Lamination of Metal Slat Profiles

Ionut - Aurelian Goloman

Abstract: *The present paper is intended to be a brief presentation of the current state of rolling of metal slats profiles. The author presents some theoretical considerations regarding the rolling process in the case of metal slat profiles. The first part of the paper presents the rolling process which is the most common process of plastic deformation of cold metal materials with the help of special equipment called rolling mills. The process having the advantage of an efficient processing of the metallic material, in the conditions of ensuring a good dimensional precision and a qualitative surface. Lamination processing consists in pressing the semi-finished product when passing between two cylinders that rotate in the opposite direction and are characterized by the degree of deformation of the material. When the sheet is bent, the surface inside the bend is compressed and the outside surface is stretched. Somewhere inside the thickness of the sheet is the neutral axis, the axis that does not compress or stretch, remaining the same length throughout the bend. Laminating is suitable for obtaining long pieces with a constant section, which cannot be obtained by other processes, but also for obtaining complicated finished products such as geometric shape. For the calculation of structures made of cold-formed steel profiles, specific calculation rules have been developed. Currently, the latest version is in the form of SR-EN 1993-1-3 from 2007. Also, in the second part of the work is presented the way of protection against corrosion of metal slat profiles and advantages of using cold formed steel profiles. The metal slat is made of galvanized steel and pre-painted in electrostatic field, which gives a high resistance to environmental factors, as well as an increased mechanical resistance. Galvanizing and painting the profiles brings an increased degree of corrosion protection of the element in the environment. An application of a 0.04 [mm] thick layer provides the standard protection required by regulations, ensuring a safe life of the structure of approximately 60 years. The third part of the paper highlighted the advantages of metal slats and the field of use of metal slat profiles, namely the use for fence panels that surround buildings, producing in various assortments of colors and sizes.*

Keywords: *laminating, plastic deformation, pressing, qualitative surface.*

1 INTRODUCTION

The rolling process is the most common process of plastic deformation of hot or cold metal materials with the help of special machines called rolling mills.

Laminating processing consists in pressing the semi-finished product when passing between two cylinders that rotate in the opposite direction and are characterized by the degree of deformation of the material. Lamination is especially suitable for obtaining long parts with a constant section, which cannot be obtained by other processes, but also for obtaining complicated finished products.

The process offers the advantage of an efficient processing of the metallic material, in the conditions of ensuring a good dimensional precision and a qualitative surface. Cold formed rolled metal profiles are found in almost all areas of activity of modern life, their use being demonstrated by the existence of a wide range of products with a variety of shapes and sizes.[1]

In Europe, the European Convention for Constructional Steelwork (ECCS) first developed European recommendations for the design of cold-formed steel elements for the first time in 1987 (ECCS, 1987). Since then, this European document has been revised and published in 1996 as a European standard Eurocode 3, Part 1.3 (ENV1993-1-3, 1996).[2]

In Romania, there has been a translated and adapted version of ENV1993-1-3 since 1997, with the name "Normative for the calculation of cold-formed thin-walled steel elements" indicative NP012-1997. Until recently, cold-formed metal profiles were used only as secondary elements in construction, but lately, due to technological developments, their use in the exterior design of buildings has increased.

Improving corrosion protection methods has been a decisive factor in the development of the market for products in this category.

A specific product, with wide applicability, is the metal slat which is used to make the fence panels that surround the buildings, producing in various assortments of colors and sizes. (Fig. 1) The metal slat is made of galvanized steel and pre-painted in electrostatic field, which gives a high resistance to environmental factors, as well as an increased mechanical resistance.

