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(54) METHOD FOR BENDING A SHEET PILE WALL

VERFAHREN ZUM BIEGEN EINER SPUNDWAND

PROCÉDÉ DE FLEXION D'UNE PAROI CONSTITUÉE D'UN EMPILEMENT DE TÔLES

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Description

[0001] The present invention relates to a method for manufacturing a sheet pile wall from a steel plate material of predetermined dimensions.

[0002] Sheet pile walls are applied in, among others, water barriers, as bank protection along a canal, as quay wall, as wall of an underground car park and the like. A sheet pile wall is an earth-retaining construction which is placed in vertical manner in the ground and which comprises separate sheet pile profiles which are mutually connected. These sheet pile profiles are manufactured in practice by hot or cold forming of plate material. In the case of cold forming use is made here of rolling, or roll bending, or roll profiling of steel plate material. This is a process for bringing the plate material into the desired profile form using profiled rolls. Manufacture of sheet pile profiles in this manner is limited to relatively thin plate material, since the friction forces which occur are not sufficient to carry thick plates between the rolls. In addition, rolls are required in this process which are adapted to the desired form of the sheet pile profile. The number of sheet pile profiles obtainable in practice is hereby limited to a number of standard types. This is caused because small series of sheet pile profiles require relatively high investment costs. The change-over to a different profile form further requires modifying the machine, and this adversely affects the efficiency of the production process. Through the use of standard types an over-dimensioned sheet pile profile is generally obtained for a specific application.

[0003] EP-A-0164296 discloses cold forming of a sheet pile part with adjacent parts of the sheet pile wall being connected by separate coupling parts.

[0004] The present invention has for its object to provide an improved method for manufacturing sheet pile profiles.

[0005] The present invention provides a method for manufacturing a sheet pile wall from a steel plate material of predetermined dimensions according to claim 1.

[0006] By defining a desired profile for a sheet pile wall the most suitable form of a sheet pile profile is obtained for a specific application. A specific application or location differs in respect of, among others, type of soil, moistness, play of forces and the like. By then bending the desired profile using for instance an angle-bending machine, or a press or folding machine, the plate material can be bent at desired locations so as to thereby obtain the desired profile. Thus is achieved that the form of the profile, as well as the amount of material, can be adapted to the specific requirements associated with the specific application for the profile. Over-dimensioning of the sheet pile profile is hereby prevented.

[0007] In a preferred embodiment according to the invention the profile is defined by calculating a width and height thereof when obtaining desired moments of resistance and area moments. A desired moment is determined on the basis of a specific application and the requirements associated therewith. The required weight of the sheet pile wall can then be minimized. When defining the profile it is further possible to take into account that an equal amount of material is preferably situated on either side of a neutral line of the profile. This achieves a correct adjustment of the width and height of the profile. The height of the profile is here the dimension transversely of the plane of the initial plate material. The adjustment of form and material of the profile to the requirements of the specific application achieves that a sheet pile profile with a larger working width is realized than in the case of a standard type of profile. It is hereby possible to suffice with fewer sheet pile profiles in the construction of for instance a quay wall. In addition to reducing material costs, this also reduces the costs associated with placing of the separate profiles. A total wall length of 520 metres for instance requires a number of 327 specially defined plates or profiles (HA-Z-666-3) with a working width of 1588 mm at 60 kg/m^2, while for a standard type of profile (PAU 22-60) 543 plates or profiles are required with a working width of 957 mm at 63 kg/m^2. The required moments are here achieved with the specially defined profiles and due to the larger working width it is possible to suffice with fewer plates of the specially developed profile. The whole wall can hereby be placed more quickly. The defined sheet pile profiles are preferably formed as a Z-profile or a U-profile, with which the desired moments can be obtained in the simplest manner.

[0008] In a preferred embodiment according to the invention the bending of a profile for the sheet pile wall is carried out with plate thicknesses up to 15 mm. For the present sheet pile profiles plate material of thicknesses up to about 8 mm is used in cold forming by means of rolling. At greater thicknesses of the plate material the forces required for the forming are too high in the rolling process. Thicknesses up to preferably about 15 mm can be processed by making use of bending of plate material. An additional advantage is that, due to the lower forces required at the same plate thicknesses in the case of bending, higher-quality plate material can also be processed. Such a higher quality of plate material comprises for instance additives for reducing rust-formation. As a result of these additives greater forces are generally required for the purpose of forming. The application of higher qualities of plate material is made possible by bending of sheet pile profiles (for instance use of steel type S355 instead of S235 of a lower quality). For the forming during bending of a normal sheet pile profile the exertion of about 3000 tonnes is required for the pressing at a length of 24 metres. The bending of sheet pile profiles takes place on so-called angle-bending machines or folding machines with which plate thicknesses up to about 25 mm with a length of 4 to 24 metres can be bent. The width of the plate material used for the profiles amounts to about 2.5 metres. An additional advantage is that, by defining the profile on the basis of the specific application, use can preferably be made of thinner plate material, wherein the same strength is obtained. During the bending plate ma-

