



## Deterioration Prediction of Infrastructures with Time Series Data Considering Long Memory Effect

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### Abstract

In order to compensate for shortcomings of asset management based on visual inspection data, asset management based monitoring data has got a lot of attention. However, there is little methodology to apply time series data to conduct a decision making on asset management. In addition, long-term monitoring data of infrastructure have long memory effect because the deterioration of gradually progress owing to accumulating various deterioration factors such as traffic load, weathering, anti-freezing agent and etc. In this study, the authors propose ARFIMAX-GARCH (Autoregressive Fractional Integrated Moving average with exogenous variables-Generalized Autoregressive Conditional Heteroskedasticity) model and attempt to demonstrate the applicability of the proposed model by studying concrete application cases.

**Keywords:** ARFIMAX-GARCH model, long memory effect, time series analysis, joint members

### 1 Introduction

Current asset management is established on methodologies based on visual inspection data [1]. However, in terms of high practical demands such as early detection of deterioration, it is pointed out the limitations of visual inspection data. To compensate for defects of visual inspection data, monitoring data has attracted a lot of attention. In fact, the improvement in monitoring technology is expected to facilitate accumulation of time series data. However, there is little methodology to apply time series data to conduct a decision making on asset management. In order to improve asset management based on monitoring data, it is indispensably to develop the methodology to analyse the time series data. Monitoring is applied to the infrastructure with the significant progress of deterioration and given the means to complement the shortcomings of visual inspection. It is expected that monitoring enable

early detection of an abnormal deterioration and a detailed deterioration. As case study on application of the maintenance management of the monitoring data, it has been developed deterioration prediction method based on statistical characteristics of the time-series data obtained by the long-term monitoring [2]. However, in this previous study, the time series model cannot be considered the long memory effect; therefore, validity of the proposed model and the reliability of predictability of deterioration.

This paper proposes a time series model considered long memory effect with time series data accumulated through long-term monitoring, and develops a methodology to predict the repair and reinforcement timing based on long-term monitoring data. Specifically, the progress process of deterioration is expressed using ARFIMAX model (AutoRegressive Fractional Integrated