Galvanizing and painting the profiles brings an increased degree of corrosion protection of the element in the environment. An application of a layer of 0.04 [mm] thickness ensures the standard protection required by regulations, ensuring a safe service life of the structure of approximately 60 years. [3]

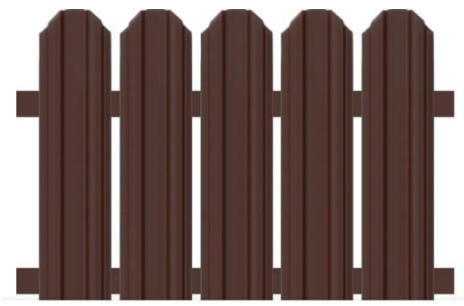
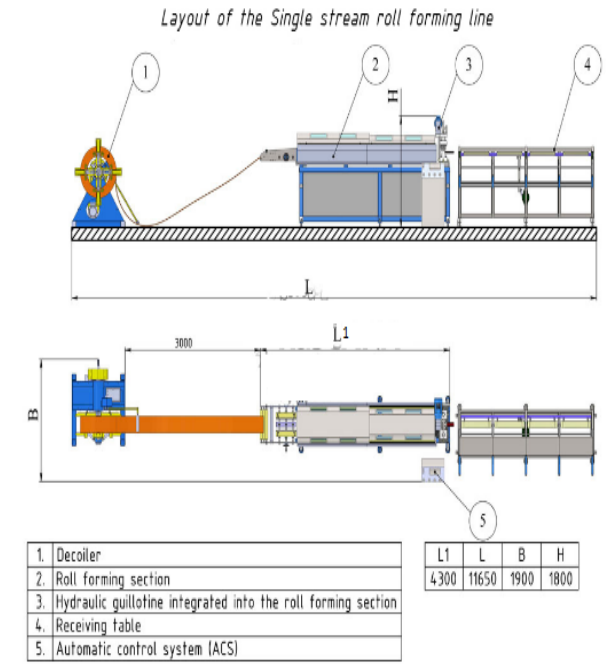


Fig. 1. Fence model made of metal slat

2. MANUFACTURING TECHNOLOGY

The rolling mill is defined as a complex installation for machining metallic materials. A rolling mill is constructed of one or more boxes, an assembly consisting of rolling cylinders, their frame and a series of basic and auxiliary mechanisms (Fig. 2).



1.	Decoiler
2.	Roll forming section
3.	Hydraulic guillotine integrated into the roll forming section
4.	Receiving table
5.	Automatic control system (ACS)

L1	L	B	H
4300	11650	1900	1800

Fig. 2. Rolling element components

The assembly of two or more cylinders working simultaneously to perform a rolling operation is called a rolling box (Fig. 3).

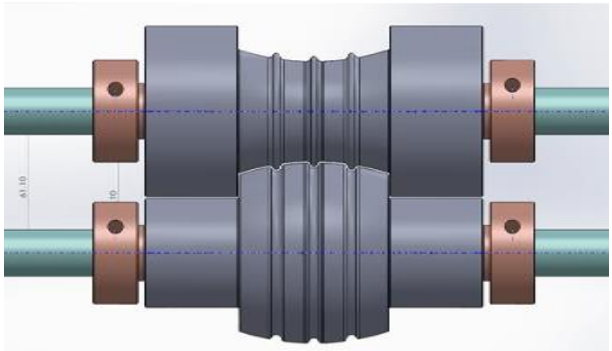


Fig. 3. Rolling mill cylinders

For the calculation of structures made of cold-formed steel profiles, specific calculation rules have been developed. In Romania, there has been a translated and adapted version of ENV 1993-1-3 since 1997, with the name "Normative for the calculation of cold-formed thin-walled steel elements" indicative NP012-1997. Currently, the latest version is in the form of Eurocode 3, Part 3 or SR-EN 1993-1-3 of 2007.[2]

In the case of cold rolling, the steel strip from which the profile is made is passed successively between two roller trains, the bending being done progressively in a sequence of the type shown in Fig. 4. [5]

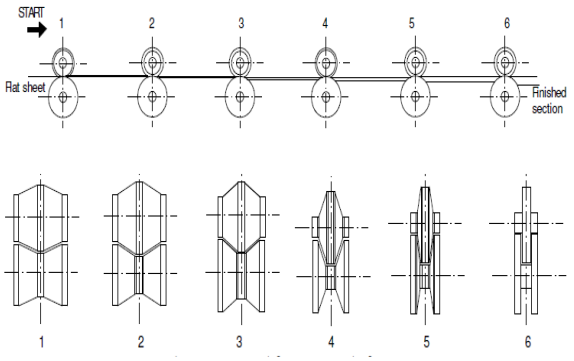


Fig. 4 . Rolling rollers in different stages of formation [6]

