The effect of differentiated exposure conditions on corrosion behaviour of weathering steel on bridges

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Application of weathering steels for bridges represents a suitable choice of this material for long term service lifetime. In the Czech Republic after year 1975 about 20 steel bridges were built from weathering steel Atmofix 52 which fulfills the requirements of EN 10025-5.

The long-term durability of these structures should be obtained in case the suitable conditions for protective rust layer (patina) forming will be created: surface cyclic wetting and drying in acceptable level of air pollution. The evaluated objects are located in atmospheric conditions with corrosivity C3, but some of them had been exposed for the first 10 years in atmospheres with corrosivity C4. The only effect of salinity is from deicing salts applied during winter seasons.

Figure 1 - The examples of evaluated bridges

Differenciated exposure conditions are evocated by different orientation to the influencing environmental effect and by level of sheltering. Structure design can cause defect points and zones (corners, concaves). All these effects modify protective ability of patina layers.

The evaluation consists from:
- visual evaluation and photodocumentation,
- measurement of corrosion product layers´ thickness
- measuring of residual thickness of steel profiles
- evaluation of corrosion layers´ structure - reprints
- analysis of corrosion products – PAI calculation.

Table 1 – Thickness of corrosion layers after 25 - 30 years

Surface area	Average corrosion layer thickness (µm)
vertical surface	145
vertical surface above low flange	240
vertical surface affected by leaking	190
horizontal surface – low flange	335
bottom view – upper flange	230
bottom view – low flange	140

Corrosion attack of vertical and horizontal surfaces is different (Figure 2). Critical areas are horizontal surface of low flange and narrow strip ca 15 cm above this flange where time of wetness of surface is longer and deposition of non-adherent rust, dust and other pollutions occurred. The rust layer is less adherent on these areas than on typical open surfaces but it is protective. This effect becomes less significant during exposure time (Figure 3).

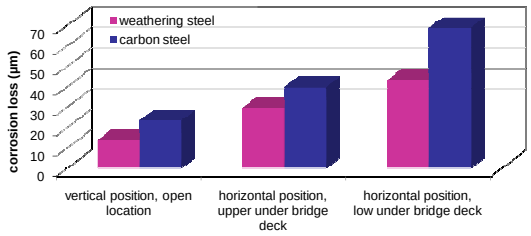

Figure 2 - The corrosion loss of weathering and carbon steels after 12 years of exposure in different positions on bridge structures

Figure 3 – The specific affected areas above low flange – the same bridge evaluated in 2002 (left) and 2009 (built 1986)

Rust layers reprints document the structure and compactness of patina layer (Figure 4).

Figure 4 – The different structure of patina layer on bridge after 30 years of exposure

Negative effect on protective layer forming has such detail as deck drainage system (scuppers, troughs, etc.). During the inspection of bridges there were found many defects caused by these functionaless, blocked or trimmed elements (Figure 5). Protective patina is not formed at such areas. In some cases precipitation containing deicing salts leaked on weathering steel surface and destroyed the protective ability of patina layer.

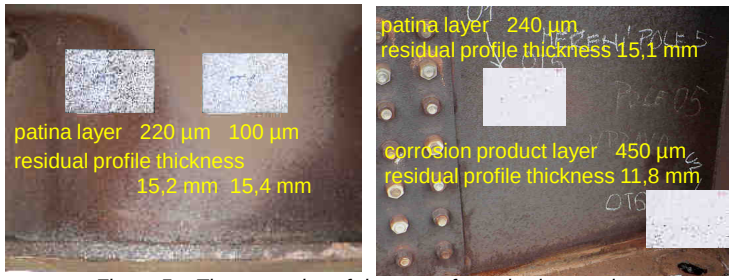

Figure 5 – The examples of damage of weathering steel structures

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