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OVERLAPPING LENGTH AND LIFETIME INFLUENCE ON LOAD OF SIMPLE OVERLAPPED ADHESIVE BOND

VLIV DÉLKY PŘEPLÁTOVÁNÍ A ŽIVOTNOSTI NA ZATÍŽENÍ JEDNODUŠE PŘEPLÁTOVANÉHO SPOJE

Abstract

A production process is various in single industrial branches; it usually has one common element – bonding pieces of material. We can say on the base of the production sphere analysis that simple overlapped adhesive bonds are the most common adhesive bonding technology application. The research publicated in this paper deals with then too. The Influence of an overlap length and lifetime of the adhesive bond were evaluated during the time interval 1000 days. Results set an optimum criterion of the adhesive bond constructional shape i. e. the influence of the overlap length, and unit costs related to acquiring the adhesive

Abstrakt

Výrobní proces je V jednotlivých průmyslových odvětvích různorodý, má však obvykle jeden společný prvek a tím je spojování materiálu. Na základě analýz výrobní sféry je možno konstatovat, že nejrozšířenější aplikací technologie lepení jsou jednoduše přeplátované lepené spoje, kterým se věnuje I výzkum zveřejnění V tomto článku. Hodnocen byl vliv délky přeplátování a životnosti lepeného spoje po dobu 1000 dní. Výsledky stanovují optimální kritérium konstrukčního tvaru spoje tj. vliv délky přeplátování a jednotkové náklady vztažená na pořízení lepidla.

1 INTRODUCTION

The adhesive bond constructional shape deals with the mutual position of adhesive bonded parts so that the certain contact area would be gained (fig. 1) and prospective unsuitable loads such as a peeling excluded. The bond constructional shape is practically applied mainly in the bonding of flat areas. Relative usage of these various bonds types depends primarily on the loading intensity [7].

Simple overlapped adhesive bonds are productively less expensive and in many cases they fulfill strength requirements while the bonds of a special constructional treatment are applied in the situations which require reaching higher adhesive bonds strength. These one need higher financial costs and they are technologically difficult [6, 9].

The simple overlapped adhesive bonds are the most applied adhesive bonds in the practice. The reasons are following:

- easy production in both short – single-part production and lot manufacture productions,

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- using for thin adherends,
- weight mineralization,
- prevailing shear stress [1, 6, 7].

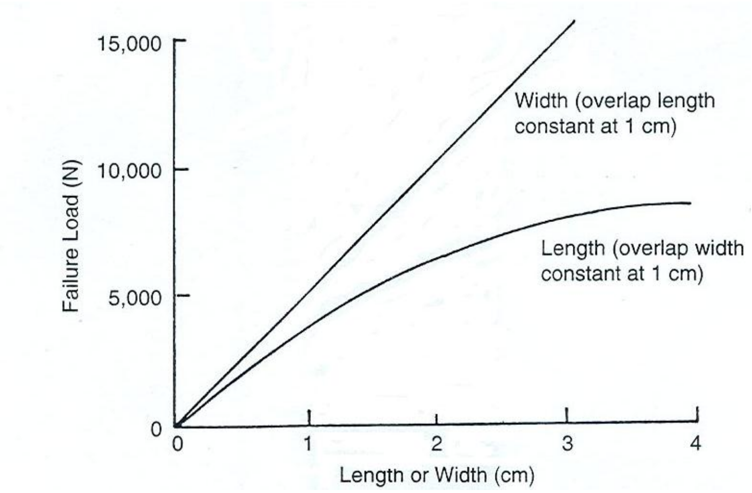

Fig. 1 Effect of overlapping width and length on simple overlapped adhesive bond load [7].

Reasons for the bond constructional shape optimization can be sum up into following criteria: to eliminate a bending moment and connected entrance of second part of the tensile stress, to take into regard the mechanical properties stress, to take into regard the mechanical properties of adhesive bonded materials, especially to the beginning of a plastic deformation affecting.

Müller and Herák [8] carried out a number of experiments and calculations with the aim to set the criteria of the optimum overlap length proposition which provides more suitable values of the adhesive bond load capacity together with the tensile stress elimination. By the optimum overlapping design not only the bonded joint loading capacity increases, but also the costs decrease, which are invested in the unwarranted overdesigned bonded joint surface. At the design of the one-side lapped bonded joints it is important to have regard to following criterions:

- the bonded material maximum loading capacity utilization by reaching of the force near the yield point,
- the adhesive maximum loading capacity utilization,
- tensile stress elimination
- utilization of shear stress type, when the bonded joints compared with other stress types (tension, peeling, their combination) reach in total higher loading force values [8].