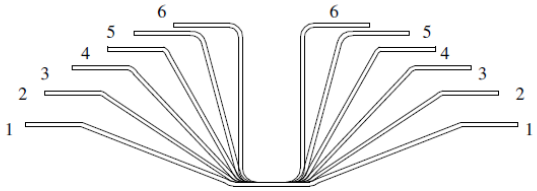


Fig. 5. Steps in cold rolling a simple section [6]

Changing cold rolling rolls to obtain profiles of different shapes and sizes is time consuming and stagnates production (Fig.5). Adjustable rollers are usually used on modern rolling lines, which allow a quick change for different size ranges of the cross section (Fig. 6).

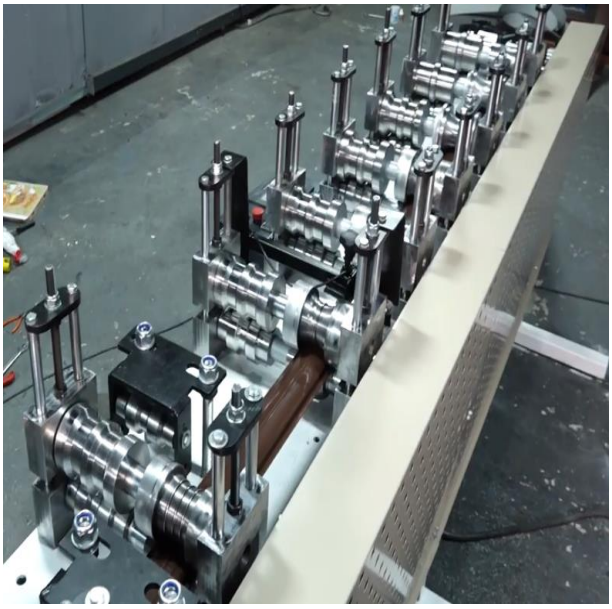


Fig. 6. Industrial rolling line

When the sheet is bent, the surface inside the bend is compressed and the outside surface is stretched. Somewhere inside the thickness of the sheet is the neutral axis, the axis that does not compress or stretch, it remaining the same length throughout the bend (Fig. 7).

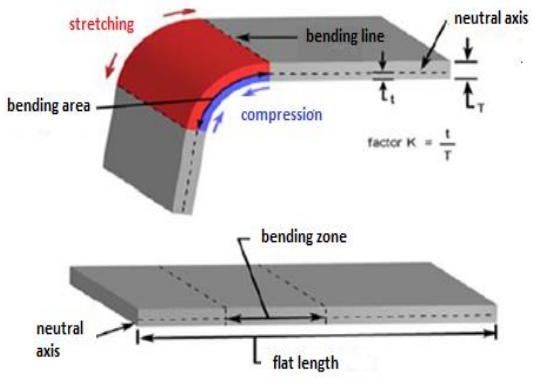


Fig. 7. The state of tension of the bending process [7]

2.1 Characteristics of cold formed profiles due to the manufacturing process

The manufacturing process influences certain mechanical and geometric characteristics of the cold formed profiles. First, cold forming changes the characteristic curve of the steel. By hardening, cold rolling leads to an increase in the flow limit, sometimes the breaking strength, a phenomenon that is more pronounced in the corners of the profiles and appreciable in the hearts and souls [4].

The increase in yield strength is due to hardening and depends on the type of steel used and the increase in breaking strength is due to the aging phenomenon, which weakens the material, whose ductility has already been reduced by hardening and depends on the metallurgical characteristics of steel. Figure 8 compares the characteristic curves of steel before and after hardening.

