Long-term experience with thin-film batch-galvanized traffic restraint systems in real-life testing

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ZINQ® Technologie

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Safeguarding infrastructure is an important prerequisite for maintaining the economic performance of an economy. Corrosion protection assumes one of the most important roles for steel constructions of all kinds. Traffic restraint systems, especially those installed along the approx. 13,000 km of motorways and 38,000 km of federal highways to safeguard moving traffic in Germany, represent a special field of application. For many decades, these systems have been designed as batch-galvanised crash barriers, posts and hollow box systems made of steel. Since the 1990s, concrete design variants have been increasingly used, especially in the area of central roadway barriers, which created a strong competitor for traditional steel systems.

Fig. 1: Overview of thin-film"microZINQ®"-galvanized traffic restraint systems.

Fig. 3: Thin-film "microZINQ®"-galvanized crash barrier with a collision mark.

Against this background, research work was initiated for steel systems with the task of examining the potential for improvement of existing systems. One issue they were aimed at addressing is whether higher-strength steel grades with a reduced material thickness can be used [1, 2]. Secondly, it focused and is still focused on testing modern corrosion protection coatings [3, 4]. Within the scope of a current project from the Research Association for Steel Application (FOSTA) for the "Proof of the equivalence of novel corrosion protection coatings for steel crash barriers", the thin-film batch galvanization microZINQ® was included as one of the innovative variants. This resource-efficient galvanizing method, based on the application of a 95 % zinc 5 % aluminium alloy in the batch-galvanizing process, which on the one hand significantly reduces the zinc layer thickness when compared to classic batch galvanizing and on the other hand increases the corrosion resistance of the coating, has already proven itself in the automotive sector since the beginning of the 2000s on millions of chassis components [5, 6].

Since it was only logical to transpose an analogous application of moving chassis components to that of static restraint systems, a first test track with thin-film batch-galvanised traffic restraint systems was set up 10 years ago for the purpose of subjecting it to long-term weathering under real conditions in the forerun to the aforementioned research project. Such testing is necessary against the backdrop of the existing regulations for the verification of the corrosion protection of alternative steel crash barrier systems and the limited informational value of short-term corrosion tests for systems forming the surface layer, despite being associated with significant time expenditure.

Ageing conditions

The test track was installed in May 2009 over a length of 200m along Federal Motorway A48 in the Eifel region. Here, microZINQ®-galvanized crash barriers, posts and hollow box profiles were installed to incorporate a wide range of restraint components. The prevailing macroscopic corrosion load at the test site lies within the range of corrosion category C2-C3 pursuant to DIN EN ISO 9224. However, the load also depends particularly on the type and quantity of road salt used that is transferred from the roadway to the restraint systems by moving traffic. Over the course of the observation period, road salt with a share of at least 96 M % NaCl in accordance with TL-STREU ("Technical delivery conditions for gritting agents") was used, which is the predominant type of road salt in Central Europe. With regards to the quantities used, the chosen location is representative and lies within the average range in Germany. In the 2009-2017 period for which data is available, consumption slightly exceeded the Germany's average of 38 tonnes of road salt per km[7]. A comparison of the design values for salt consumption in accordance with the directive for the dimensioning of de-icing salt stores (Ri-TAUSALA) also shows that the selected site is within the federal areal average with a quantity of 2,700g/m².

Visual assessment of the galvanized components

After 10 years, the fourth on-site inspection of the thin-film, batch-galvanized restraint system in total was carried out in May 2019. The overall impression of all the components used was positive throughout. As expected, the original silver-gloss zinc coating lost its "initial gloss" over time and took on the characteristic matt-light grey colour of zinc coatings, accompanied by the formation of the natural passivation layer of the zinc coating. Neither zinc corrosion, commonly known as white rust, nor base material corrosion can be detected. There are collision marks at various points, however they did not damage the zinc layer.

Fig. 2: Thin-film "microZINQ®"-galvanized C-profile posts after 10 years.