2 MATERIALS AND METHOD

The criterions plan of the optimum lapping length determination was the aim of the laboratory measurements. The evaluation was carried out according to the standard CSN EN 1465 (Determination of tensile lap-shear strength of rigid-to-rigid bonded assemblies) [4]. The tests were carried out using the steel S235J0 specimens of dimensions 100×25×1.5 mm.

For the bonded surface preparation the mechanical method of blasting by the use of synthetic corundum F24 was used. The adhesive layer thickness was secured by the insertion of two distance wires placed parallel to the acting force. For tests two two-component epoxy adhesives were used BISON epoxy metal [BEM] – the two-component epoxy adhesive, ratio of mixture 1:1, usable life 60 minutes and ALTECO 3-TON epoxy adhesive 30 min [A3TEA] – the two-component epoxy adhesive with metallic filler, ratio of mixture 1:1, usable life 30 minutes [2, 3]. Using the adhesive BEM and A3TEA the adhesive layer thickness was of 0.11 mm. According to previous tests this thickness proved the optimum [8].

The length and the width of tested specimens were used according to the standard. The lapping was not made according to the standard, but it in the interval 10 till 50 mm.

The adhesive bonds were divided after hardening into two series:

- destructed immediately after hardening – signed as series 0,
- destructed after 1,000 days exposing to the laboratory conditions i. e. the laboratory temperature 22 ± 2 °C and the relative humidity 50 ± 5 % - signed as series 1,000.

Then the specimens were bonded. The tested assemblies number of each series was determined according to the standard demands. The bonded assemblies were left in the laboratory for the time which was needed for the curing. The tensile-strength test was carried out using the universal tensile-strength testing machine. After the bonded joint destruction the maximum force was read, the lapping length was measured, the failure type according to ISO 10365 was determined [5].

For the correct evaluation of the relations the closeness coefficient was calculated using the correlation analysis. The R^2 value can be from 0 to 1. The higher value corresponds to the higher telling capacity.

3 RESULTS

The bonded joints were prepared according to the above mentioned specifications and destructively tested. The test results were the destructive force and the lapping length. The fracture area between the adhesive and the bonded material was evaluated as the cohesive failure. Experiment results are showed in the fig. 2 and 3. The adhesive bonds showed a similar course.

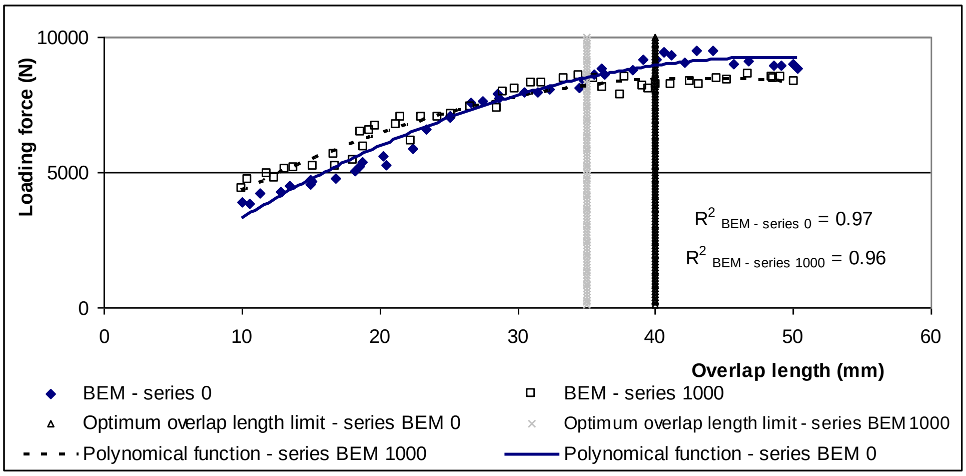

Fig. 2 Influence of overlap length and lifetime of simple overlapped adhesive bond on loading force - Adhesive BEM.

A difference was only in the reached values of the loading force. The loading force of the stressed bond increases with the overlapping size until reaching the marginal status of the adhesive bond overlapping. As the marginal status stopping the loading force increase is considered. The loading force increases slowly after reaching the marginal status of the adhesive bond overlapping and it comes to the stagnation or prospectively to the decrease. a point of a deflection from the linear increasing course can be described as the optimum overlap length, i. e. cca 35 till 400 mm. The loading force decrease of adhesive bonds exposed to the laboratory conditions during the time interval 1,000 days. Did not manifest more markedly. The average decrease was about 1.18 % at the bonds adhesive bonded by the adhesive BEM and 6.50 % by the adhesive A3TEA.

