THE INVESTIGATION OF THE CORROSION RESISTANCE OF THE TENSION CLAMPS Skl14

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Resume

At the level crossings it is possible to find the problems with the corrosion of the parts of the fastening system. These problems are especially at the rubber level crossings and in the tunnels. As a part of the thesis the problem of the corrosion of the tension clamp Skl14 of the producer Vossloh at the rubber level crossings is examined. For the purposes of the comparison the tension clamps without the corrosion protection and the tension clamps with the corrosion protection KTL were examined. As a first step the corrosion features of the tension clamps Skl14 were solved. The examination was divided into two parts. First part it was the examination according to ČSN EN ISO 9227. The samples of the tension clamps were putted into the corrosion chamber. After 1728 h the results of the corrosion impacts were not satisfied. It was decided for the second step of the examination. It was the immersion in an electrolyte solution. As a result of the paper the corrosion features of the tension clamps without the corrosion protection and with the corrosion protection are compared.

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1. Description of the problem

The tension clamps Skl14 of the manufacturer Vossloh are standard parts of the fastening systems that are used at the main lines not only in the Czech and the Slovak Republic but almost everywhere in the world. Details about the fastening system can be found in [1]. What is the quite common problem is corrosion of parts of the fastening system – see Fig. 1. It is possible to observe this problem at level crossings and in tunnels.

At these places, compared to other places of the railway line, are suitable conditions for increase of corrosion:

- Higher humidity.
- Elevated temperature.
- At the level crossing – a significant effect of the de-icing products that are used during the winter maintenance (NaCl, $CaCl_2$…). Information about winter maintenance of roads can be found in [2].
- Dynamic loading from the road traffic and the railway traffic.

As a part of the dissertation, the influence of the corrosion decrease of the material of the tension clamps Skl14 to the service life is solved. One of the problems that was necessary to investigate was the resistance of the tension clamps against corrosion surroundings. This topic was presented at SEMDOK 2015. The Scientific Committee has been accepted the paper for publication in an issue of the Slovak journal Materials Engineering - Materiálové inžinierstvo. The paper from SEMDOK 2015 can be found in [3].

2. Samples of the tension clamps Skl14

For the investigation, both new tension clamps Skl14 without anticorrosion surface protection and the tension clamps with the anticorrosion surface protection KTL were used.

Fig.1. The corroded tension clamp at the level crossing.
(full colour version available online)

Both surfaces were examined for purposes of a comparison and checking wheather the tension clamps with the anticorrosion protection KTL are really more resistant against corrosion surroundings. KTL is the cataphoretic method of the corrosion protection of metal parts using dipping in a bath. Cleaned metal parts are phosphated and subsequently coated with KTL. In this method, the molecules are used. The resin molecules are adapted so that are soluble in water at the required extent [4]. The surface treatment that should be very resistant against corrosion is the result of the process. The tension clamps that are treated with the method mentioned above are used at level crossings and in tunnels.

For the investigation two methods were used. The first method was the neutral salt spray test and the second method was the immersion test in electrolyte solution.

3. The neutral salt spray test

The first method that was used for corrosion influencing of the tension clamps was the neutral spray test according to ČSN EN ISO 9227 [5]. This test is used for the simulation of surroundings with increased chloride content, eg. seaside areas or salted roads. The test is used for acceleration of corrosion with the action of NaCl, the increased humidity and the elevated temperature. For the test, corrosion chamber SKB 400 A-TR of manufacturer Gebr. Liebish GmgH&Co, Bielefeld, Germany was used.

The manufacturer of the tension clamps uses the neutral salt spray test according to EN ISO 9227 too.

For the purposes of the neutral salt spray test, forty samples of the tension clamps Skl14 were used, twenty samples without anticorrosion surface protection and twenty samples with the anticorrosion surface protection KTL. The samples in the corrosion chamber are shown in Fig. 2.