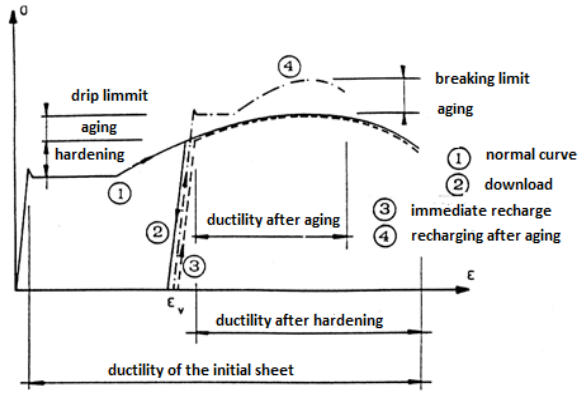


Fig. 8. The influence of cold forming on the mechanical properties of steel [7]

2.2 Specific problems in the design of cold formed elements

2.2.1 Specific stability issues

Thin-walled metal elements can be subjected to one of the generic buckling modes: local, distortion, or global, and their interaction. The local buckling or veiling of the cross-section walls, respectively the distortion or distortion of the section, are found in the cold-formed steel profiles which, as a rule, have thin walls (Fig. 9).

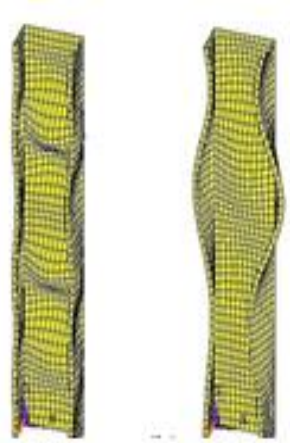


Fig. 9. Local buckling [2]

2.2.2 Torsional rigidity

Cold formed profiles usually have thin walls and consequently low torsional rigidity (Fig. 10). Many cold-produced profiles have monosymmetrical sections, with the cutting center eccentric to the center of gravity.

To produce bending without twisting the force line must pass through the section cutting center.

Any eccentricity of the load relative to the axis of the cutting center will result in considerable twisting deformations in a thin-walled sheet.

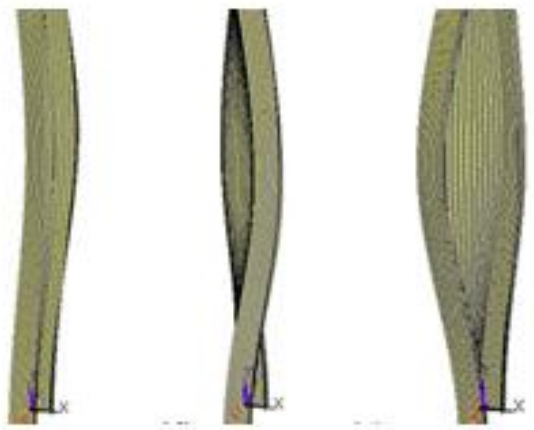


Fig. 10. Torsional stress [2]

3 CORROSION PROTECTION

The corrosion resistance of cold formed profiles depends on the aggressiveness of the environment and the type and thickness of the protective treatment applied. The cold manufacturing process allows corrosion protection to be applied to the baseboard before rolling (Fig. 11). Consequently, the galvanized and / or painted sheet can be passed through the rolling rolls and no further treatments are required.

Galvanized protection is sufficient to ensure corrosion resistance for the entire life of a building, provided it has been properly constructed. Corrosion protection can be easily destroyed by handling and transporting profiles.