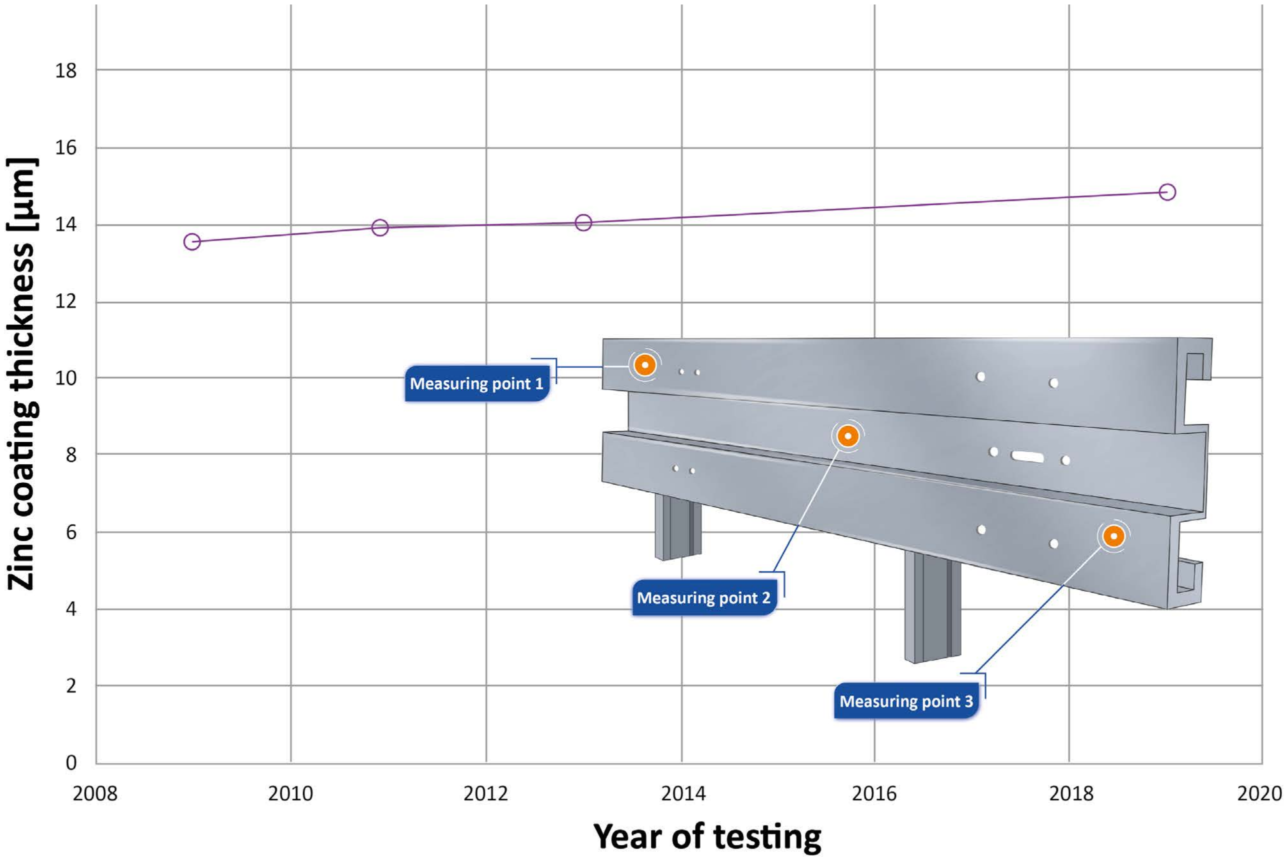

Fig. 4: Development of the zinc coating thickness on thin-film "microZINQ®"-galvanized crash barriers.

Coating thickness measurement

With zinc coatings, the reaction of the zinc with the atmosphere results in the formation of a passivation layer, the resistance of which ensures the durability of the zinc coating. Depending on the composition of the zinc layer and the prevailing atmospheric conditions, the zinc corrosion kinetics and the passivity of the zinc coating have a significant influence on the degree of corrosive attack and, if there is insufficient resistance, on the zinc loss rate, equivalent to a reduction in the thickness of the zinc coating. Regularly checking the coating thickness over the entire testing period is thus an essential instrument for evaluating the resistance of the zinc coating under real loads.

In this case, the layer thicknesses in the initial state and at the subsequent on-site inspections were recorded by means of a magneto-inductive method at three defined measuring points, ensuring a representative distribution of the layer thickness, on the crash barriers on the side facing the roadway (see fig. 4). As part of the measurement process of the weathered components, the areas to be tested were first cleaned of loose impurities with a cloth, and then cleaned again with a mildly acidic cleaning solution. The coating thickness was subsequently measured, with five individual measured values collected for each measuring point and the mean value was calculated from them. Fig. 4 shows the results of the coating thickness measurement and how they developed over the observation period of 10 years. This illustration shows that there was no noticeable impact on the microZINQ® coating over the 10 years. The slight increase of the coating thickness can be classified as being within the usual measuring tolerance or caused by impurities which cannot be removed completely during pre-cleaning.

This result confirms both the findings gathered from previous field experience with chassis components and the findings found in a research project of the Federal Highway Research Institute (BASt) in the field of continuously galvanised (strip) traffic restraint elements that ZnAl coatings do not exhibit any relevant measurable abrasion [8].

Conclusion

In 2009 as part of a long-term test, components of a traffic restraint system were equipped with the thin-film batch-galvanization microZINQ®, which was installed on a 200m-long test track along Federal MotorwayA48. Since then, the effectiveness of this modern corrosion protection has been tested under real weather conditions. After 10 years, the preliminary conclusion is that the thin corrosion protection layers are fully effective and do not exhibit any signs of wear. The development of the recorded zinc coating thicknesses over the years without inspection proves this impressively. It confirms the very high degree of resistance of this special type of batch galvanizing, which has already been proven in millions of applications in vehicle construction, even under the specific requirements of passive traffic safety devices, and fully meets the expectations placed upon it. With regards to the urgently needed resource-efficient, sustainable systems in the area of infrastructure, which are also required in the Federal Government's current draft of the Climate Action Act, microZINQ® offers an excellent solution for the corrosion protection of steel structures which has been proven in long-term testing.

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