ribs. The region preferably increases in thickness from the adjacent unthickened strip gradually at each end, preferably rising to maximum thickness over about 1/4 to 1/13 of its overall length, to assist in rolling. In some instances, it may be preferably to increase the thickness of the strip in two sections. For example, the use of two generally straight sections of different gradient might minimise the effect of a sudden discontinuity during rolling.

- The reinforcement region should also preferably be symmetrical about the laterally extending central plane of the strip. Otherwise, in the transition from one thickness to another the strip centre plane may shift for a short time in the rolling operation, leading to unwanted vibrations. However, absolute symmetry is not essential, so that although the increase in thickness might take place on both faces of the strip with the longitudinal profiles of the two faces being substantially the same as each other, these profiles might be longitudinally offset.

- Preferably, the reinforcement regions will extend over the entire width of the strip, as any transverse ribs would also do. However, rolling of a thickened region results in a reduction of width. For the 50 x 5mm strip with 8mm thick reinforcement regions, the maximum reduction in strip width may be about 4 to 5 mm. This is acceptable.

The size of aperture which can be provided in the desired reinforcement regions will depend on many factors, but the diameter is likely to be substantially greater than the thickness of either the basic strip or the reinforcement region. Thus although the diameter of the aperture will vary it will generally be at least 10 mm. For the 5mm strip with an 8mm thick reinforcement region, an aperture of nominal 12.7mm diameter may be used.

The strip may be of any suitable metal, bearing in mind the condition of forming and of use. ASTM A36 mild steel may be used, or higher strength steel such as ASTM A572, grades 40, 50, 60 or 65. Typical basic cross sections may be 40 x 5mm, 60 x 5mm, 50 x 6mm and 50 x 8mm for the ASTM A36 mild steel. With the higher strength steel, cross sections of 50 x 4 mm or 50 x 5mm are possible and it is in the context of these that the reinforcement of the ends may be of particular importance.

The strip can be rolled using conventional apparatus but with the final rollers being suitably profiled to give the reinforcement regions. The existence of the reinforcement regions of increased thickness may have a tendency, in some cases, to cause bunching during the rolling process but since the duration of forming the reinforcement regions is relatively very short in most cases, there will generally be no insurmountable problems. It may be desirable to monitor and if necessary vary the roller drive velocity at appropriate points for example by terminating or varying the current supply in the case of electrically driven rollers. The cutting and handling of the strips subsequently may be by any convenient means. The lengths of strip cut could be e.g. from 3.5m to 11.5m or more.

It will be seen that the process for forming strip lengths with reinforcement regions at either end, has a number of advantages over the known processes

using e.g. welding. Furthermore, the strips themselves may have improved properties leading to more reliability in the stabilised earth structures themselves.

5 The invention also provides a stabilised earth structure including facing units to which are attached rolled metal strips as discussed herein, each strip being attached by fastening means received by the aperture formed through the strip.

10 An embodiment of some of the broad aspects discussed above will now be described by way of example only and with reference to the accompanying drawings, in which:-

15 Fig. 1 is a side view of a length of strip joined to a facing element;

Fig. 2 is a plan view of the strip;

Fig. 3 is an enlarged side view of the strip;

Fig. 4 is a diagrammatic view of the rolling process; and;

20 Fig. 5 is an enlarged view of the last part of the rolling process.

Referring now to Figures 1 and 2 a strip 1 of high strength steel A572 (ASTM) is joined to a facing 2 of a stabilised earth structure by means of a bolt 3 passing through a bracket 4 secured to the facing 2 and through an aperture 5 formed in a thickened end portion 6 of the strip 1. The thickened end portion 6 is provided by the major part of one of a number of reinforcement regions 7 spaced regularly along the strip at about 700mm intervals. The strip has a nominal thickness of 5mm and a nominal width of 50mm.