terial is preferably further used with a width of 2.0 metres instead of 1.20 metres as used in practice during rolling. An example of a sheet pile profile known in practice is PAU 22-40 with a working width of 957 mm. With a specially defined profile (e.g. HAZ 196-4) a greater working width of 1059 mm is obtained at 40.4 kg/m^2. A much used length for sheet pile profiles is 8 metres, although other lengths can also be bent. The bending of such a profile takes place preferably by making the bends one by one. In the case of a U-profile there are for instance eight bends.

[0009] In a further preferred embodiment according to the invention the sheet pile profiles are provided with interlock members for the purpose of coupling to adjoining sheet piles. This achieves that sheet piles can be connected to each other so that they together form a complete wall. About 1 mm of additional free play is preferably provided here, whereby sheet piles can be placed in connection with the adjoining sheet pile profile in a simpler manner. This achieves that a wall can be placed more quickly and at lower cost.

[0010] Further advantages, features and details of the invention are elucidated on the basis of a preferred embodiment thereof, wherein reference is made to the accompanying drawings, in which:

- Figure 1A shows a schematic view of the bending of plate material;
- Figure 1B shows a schematic view of the bending of a plate material in an angle-bending machine or press;
- Figure 1C shows a view of a small angle-bending machine;
- Figure 2 is a top view of two mutually connected U-profiles according to the invention;
- Figure 3 is a top view of a Z-profile according to the invention; and
- Figure 4 is a top view of an alternative embodiment of a Z-profile according to the invention.

[0011] Figure 1A shows schematically the bending of a steel plate material 2 which is placed on a table 4 of an angle-bending machine. Plate 2 is bent to the desired angle by means of the tilting bending beam 6. The bent plate 2 after forming is shown in the figure together with the tilting bending beam 6 in broken lines as respectively 2' and 6'. The swivel bending takes place on a so-called the bending frame 8 which is held in position by means of a pressing beam 10.

[0012] Figure 1B shows the principal of a press wherein a plate material 2 is bent by means of a punch 12 and a die 14. As shown in the figure, punch 12 can here be moved substantially vertically for the purpose of the bending. The bending process shown in the figure relates to free bending. Just as die-bending (not shown), this can be carried out with a press. A simple, small angle-bending machine 16 is shown in figure 1C.

[0013] Figure 2 shows two U-profiles 20 which are mutually connected by means of an interlock 22 by hooking together these interlocks 22 of the two profiles 20. For the shown profile the bends 24, 26 and 28 are made for the purpose of interlock 22, while bends 34, 36 and 38 are made for interlock 22 on the other side of profile 20. In order to obtain the correct stability and moments, a U-profile is arranged by means of the bends 28, 30, 32 and 34. The working width b is determined on the one hand by the width of the plate material of which use is made and on the other by the height h in the direction transversely of the plane of the initial plate material.

[0014] Figure 3 shows a sheet pile profile embodied as a Z-profile 40. Profile 40 is herein provided with an interlock 42 formed by the bends 44, 46 and 48. The bend 50 is provided in order to realize a good connection to an adjacent sheet pile profile 40. The other interlock 42 of profile 40 is formed by bends 52, 54 and 56. The moments and the amount of material on either side of the neutral line 60 are influenced by the bends 62 and 64. The height h' and working width b' of profile 40 are also determined by these two bends 62 and 64.

[0015] Sheet pile profile 70 as shown in figure 4 has a longer strip between bends 72 and 74 compared to the strip between bends 48 and 50 of profile 40 in figure 3. The height h" and working width b" of the sheet pile profile are also determined for this profile by the distances between the bends, as is the amount of material on either side of the neutral line.

[0016] The present invention is by no means limited to the above described preferred embodiments; the rights sought, within the scope of which many modifications can be envisaged, are defined by the following claims.

Claims

1. Method for manufacturing a sheet pile wall from a steel plate material (2) of predetermined dimensions, comprising the steps of:

   - defining the desired profile for the sheet pile wall to obtain a most suitable form of a sheet pile profile for a specific location, thereby preventing over-dimensioning of the sheet pile profile, such that the form, as well as the amount of material, is adapted to the specific requirements associated with the specific application for the profile,
   wherein the profile is defined by calculating a width and/or height of the profile when realizing the desired moment of resistance, and
   - bending the plate material at desired locations with an angle-bending machine (16) or folding machine in order to bend a desired profile,
   wherein the desired profile is provided with interlock members (22, 42) formed by bends (44,46 and 48) of the two ends of the profile for the purpose of coupling to adjoining sheet piles.