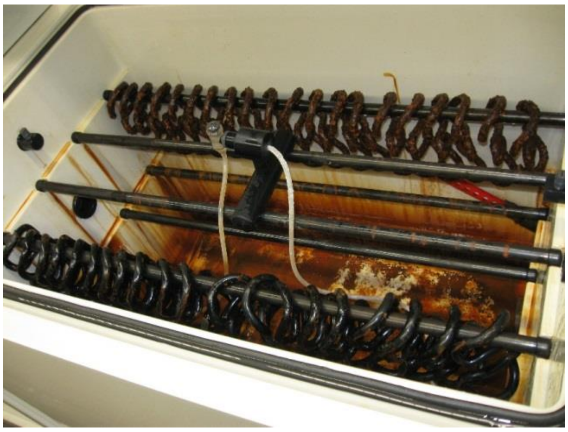

Fig. 2. The samples in corrosion chamber.
(full colour version available online)

3.1 The procedure of the neutral salt spray test

The procedure was in accordance with [5]. The test was carried out in twelve-hour cycles. For six hours, the samples were exposed to 5 % NaCl salt mist at 35 ± 1 °C followed by two-hour drying at 28 °C and the cycle was completed with four-hour condensation at 40 °C. During the test, the samples were monitored continuously and the photo shoots were taken. The photos were taken in order to document the increase of the corrosion products at the surfaces of the tension clamps.

Total time of the test was counted by the corrosion chamber. Total time of the test was 1728 h. After 1728 h it was decided to terminate the neutral salt spray test. While checking the samples in the corrosion chamber the increase of the corrosion products on the surfaces of tension clamps was not significant in two consecutive cycles. The barrier effect of the corrosion products on the surfaces of the tension clamps without the anticorrosion protection was the biggest reason of above mentioned. These corrosion products on the surfaces of tension clamps partially prevent transmission of corrosion surroundings to the material of tension clamps. According to requirements of ČSN EN ISO 9227 it was impossible to remove corrosion products from the surfaces of tension clamps. Moreover, it was not possible to perform the laboratory simulation of the combination of corrosion surroundings and the repeated dynamic loading. If this was possible, as in the operated railway track, the action of the corrosion surroundings would cause corrosion of the tension clamps Skl14. On their surfaces the corrosion products would be produced but due to the dynamic strain of the clamps the corrosion products would be peeled and sloughed. The combination of these stresses could then achieve the greater corrosive effect. At the tension clamps with the anticorrosion surface protection KTL corrosion traces appeared only locally.

As mentioned above (the barrier of the corrosion products) it was proceeded to the immersion test in electrolyte solution.

4. The immersion test in electrolyte solution

An electrolyte solution consisted of 5 % NaCl and 3.5 % $(NH_4)_2SO_4$. The proposed procedure is in accordance with [6, 7]. In [6, 7] it is stated it is possible to carry out cycle tests that represent a combination of the accelerated corrosion tests. In this case it is a combination of the test in a corrosion chamber and the immersion test in electrolyte solution (sulphates and chlorides). The test was not performed according to the standard but it can be reproduced any time.

For the immersion test in electrolyte solution, half of the samples that were removed from the corrosion chamber (1728 h) were used. It means ten samples without anticorrosion surface protection and ten samples with the anticorrosion surface protection KTL.

For the test, the plastic container was used. A special crafted sheet metal profile was placed to the plastic container. The samples were hung on this profile – Fig. 3.