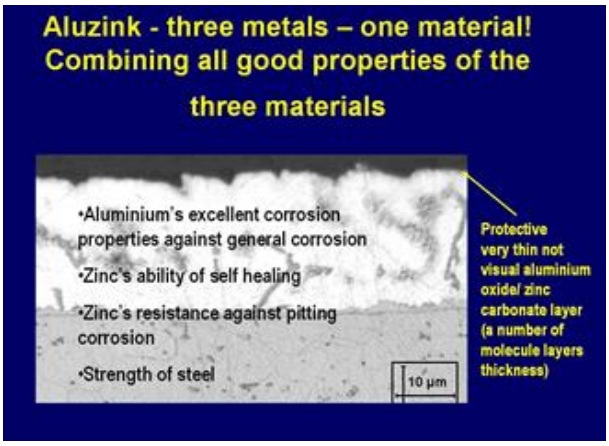


Fig. 11. Corrosion protection [6]

Another type of corrosion protection used for cold formed thin-walled profiles is plastic film protection. This type of protection consists in covering the steel surface with a layer of plastic, which can be applied by projecting on the surface to be protected a layer of molten plastic in a liquid state, by immersing the steel element in suspensions of protective powders, which are strengthen later, or by direct application of foils. The plastic can be applied to the steel strip before forming the profile (Fig. 12).

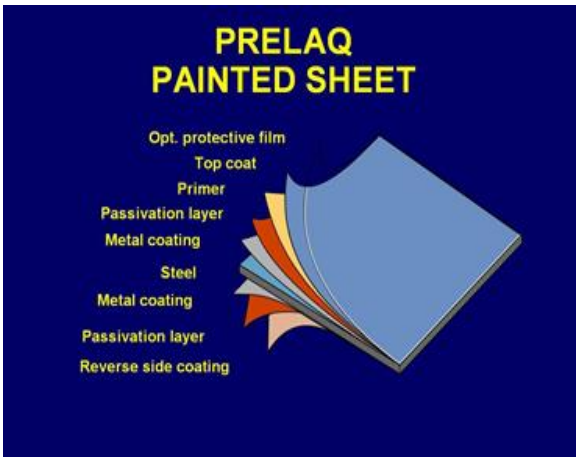


Fig. 12. *Coverage mode [7]*

4 ADVANTAGES OF USING COLD FORMED STEEL PROFILES

In a series of publications entitled "Light Steel," the Steel Construction Institute (SCI) published a guide to building design using cold-formed steel profiles (Grub, 1997). According to this guide, the following advantages of using these materials in construction are presented:

1. Low weight;
2. Light manufacturing;
3. Quick and easy installation;
4. Increased accuracy of details;
5. Reduced transport and handling costs;
6. They are incombustible;
7. They are recyclable;

5 CONCLUSIONS

Laminating is suitable for obtaining long pieces with a constant section, which cannot be obtained by other processes, but also for obtaining complicated finished products such as geometric shape. The process having the advantage of an efficient processing of the metallic material, in the conditions of ensuring a good dimensional precision and a qualitative surface. The concern is to meet the demanding requirements of customers and to maintain competitiveness in the market through a continuous improvement in the field of plastic deformation while keeping costs under control.

Acknowledgments
[1]S.C. Ge.Co Gestione Commessee e Meccanica a Disegno SRL

REFERENCES

[1] Cazimirovici, E (2001) – *Tehnologia Laminarii* , Editura BREN, Bucuresti
[2] Eurocod 3 : Proiectarea structurilor de otel www.ct.upt.ro/studenti/cursuri/dubina/Curs_metal_11.pdf (10.04.2008)
[3] Frățilă, D (2019)– *Tehnologii de fabricatie*, Editura UTPress Cluj Napoca
[4] Lawson, R., & Rhodes, J. (1992) - *Design of Structures using Cold Formed Steel Sections.*
[5] Ungureanu, V. & Dubină, D. (2004) - *Calculul și proiectarea construcțiilor din profile metalice cu pereți subțiri formate la rece.* București
[6] *[https://pdfcoffee.com/prezentare-profile-laminate-la-rece-pdf-free.html]*
[7] *https://pdfslide.net/documents/profile-laminate-la-rece-56975d2cdd337.html*

Authors addresses
[1]Goloman Ionut-Aurelian, Lamination of metal slat profiles, Plopis, no.37, Maramures, 0740529139, goloman.ionut08@gmail.com
Contact person
[*]Goloman Ionut-Aurelian, Lamination of metal slat profiles, 0740529139, goloman.ionut08@gmail.com