35 Each reinforcement region 7 has a maximum thickness of 8mm for a central portion 50mm long, and tapers at either end to the 5mm thickness over a length of 10mm. In an alternative embodiment the length of taper could be as little as 5 mm,

while the central portion could be 55 mm long.
Greater lengths of taper e.g. 25 mm are also possible.
In the illustrated embodiment the tapering occurs
in a single generally straight section, but it could
5 also occur as two sections of differing gradient.
The reinforcement region 7 has a reduced width,
the reduction being about 5 mm maximum in the central
portion. End portion 6 is formed by one tapered
part and the central portion of a reinforcement
10 region 7.

The strip is also provided with transverse
ribs 8 of known type, each extending a few millimetres
high and a few millimetres in the direction of the
length of the strip. The ribs 8 between the adjacent
15 reinforcement regions 7 are arranged in groups spaced
apart by about 175mm. The ribs in the groups alternate
on the two faces of the strip, the spacing between
two adjacent ribs being about 25mm. There are a number
of groups of four ribs and, in this arrangement, one
20 group of three ribs between two adjacent reinforced regions.

Each reinforcement region 7, and thus end
portion 6, is symmetrical having identical and aligned
profiles on both faces of the strip. However, in
an alternative arrangement the profiles on the two
25 faces could be longitudinally offset relative to
each other. For example there might be an offset
of about 3 mm in a case where the length of taper
is 5 mm.

With reference to Figures 4 and 5, the strip
30 is formed in a generally conventional manner. A
hot billet 9 from a continuous casting process passes
through sixteen sets of rollers 10, to produce a
strip of reduced thickness. It is then passed through
final profiling rollers 11 which produce the final
35 strip 1. The circumferences of the rollers are
provided with grooves 12 to produce the ribs 8 at
the required intervals. However, two larger profiled
regions 13 are also provided to produce the thicker

reinforcement region 7. The circumference of the rollers is about 1346 mm but the strip is extruded by about 4% during rolling, so that this corresponds to about 1400mm in the finished strip. Thus, the
5 reinforcement regions are provided at the required intervals of 700mm since two are formed for every rotation of the rollers.

The rolled strip is then cut into suitable lengths with a reinforcement region at one end at
10 least constituting a thickened end portion 6 through which an aperture 5 is punched. The reinforcement regions 7 intermediate the ends are not punched. The strips can be galvanized by known means to improve corrosion resistance.

15 There may be a number of possible variations to the broad aspects and specific details disclosed herein and it is intended that these be included within the scope of this specification. Furthermore, this specification is relevant to the strips, the
20 processes for forming them, and stabilised earth structures incorporating them.

Claims

1. A rolled metal strip for use in stabilised earth structures, which has at periodic intervals along its length thickened reinforcement regions formed during the rolling operation and each being between 40 mm and 100 mm in length, the strip being cut to a desired length with one of said reinforcement regions being located at or near an end of the strip, an aperture being formed through the end reinforcement region and being suitable to receive fastening means to locate the strip in a stabilised earth structure.
2. A strip as claimed in claim 1, wherein the cut is made at or near one longitudinal end of the reinforcement region.
3. A strip as claimed in claim 1 or 2, wherein the reinforcement regions increase in thickness from the adjacent unthickened strip gradually at each end of the said regions.
4. A strip as claimed in claim 3, wherein the increase in thickness takes place in two generally straight sections of different gradient.
5. A strip as claimed in any preceding claim, wherein the reinforcement regions are symmetrical about the laterally extending central plane of the strip.
6. A strip as claimed in any of claims 1 to 4, wherein the increase in thickness takes place on both faces of the strip, the longitudinal profiles of the two faces being substantially the same as each other but longitudinally offset.



7. A strip as claimed in any preceding claim, including transverse ribs provided at intervals on both faces of the strip between said reinforcement regions.
 8. A stabilised earth structure including facing units to which are attached rolled metal strips as claimed in any preceding claim, each strip being attached by fastening means received by said aperture formed through the strip.
 9. A rolled metal strip for use in stabilised earth structures, substantially as hereinbefore described with reference to the accompanying drawings.
 10. A stabilised earth structure, substantially as hereinbefore described with reference to the accompanying drawings.
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