Fig. 3. The samples prepared for the immersion test in electrolyte solution.
(full colour version available online)

4.1 The procedure of the immersion test in electrolyte solution

The procedure of the immersion test in electrolyte solution was following. The samples were immersed to an electrolyte solution. The electrolyte solution consisted of 5 % NaCl and 3.5 % $(NH_4)_2SO_4$ in distilled water. Every 48 h the electrolyte solution was aerated with compressed air for about 5 minutes. After roughly 30 days the samples were removed from the electrolyte solution and immersed to pickling solution. The purpose of pickling solution was to remove the residues of the corrosion products from the surfaces of the tension clamps. After immersing in pickling solution the residues of the corrosion products were mechanically removed and the surface was cleaned with a stream of distilled water. The pickling solution was prepared by dissolving of 5 g urotropine (hexamethylenetetramine) in 1 l of 20 % HCl [8]. By removing of the corrosion products from the surfaces the barrier effect was removed and corrosion surroundings could effectively attack the surfaces of tension clamps. After this procedure, the samples were inserted to newly prepared electrolyte solution. The whole procedure was repeated three times. It means 96 days, approximately 2300 h.

5. Description of achieved results

The article brings first introduction to the corrosion investigation of the tension clamps. It is one of the first steps of the dissertation. The best way how to describe corrosion of the tension clamps would be metallographic analysis and comparison. Unfortunately, it is not possible to perform because it is not possible to destroy the samples. The resulting samples of the tension clamps will be used for the tests on the dynamic test stand. Different corrosion decrease is important for the assessment of the fatigue properties. Therefore only weight decrease and the pictures of the tension clamps are presented.

The samples were subjected to the long-term exposition to corrosion surroundings. Firstly, it was the neutral salt test spray according to ČSN EN ISO 9227 followed by immersion in electrolyte solution. The final appearance of the samples is shown in Fig. 4, Fig. 5 and Fig. 6.

Fig. 4 shows the sample without anticorrosion surface protection. The figure shows that the transport varnish was completely removed.

Furthermore, the corrosion decrease is evident. The corrosion decrease is uneven. Fig. 5 shows the sample with the anticorrosion surface protection KTL and Fig. 6 shows the same sample but more detail. The investigation showed that tension clamps with this anticorrosion protection are significantly more resistant to corrosion compared to the tension clamps without anticorrosion surface protection. Due to the statistical evaluation of corrosion decrease of the material of tension clamps, the new tension clamps and the tension clamps after the corrosion investigation were loaded. The results are shown in Table 1.

Fig. 4. The tension clamp without anticorrosion protection after corrosion loading.
(full colour version available online)

Fig. 5 The tension clamp with anticorrosion protection KTL after corrosion loading.
(full colour version available online)

Table 1

Weights and weight losses of tension clamps.

	Weight (g)		Weight loss (%)
	New	**After the corrosion loading**	
The tension clamps without anticorrosion protection	498.95	459.20	**8.66**
The tension clamps with anticorrosion protection KTL	498.59	494.71	**0.78**

Fig. 6. The tension clamp with anticorrosion protection KTL after corrosion loading – detail of the corrosion.
(full colour version available online)

The average weight of new clamps without the anticorrosion protection was 498.95 g. The average weight of new clamps with the anticorrosion protection KTL was 498.59 g. The average weight of clamps without the anticorrosion protection after the corrosion loading was 459.21 g and clamps with the anticorrosion protection KTL was 494.71 g. From the results it is evident that, after loading, the weight loss of the clamp without the anticorrosion surface protection is approximately 8.65 %, while at the clamp with the anticorrosion protection KTL is only 0.8 %, almost 11 times less.

6. Conclusions

From the above mentioned it is possible to state that the tension clamps with the anticorrosion protection KTL have very good corrosion resistance compared to the tension clamps without anticorrosion protection. However, it is necessary to be noted that the tension clamps were exposed only to corrosion surroundings without the dynamic loading. It can be assumed that dynamic loading can affect resistance of the surface layer of tension clamps. This surface layer can be distorted and corrosion can then easily penetrate the material of tension clamps. Moreover, the dynamic loading can remove the barrier effect of the corrosion products. This assumption will be verified within the next investigation. Other measurements and investigations of tension clamps were made by author of the paper. It means especially fractography of cracked surface and metalography of the tension clamp. Details can be found in [9 - 11]. Other measurements and investigations will be presented in next paper.

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