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基于扩孔理论的混凝土钢筋锈胀开裂分析

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摘要: 采用圆孔扩张理论对钢筋混凝土保护层锈胀开裂过程进行分析, 推导不同锈蚀率下的混凝土塑性区边界应力及塑性区半径计算公式, 建立保护层锈胀开裂扩孔模型。依据扩孔模型导出与保护层开裂时刻对应的临界钢筋锈蚀率表达式 $\rho(t)$, 并对临界钢筋锈蚀率模型影响因素进行分析。研究表明: 临界钢筋锈蚀率 $\rho(t)$ 与混凝土强度等级、相对保护层厚度、钢筋锈蚀速率和铁锈膨胀率相关; 随着混凝土相对保护层厚度增大, 锈胀开裂临界锈蚀率 $\rho(t)$ 快速增大; 随着铁锈膨胀率增大, 临界锈蚀率 $\rho(t)$ 快速下降; 随着混凝土强度等级增大, 临界锈蚀率 $\rho(t)$ 增加不明显。该模型为进一步研究碳化或者氯离子侵蚀的钢筋锈胀开裂寿命预测提供了理论基础。

关键词: 扩孔理论; 塑性区半径; 锈胀开裂; 临界锈蚀率; 寿命预测模型

Analysis of rebar rust cover cracking in reinforced concrete with cylindrical cavity expansion theory

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Abstract: The cover cracking process of rebar corrosion expansion in reinforced concrete was analyzed with cylindrical cavity expansion theory, and animation model was set up for this cover cracking process. By the animation model, the radius and pressing stress analytic equations on plastic zone borderline were deduced respectively for different rebar corrosion ratios in reinforced concrete. Based on cylindrical cavity expansion theory, the critical rebar corrosion ratio $\rho(t)$ for reinforced concrete rebar corrosion cover cracking was presented with the rust counting model and the main factors' effects on this the critical rebar corrosion ratio $\rho(t)$ model's properties were theoretically analyzed. The results show that the critical rebar corrosion ratio $\rho(t)$ is directly relative to the concrete strength grade, relative covering depth and rust expansion rate. The critical rebar corrosion ratio $\rho(t)$ increases quickly as the relative covering depth increases, the critical rebar corrosion ratio $\rho(t)$ decreases quickly as the rust expansion rate increases, and the critical rebar corrosion ratio $\rho(t)$ increases slowly as the concrete's strength grade increases. This animation model presents the basic theory for the concrete cover rust expansion cracking life prediction of Chlorides or carbonization aggression.

Key words: cylindrical cavity expansion theory; plastic zone radius; rebar corrosion expansion crack; critical rebar corrosion ratio; service life forecast

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