2. Method as claimed in claim 1, wherein the profile is defined by minimizing a required weight of the sheet pile wall when realizing the desired moment of resistance.

3. Method as claimed in claim 1 or 2, wherein the profile is defined by an equal amount of material on either side of a neutral line (60) of the profile.

4. Method as claimed in one or more of the claims 1-3, wherein a Z-profile (40) or a U-profile (20) is obtained by calculating the desired profile.

5. Method as claimed in one or more of the claims 1-4, wherein the bending of the profile for the sheet pile wall is carried out on plate material with a thickness up to 15 mm.

6. Method as claimed in one or more of the claims 1-5, wherein a relatively low force can be exerted on the plate material during bending of the profile compared to roll forming of the profile.

7. Method as claimed in one or more of the claims 1-6, wherein the interlock members are provided with about 1 mm of free play for placing of the sheet pile wall.

Patentansprüche

1. Verfahren zum Herstellen einer Spundwand aus einem Stahlplattenmaterial (2) vorgegebener Abmessungen, mit folgenden Schritten:

   - Definieren des gewünschten Profils für die Spundwand, um eine möglichst geeignete Form eines Spundbohlenprofils für einen bestimmten Ort zu erhalten, wobei dadurch eine ÜberDimensionierung des Spundbohlenprofils vermieden wird, derart, dass die Form sowie die Menge an Material an die spezifischen Erfordernisse angepasst sind, die mit der speziellen Anwendung für das Profil zusammenhängen, wobei das Profil durch eine Berechnung einer Breite und/oder einer Höhe des Profils definiert ist, wenn das gewünschte Widerstandsmoment realisiert wird, und
   - Biegen des Plattenmaterials an gewünschten Positionen mit einer Winkelbiegemaschine (16) oder einer Faltmaschine, um ein gewünschtes Profil zu biegen, wobei das gewünschte Profil Verriegelungsmittel (22, 42) aufweist, die aus Biegungen (44, 46 und 48) der zwei Enden des Profils für den Zweck des Verbindens mit benachbarten Spundbohlen geformt sind.

2. Verfahren nach Anspruch 1, wobei das Profil durch eine Minimierung eines erforderlichen Gewichts der Spundwand definiert wird, wenn das gewünschte Widerstandsmoment realisiert wird.

3. Verfahren nach Anspruch 1 oder 2, wobei das Profil durch eine gleiche Menge an Material auf jeder Seite einer neutralen Linie (60) des Profils definiert wird.

4. Verfahren nach einem oder mehreren der Ansprüche 1 bis 3, wobei ein Z-Profil (40) oder ein U-Profil (20) durch eine Berechnung des gewünschten Profils erhalten wird.

5. Verfahren nach einem oder mehreren der Ansprüche 1 bis 4, wobei das Biegen des Profils für die Spundwand an Plattenmaterial mit einer Dicke von bis zu 15 mm ausgeführt wird.

6. Verfahren nach einem oder mehreren der Ansprüche 1 bis 5, wobei eine relativ geringe Kraft auf das Plattenmaterial während des Biegens des Profils im Vergleich zu einem Rollformen des Profils ausgeübt werden kann.

7. Verfahren nach einem oder mehreren der Ansprüche 1 bis 6, wobei die Verriegelungsmittel mit einem freien Spiel von ungefähr 1 mm für eine Anordnung der Spundwand versehen sind.

Revendications

1. Procédé pour fabriquer une paroi faite d'un empilement de tôles à partir d'un matériau de tôle (2) de dimensions prédéterminées, comprenant les étapes consistant à :

   - définir le profil souhaité pour la paroi faite d'un empilement de tôles afin d'obtenir la forme la plus appropriée d'un profil d'empilement de tôles pour un emplacement spécifique, empêchant ainsi le surdimensionnement du profil d'empilement de tôles, de sorte que la forme ainsi que la quantité de matériau sont adaptées aux exigences spécifiques associées à l'application spécifique pour le profil,
   dans lequel le profil est défini en calculant une largeur et/ou une hauteur du profil lorsque l'on réalise le moment souhaité de résistance, et
   - cintrer le matériau de plaque aux emplacements souhaités avec une machine de cintrage (16) ou une machine de pliage afin de cintrer un profil souhaité,
   dans lequel le profil souhaité est prévu avec des moyens de verrouillage (22, 42) formés par des coudes (44, 46 et 48) des deux extrémités du profil afin de se coupler aux empilements de tôles attenants.