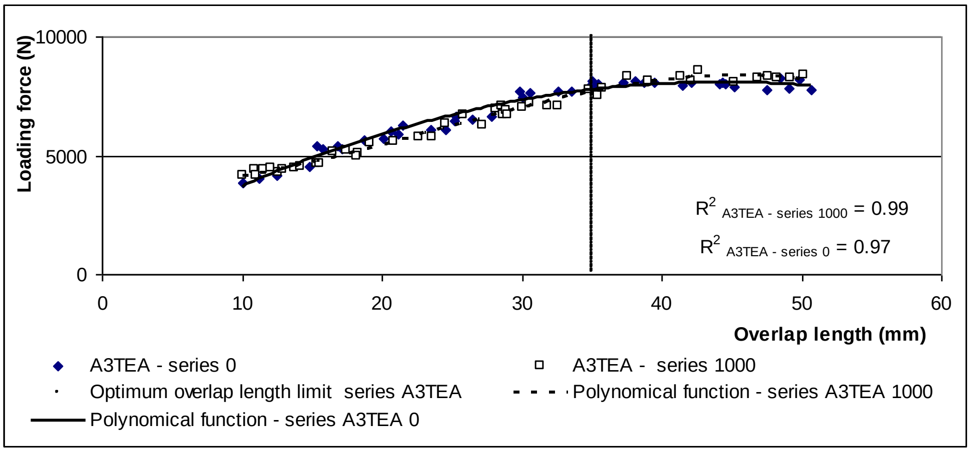

Fig. 3 Influence of overlap length and lifetime of simple overlapped adhesive bond on loading force - Adhesive A3TEA.

The adhesive input cost is 6.71 CZK·g^{-1} for adhesive BEM and 1.09 CZK·g^{-1} for the adhesive A3TEA. The density of tested specimens was set 1.13 g·cm^{-3} for the adhesive BEM and 1.64 g·cm^{-3} for the adhesive A3TEA. a volume of consumed adhesive was set on the base of the bond geometry, i. e. the constant overlap width 25 mm, the adhesive layer thickness 0.11 mm and the variable overlap length in the interval 10 till 50 mm. Fig. 4 shows the increase of the adhesive unit costs depended on the increasing overlap length. Regarding the value of the stated marginal limit of the optimum overlap length brings significant savings in the adhesive consumption.

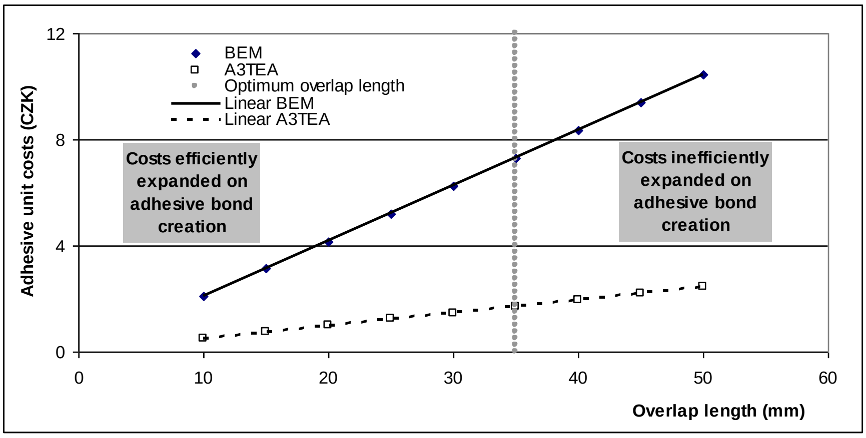

Fig. 4 Influence of adhesive unit costs on adhesive bond overlap length.

4 CONCLUSIONS

By the optimum overlapping design not only the bonded joint loading capacity increases, but also the costs decrease, which are invested in the unwarranted overdesigned bonded joint surface.

The loading force of the stressed bond increases with the overlap size. However, it does not increase in linear course with the overlap length. The force increase in linear course with the overlap length. The force increases slowly behind the linear bounds than the linear increasing area of the bond and that is why the results strength shows the decreasing trend. The point of the deflection from the linear increasing can described as the optimum overlap length, i. e. cca 35 mm at the steel substrate.

The deflection from the linear increase of the loading force behind the marginal status can be considered as the marginal status for the constructional calculation, i. e. maximum overlap length, with regard to the linear increase of the adhesive unit costs. The aim of lifetime influence minimization, i. e. definitely 1000 days, on resulted adhesive bond strength is also essential for the practical application. It follows from the above stated that the laboratory conditions do not affect significantly the adhesive bond ageing process (adhesive bonded with the epoxy adhesives).

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