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SAFETY ANALYSIS AND RISK ASSESSMENT FOR BRIDGES HEALTH MONITORING WITH MONTE CARLO METHODS

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ABSTRACT

With the increasing requirements of building safety in the past few decades, healthy monitoring and risk assessment of structures is of more and more importance. Especially since traffic loads are heavier, risk Assessment for bridges are essential. In this paper we take advantage of Monte Carlo Methods to analysis the safety of bridge and monitoring the destructive risk. One main goal of health monitoring is to reduce the risk of unexpected damage of artificial objects.

KEYWORDS: Monte Carlo Methods; Monitoring; Risk; Assessment.

INTRODUCTION

The health monitoring of bridges and other structures are great importance as a part of the general problem of ensuring life support systems. Monte Carlo Methods (MCM) are widely applied in engineering for sensitivity analysis and quantitative probabilistic analysis in process design. In reliability engineering, one can use Monte Carlo simulation to generate mean time between failures that is the predicted elapsed time between inherent failures of a system during operation [1] and mean time to repair that is a basic measure of the maintainability of repairable items for components.

1.1. Research Status

The methodology in applied geodesy founded decisions are usually based on probabilities and significance levels but not on the risk itself [2]. As usually, two ways of risk assessment for bridges are considered. The first way is based on statistical data. The second way bases on the theoretical investigation of bridges behavior under loads. To carry out this investigation some typical bridges were chosen. For each type of bridge the correlation between the displacements and their damages was estimated. Each time-history bridge computation was considered as a realization of a random process [3].

1.2. Monte Carlo Analysis

A variety of methods are proverbially adopted in engineering analysis and Monte Carlo Methods (MCM) is one of them. In reliability engineering, one can utilize Monte Carlo simulation to generate mean time between failures that is the predicted elapsed time between inherent failures of a system during operation and mean time to repair that is a basic measure of the maintainability of repairable items for components.

MCM are quite useful for simulating systems that include modeling phenomena with significant uncertainty, such as the calculation of risk and evaluation of multidimensional definite integrals with complicated boundary conditions. In application to Engineering problems, In generally MCM predictions are better than human intuition.[4]

EXPERIMENT SETUP

The load increment was selected at 4kN up to the formation of the first crack and then the load increment increased to 5kN. Each load step was held for 5 minutes. The loading was continued until the ultimate load. The test setup will be introduced in Figure 1.

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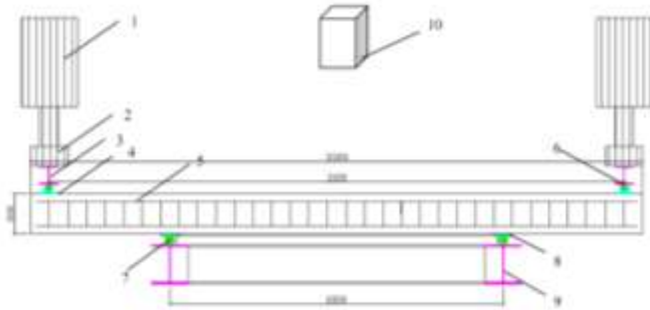

Fig. 1: Introduction of test setup [5].

The No. in the picture are list here: 1. Hydraulic jack; 2. Force sensors; 3. HEB 200 I-steel; 4.Steel plate of 5mm; 5. Test specimen; 6. Steel tube (Diameter: 5mm); 7. Steel tube (Diameter: 5mm); 8.Steel plate of 5mm; 9. I-steel frame (HEB 200); 10. Laser scanner. More details see [5].

ANALYSIS

Risk and safety during the health monitoring will be generated randomly, weighted with the relation to displacements and loads. For the randomly generated we will choose the MCM which are diffusely applied in engineering analysis and probabilistic simulate, including co-linear and non-linear behavior of typical process simulations.

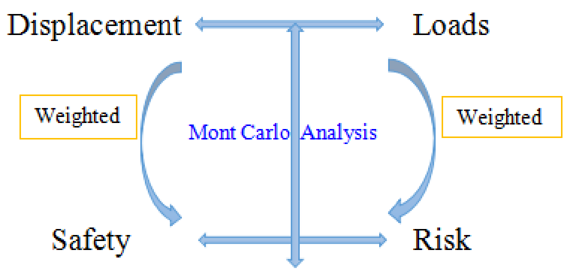

Fig. 2: The work flow of risk and safety analysis

After the Monte Carlo simulated, distribution between the risk and load can be obtained. Also the distribution of uncertainty will be reconstructed by the Monte Carlo.The frame of schematic diagram is present in Figure 2.

RESULT

The tested slab-strips were carefully inspected at each load step. The load and deformation were measured by force sensors and laser displacement sensors. The triangular displacement sensor is in the middle position under the beam. The TLS obtains the point clouds of beam at every load step. We gather the data about load and displacement as table 1. Here presented experimental setup should provide an example for the general working steps and ideas in the paper. For future information about the test see [5].

Epoch data	1	2	3
Load（kN）	0	14.17	22.40
Displacement(mm)	0	2.13	4.38

Table 1: The measurement of load and displacement

In the table 1, the load (force) is added step by step as the first line and the displacement in second line responds to the middle of beam.

CONCLUSION

In this experiment we obtained date from TLS measurement and analyzed with Monte Carlo simulation. In this paper we attempt to assess the safety of bridge with Monte Carlo Methods, in which we discover the relation between safety and risk for bridges health monitoring through weighted the displacements and loads. This innovative concept is based on a hypothesis where risk associated with the displacements and safety associated with the loads, and others are independent. The uncertainty between this relation will be in

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