

Monitoring corrosion of reinforced concrete beams in a chloride containing environment under different loading levels

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Abstract. Corrosion has significant adverse effects on the durability of reinforced concrete (RC) structures, especially those exposed to a marine environment and subjected to mechanical stress, such as bridges, jetties, piers and wharfs. Previous studies have been carried out to investigate the corrosion behaviour of steel rebar in various concrete structures, however, few studies have focused on the corrosion monitoring of RC structures that are subjected to both mechanical stress and environmental effects. This paper presents an exploratory study on the development of corrosion monitoring and detection techniques for RC structures under the combined effects of external loadings and corrosive media. Four RC beams were tested in 3% NaCl solutions under different levels of point loads. Corrosion processes occurring on steel bars under different loads and under alternative wetting - drying cycle conditions were monitored. Electrochemical and microscopic methods were utilised to measure corrosion potentials of steel bars; to monitor galvanic currents flowing between different steel bars in each beam; and to observe corrosion patterns, respectively. The results indicated that steel corrosion in RC beams was affected by local stress. The point load caused the increase of galvanic currents, corrosion rates and corrosion areas. Pitting corrosion was found to be the main form of corrosion on the surface of the steel bars for most of the beams, probably due to the local concentration of chloride ions. In addition, visual observation of the samples confirmed that the localities of corrosion were related to the locations of steel bars in beams. It was also demonstrated that electrochemical devices are useful for the detection of RC beam corrosion.

Keywords: corrosion; reinforced concrete beams; electrochemical devices; loading; galvanic current

1. Introduction

Reinforced concrete (RC) plays a very important role in the construction industry worldwide, because of its versatility, low price, and especially its advantage of being resilient to extreme environmental conditions (Lomborg 2001). The effective bonding between a steel bar and concrete can take advantage of physical, mechanical and chemical properties for both materials. Unfortunately, adverse effects from factors such as corrosion may decrease the bonding force, and lead RC structural elements to durability reduction, serviceability decrease, bond strength drop and longitudinal cracking (Cabrera 1996). Corrosion of rebar in concrete is generally recognised as one

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17	-0.616	-0.622	-0.638	-0.650	-0.631	-0.637	-0.636	-0.636	-0.634	0.020	-0.039	-0.072	0.016	-0.016	-0.002	-0.011	0.008
28	-0.634	-0.624	-0.644	-0.646	-0.638	-0.632	-0.634	-0.633	-0.631	0.038	-0.038	-0.019	-0.009	0.019	0.004	0.009	0.004
29	-0.634	-0.623	-0.647	-0.654	-0.638	-0.640	-0.635	-0.640	-0.639	0.049	-0.066	-0.071	0.003	-0.011	0.014	-0.015	0.004
30	-0.635	-0.623	-0.648	-0.655	-0.638	-0.639	-0.634	-0.638	-0.626	0.045	-0.049	-0.059	-0.006	0.012	-0.003	-0.006	0.017
31	-0.633	-0.625	-0.650	-0.656	-0.640	-0.641	-0.635	-0.639	-0.633	0.030	-0.067	-0.067	-0.014	-0.006	0.005	-0.008	0.021
32	-0.633	-0.624	-0.650	-0.656	-0.640	-0.622	-0.636	-0.646	-0.630	0.034	-0.064	-0.063	-0.004	0.021	0.006	-0.023	0.034
35	-0.632	-0.623	-0.650	-0.656	-0.641	-0.625	-0.639	-0.647	-0.629	0.033	-0.074	-0.067	-0.007	0.047	-0.012	-0.031	0.032
36	-0.632	-0.624	-0.650	-0.656	-0.642	-0.629	-0.639	-0.647	-0.633	0.027	-0.071	-0.068	-0.010	0.014	-0.006	-0.030	0.025
37	-0.632	-0.623	-0.649	-0.655	-0.641	-0.642	-0.638	-0.642	-0.631	0.089	-0.121	-0.130	-0.050	-0.045	-0.019	-0.044	0.030
38	-0.632	-0.624	-0.647	-0.654	-0.641	-0.643	-0.639	-0.642	-0.631	0.026	-0.059	-0.088	-0.030	-0.032	-0.015	-0.034	0.017
39	-0.635	-0.624	-0.645	-0.653	-0.642	-0.643	-0.639	-0.643	-0.631	0.034	-0.061	-0.070	-0.011	-0.016	-0.002	-0.015	0.030
42	-0.635	-0.623	-0.646	-0.656	-0.643	-0.639	-0.640	-0.643	-0.631	0.032	-0.059	-0.075	-0.014	0.006	-0.006	-0.024	0.032
43	-0.631	-0.622	-0.646	-0.656	-0.642	-0.630	-0.640	-0.647	-0.630	0.037	-0.058	-0.076	-0.016	0.029	-0.016	-0.043	0.029
44	-0.630	-0.621	-0.644	-0.654	-0.640	-0.626	-0.638	-0.644	-0.629	0.037	-0.065	-0.077	-0.016	0.032	-0.017	-0.037	0.025
45	-0.624	-0.620	-0.645	-0.656	-0.642	-0.626	-0.638	-0.643	-0.632	0.032	-0.060	-0.085	-0.018	0.033	-0.018	-0.034	0.014
46	-0.629	-0.620	-0.645	-0.655	-0.641	-0.626	-0.639	-0.643	-0.634	0.054	-0.055	-0.079	-0.014	0.036	-0.015	-0.029	0.015
49	-0.626	-0.617	-0.642	-0.653	-0.639	-0.620	-0.637	-0.637	-0.631	0.037	-0.070	-0.088	-0.021	0.038	-0.033	-0.028	0.001
50	-0.628	-0.621	-0.646	-0.658	-0.642	-0.623	-0.640	-0.645	-0.635	0.027	-0.074	-0.092	-0.020	0.044	-0.022	-0.043	0.009
51	-0.627	-0.620	-0.645	-0.656	-0.641	-0.621	-0.639	-0.644	-0.636	0.027	-0.070	-0.087	-0.019	0.046	-0.023	-0.041	0.002
52	-0.628	-0.620	-0.644	-0.656	-0.641	-0.621	-0.640	-0.643	-0.636	0.028	-0.071	-0.091	-0.022	0.047	-0.030	-0.040	-0.003
53	-0.629	-0.622	-0.646	-0.659	-0.643	-0.623	-0.643	-0.649	-0.639	0.028	-0.072	-0.093	-0.022	0.030	-0.028	-0.041	-0.004
56	-0.625	-0.622	-0.643	-0.656	-0.642	-0.621	-0.642	-0.645	-0.638	0.017	-0.067	-0.089	-0.025	0.044	-0.036	-0.044	-0.007