UNIVERSITY OF PATRAS
DEPARTMENT OF MECHANICAL ENGINEERING AND AERONAUTICS
FIELD OF APPLIED MECHANICS, MATERIAL TECHNOLOGY & BIOMECHANICS
LABORATORY OF TECHNOLOGY & STRENGTH OF MATERIALS

THESIS
"The effect of steel bars' exposure length to corrosion on seismic loads"
Lagousis-Botonis Dionisios, R.N. 245997

Apostolopoulos Charis, Associate Professor

TECHNOLOGICAL PROBLEM

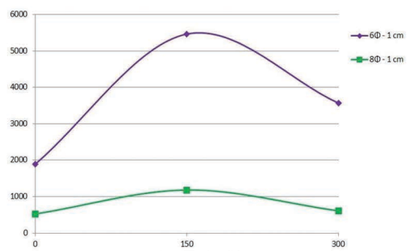
A reduction in durability of steel reinforcement constructions, due to corrosion, constitutes a main performance issue. In Greece, problems of construction durability are high in intensity due to aggressive chloride action, since a large building portion is located in coastal areas, causing it to either come in direct contact with sea water, or be infected by air-transported chlorides. Especially in seismogenic areas, these degradation problems intensify, as frequent seismic action dynamically wears out steel reinforcement, facilitating steel reinforcement corrosion, since it is the steel that absorbs this seismic energy. Based on the above, the combined corrosion accumulation due to steel corrosion and fatigue effects of seismic loads, has a significant impact on steel's mechanical performance and furthermore, on the overall structural performance of steel reinforcement construction.

OBJECTIVE OF STUDY

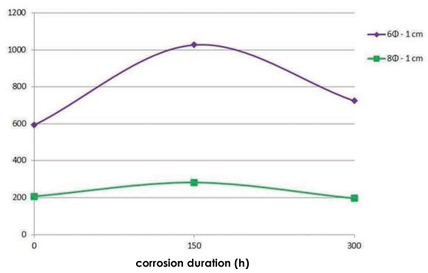
In this experimental study, the effect of steel reinforcement's exposed corrosion length was placed under examination. Two sub-groups, one with exposed corrosion length of 1 cm and another of 10 cm, were examined. For the purposes of this laboratory study, the two sub-groups of steel bars underwent an accelerated corrosion process via electrical current, in order to test the effects of corrosive agents in a short amount of time.
In addition, due to the need for anticorrosive protection of steel reinforcement constructions, a second subject of this study was of shot blasting process' contribution to the specimens' mechanical properties. Specifically, all the corroded specimens underwent a shot blasting process prior to corrosion. The shot blasting process consisted of two parts, one shot with Olivine particles, followed by a second shot of glass bead particles. Taking into account the elevated seismic activity in Greece, which causes mechanical fatigue on steel reinforcement, studying steel reinforcement's mechanical performance focused on simulating seismic loads, via mechanical, low-cycle, fatigue testing.

Failure cycles – Corrosion duration graphs for each exposed fatigue length

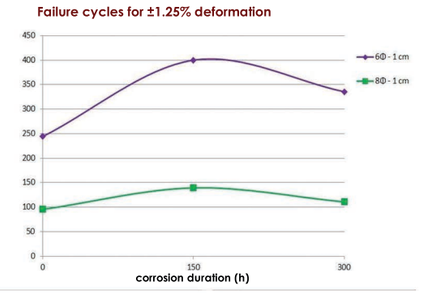
Failure cycles for ±0.75% deformation



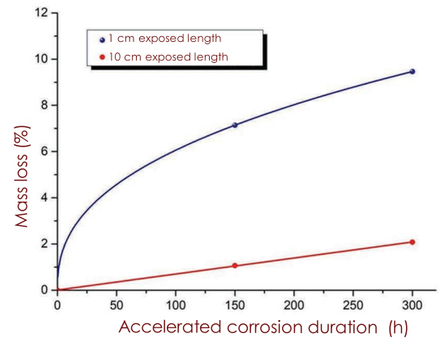
Failure cycles for ±1% deformation



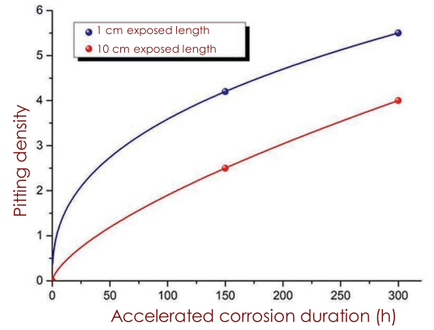
Failure cycles for ±1.25% deformation



Mass loss graph relative to accelerated corrosion duration for small (1 cm) and large (10 cm) exposed corrosion length

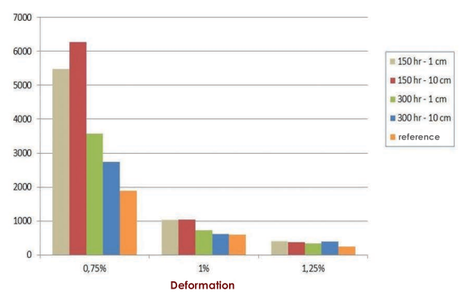


Pitting density graph over 500 μm x 500 μm surface area

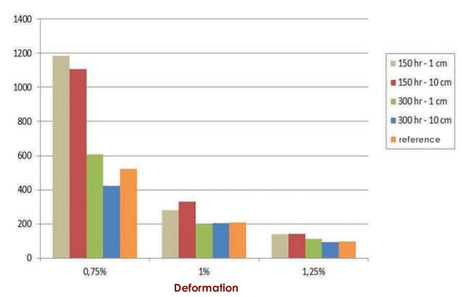


Failure Cycles charts

Failure Cycles of 6Φ specimens



Failure Cycles of 8Φ specimens



CONCLUSIONS

1. Corrosion length

- Concentrated corrosion surface caused great corrosion damage of specimens, in comparison to larger surface areas. The above statement was confirmed by the comparison of the percentage mass loss and pitting size and density between the two corrosion length groups. Corrosion length barely impacted mechanical performance at higher deformation levels (±1% and ±1.25%) and more so at lower deformations (±0.75%)

2. Shot blasting

- The Olivine and glass bead shot blasting process greatly improved specimen's life duration in relation with the reference specimens, even after mass loss rates of 10%.

3. Fatigue length

- Buckling effects in the case of an exposed fatigue length of 8Φ reduced life duration of steel reinforcement. In general, these buckling effects play a major role in all steel bars' life duration.