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T.I. Molodetska

RESEARCH OF THE BENDING PROCESS OF COATED MATERIALS

Vinnytsia National Technical University

Abstract

The relevance of the study is due to the current trend of using complex profile products from coated materials in various industries, especially in construction, which can significantly increase corrosion resistance, durability, temperature range and manufacturability, and the most common methods of obtaining such products are processing methods pressure, in particular bending, which is a stressful thermal force process that affects the quality and integrity of the pre-applied coating.

Keywords: coated material, bending, deformability.

Анотація

Актуальність дослідження обумовлена сучасною тенденцією з використання складних профільних виробів із матеріалів з покриттям у різних сферах промисловості, особливо в будівництві, що дає змогу значно підвищити корозійну стійкість, довговічність, температурний діапазон застосування та технологічність, а також найпоширенішими методами отримання таких виробів є методи обробки тиском, зокрема гнуття, який представляє собою напружений термічно-силовий процес, що здійснює вплив на якість та цілісність попередньо нанесеного покриття.

Ключові слова: матеріал з покриттям, згин, деформівність.

Trends in the development and application of high-tech coated materials for the production of profiles for car components, in the production of furniture and the development of a large number of structures based on bent profiles for the construction industry are due to their high corrosion resistance (increased resistance to precipitation, ultraviolet radiation, exhaust gases, alkaline and acidic aggressive environments), temperature range of application from -50°C to +80°C, resistance to mechanical impact, manufacturability (simplicity, convenience and reliability of fastening), environmental safety and aesthetics [1].

As metal coatings of steel sheets, zinc is most often used to protect the metal from corrosion. Application of a zinc-based metal coating of a certain thickness is carried out by hot or electrolytic method [2]. Hot-melt galvanised steel shows better protective properties and the coating has better adhesion and strength compared to electrolytic steel, so about 70% of surfaces are galvanised from melts.

Modern trends in construction are the use of combined multilayer coatings (fig. 1) – a combination of polymer and zinc coatings. Such materials demonstrate increased anti-corrosion properties. The coating can be one-sided or two-sided in various combinations. In the standard version, a protective polymer coating is applied to the front surface of a galvanised steel sheet, and the backside of the sheet is painted.

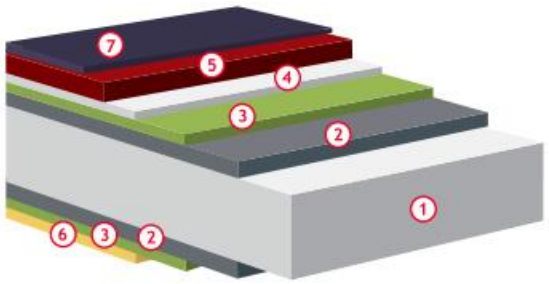

Fig. 1 – Structure of sheet metal with a combined multi-layer coating: 1-steel sheet (0.4-0.6 mm thick); 2 – zinc layer; 3 – passivation layer; 4 – primer layer; 5 – polymer coating (front side); 6 – protective painting (backside); 7 – protective film if necessary

Polymer-coated sheet steel can be deformed by most known methods: bending, flanging, rounding and deep pulling, and on equipment used for sheet metal processing. From the point of view of profiling, the most important physical and mechanical properties of coatings are their elasticity [3]. The deformation characteristic depends on the substrate material, the zinc layer, and the type and thickness of the coating layer. Using typical equipment and technological characteristics of the deformation process, it is now very difficult to obtain a ready-made profile without defects in the applied coating. The work contains information that defects in the profile surface occur in the form of scuff marks, scratches, destruction of the coating when manufacturing profiles from coated materials for a number of reasons: rigid forming schemes, unsatisfactory quality of forming rollers, uneven gap in the calibre, excessive width of the workpiece, and it is also noted that under equal conditions for materials without coatings defects were not observed.

Analysis of theoretical and experimental works [1; 4-6] in this subject area has shown that when manufacturing profiles from polymer-coated materials, the issues of shaping schemes and the associated stress-strain state of shelves and corner zones remain relevant, ensuring the dimensional accuracy of the cut and the length of the smooth transition zone. Therefore, it is of great interest to improve the quality of finished profiles made of polymer-coated materials to study them from the point of view of the influence of the main deformation conditions on the occurrence of defects in the material and develop a classifier of defects and their causes. Analysis of the stress-strain state of the workpiece material will provide a deeper understanding of the processes that occur in a multi-layer coating. Based on such studies, effective actions will be developed aimed at improving the bending technology for polymer-coated materials.

A study of the scientific literature led to the conclusion that defects in the coatings of the workpiece in the form of peeling and cracking are characteristic of 60-70% of profiles at the initial stage of profile processing and are the most significant defect for simple section profiles with a base thickness of 1.5-2 mm. Creating a classifier that reflects the dependence of the appearance of this defect on the geometric and technological parameters of the process will help prevent the formation of this defect.

For a more systematic approach to the selection of modelling objects, a classifier of the causes of coating defects has been compiled. The causes of defects in coatings can be divided into three main groups. The first group includes factors related to the choice of equipment. The wrong choice of equipment can lead to an insufficient number of transitions, high processing speed, the lack of additional devices that would allow pre-processing the workpiece before it enters the bending process, this technique reduces the contact pressure in the working transition, but the additional device itself must ensure the safety of the coating. Reducing the profiling speed makes it possible to reduce the impact of the tool on the coating, significantly intensifying the process. The low profiling speed provides a sufficient time interval during which relaxation processes in the coating have time to take place, which has a positive effect on its condition. However, the low speed requirement is a competing factor in terms of process performance. This contradiction can be resolved by optimising the speed characteristics of the process while ensuring the quality of the manufactured profile.

The results of the work make it possible to understand in more detail the processes that occur with materials with a multilayer coating during pressure treatment and are of practical value for companies that specialize in the manufacture of products with a complex profile.

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Molodetska Tatyana Igorivna, candidate of engineering sciences, docent, Vinnytsia National Technical University, Vinnytsia, molodetska_tanya@ukr.net.

Молодецька Тетяна Ігорівна к.т.н., доцент, Вінницький національний технічний університет, м. Вінниця, molodetska_tanya@ukr.net