2. Procédé selon la revendication 1, dans lequel le profil est défini en minimisant un poids requis de la paroi faite d'un empilement de tôles lorsque l'on réalise le moment de résistance souhaité.

3. Procédé selon la revendication 1 ou 2, dans lequel le profil est défini par une quantité de matériau identique de chaque côté d'une ligne neutre (60) du profil.

4. Procédé selon une ou plusieurs des revendications 1 à 3, dans lequel un profil en Z (40) ou un profil en U (20) est obtenu en calculant le profil souhaité.

5. Procédé selon une ou plusieurs des revendications 1 à 4, dans lequel le cintrage du profil pour la paroi faite d'un empilement de tôles est réalisé sur le matériau de plaque avec une épaisseur allant jusqu'à 15 mm.

6. Procédé selon une ou plusieurs des revendications 1 à 5, dans lequel une force relativement faible peut être exercée sur le matériau de plaque pendant le cintrage du profil par rapport au formage par laminage du profil.

7. Procédé selon une ou plusieurs des revendications 1 à 6, dans lequel les éléments de verrouillage sont prévus avec environ 1 mm de jeu pour placer la paroi faite d'un empilement de tôles.

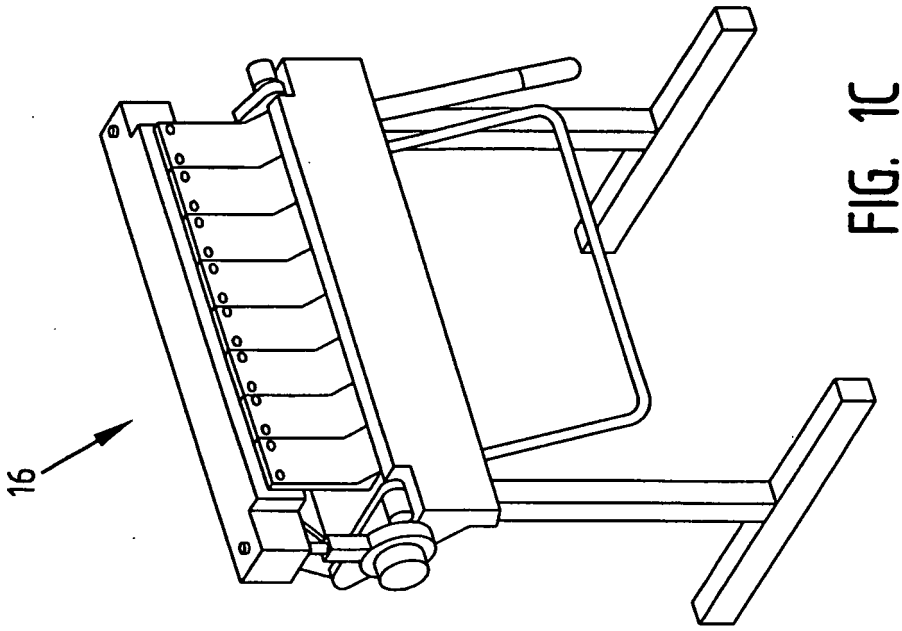


FIG. 1C

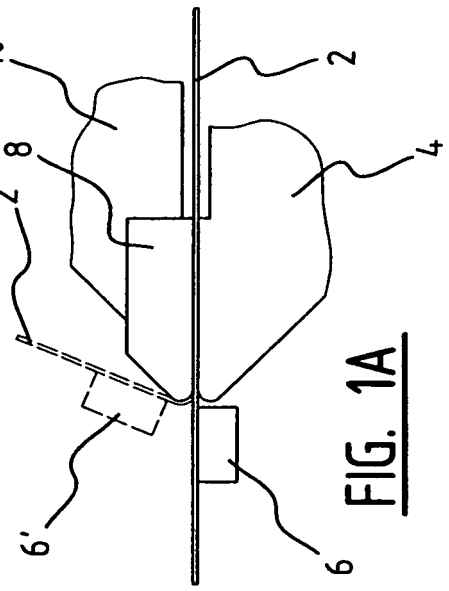


FIG. 1A

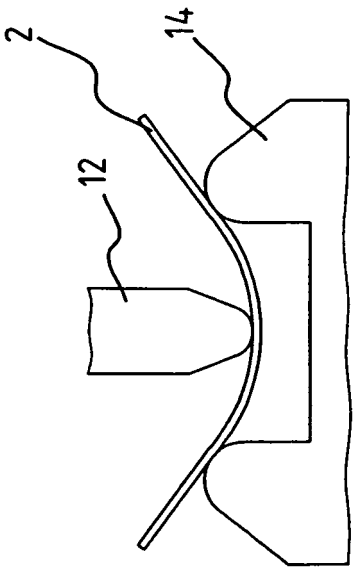
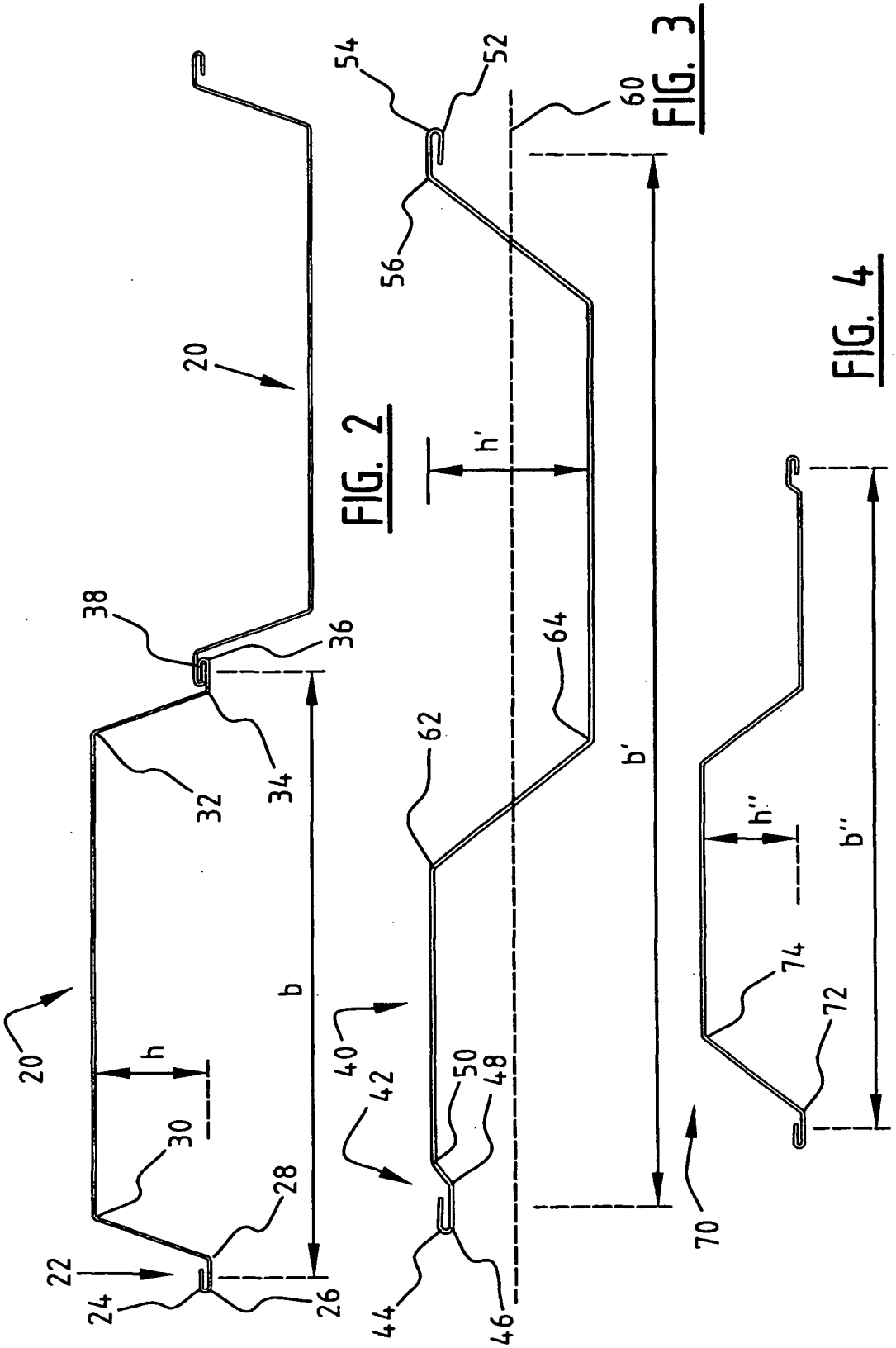


FIG. 1B


20
38
36
32
34
h
b
22
24
26
28
30
FIG. 2
20
40
42
44
46
48
50
52
54
56
60
h'
b'
62
64
FIG. 3
70
72
74
h''
b''
FIG. 4

REFERENCES CITED IN THE DESCRIPTION

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