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TECHNICAL INFORMATION

Introduction

Background

Cable stayed bridges represent an alternative optimal structural solution, for great spans as well as conventional bridges (beam and arch type) and suspension bridges.Their use has experienced a great increase in recent years even for smaller spans due not only to structural and economic advantages but also to others such as aesthetics. The maximum length of the staying cables is already above 250 m., but an upper limit is not yet envisaged, so that much larger lengths are expected to be reached safely.

Since the staying cables cannot be tested on a real scale because it is physically impossible, deduction of the fatigue properties of the real elements is needed using statistical techniques in order to permit:

- Extrapolation of the fatigue strength of the cables from short test specimens (usually as short as 200 mm) to the real length.

- Prediction of the fatigue strength of the cables from tests of limited duration for the equivalent number of cycles in the real structure, lasting for a period of 50 years.

Moreover, the interest of the size effect spreads over other structures (suspended roofs, prestressed ungrouted members) or conventional elements (crane ropes, etc.)

In addition, some complementary factors, such as anchorage, fretting or other possible failure mechanisms, which require one-to-one scale tests of propotypes, or demand fracture mechanics considerations, must be taken into account in order to ascertain whether one or several of these constructive or complementary details are the determining factors for bridge design as alternative to the fatigue failure of the cable in the free length.

Workshop

The need for a Workshop related to the length effect in fatigue arises from the following facts:

- Cable stayed bridges and other structures, in which fatigue design is the determining factor are becoming more and more common; whilst the relevance of the application of statistical knowledge and techniques to their design has not yet been generally recognized or even discovered by the structural community.

- A normalization of fatigue test techniques and posterior uses of test results are an inescapable condition for establishing a future international code.

- The lack of communication existing between statisticians and design engineers has to be surmounted in order to bring together two ways of thinking (theoretical and applied), both necessary for a safe design.

- Theoretical and experimental advances in the field of fatigue are applicable and extendable to other problems of mechanical, electrical and civil materials engineering in which a size effect is also to be taken into account.

Objectives of the Workshop

The main objectives of the Workshop are:

- To develop a common basis for statisticians and experimental or design engineers in the analysis of fatigue.

- To identify the factors influencing the size effect in the fatigue failure of longitudinal elements.

-- To define test guidelines and testing strategies in order to optimize the sample size and improve the reliability of the model under consideration.

- To analyze such factors as anchorage, fretting, etc., which could be a determinant for fatigue design.

- To define procedures for determining realistic design loads causing fatigue failure.

Topics

The Workshop attempts to embrace contributions covering the following topics:

1. Statistical Models

Dealing with the influence of length on the fatigue resistance of longitudinal elements.

Suggested items for discussion:

- Statistical models for the study of the length effect in fatigue resistance and the associated physical interpretation of the models.

- Minimal requirements for the definition of statistical models as suggested by design engineers from practical and experimental evidence.

- Model estimation techniques, including confidence and tolerance intervals.

- Implication of the selected models on testing strategies and practical recommendations, including extrapolation to real design situations.

- Information about the associated risks involved in using incorrect models.

- Discussion of the influence of dependence within the strength of neighbouring elements and election of the statistical model taking into account this influence.

2. Experimental studies

Comprising length effect observations and experiences from experimental laboratory programs.

Suggested items for discussion:

- Experimental evidence of length effect: Reduction of fatigue strength and its variance with length. Asymptotic behaviour from laboratory programs for different types of elements (wires, strands, tendons).

- Practical guidelines for test strategies as well as advice for the creation of future codes.

- Recommendations for fatigue testing techniques (test setup, type of clamping, frequency).

- The transfer of test results on specimens to full size elements (effect of length).

- Reporting the methods used in the fatigue laboratory for the statistical evaluation of tests results.

3. Failure mechanisms

Determining fatigue life as opposed to length effect.

Suggested items for discussion:

- Verification of current statistical models through fracture mechanics theory and experience.

- Macroscopic and microscopic study of fatigue failures in wires and strands and considerations related to fracture mechanics.

- Laws of flaw distribution from microstructure studies.

- Influence of mechanical and chemical attack (fretting, corrosion, corrosion protection system).

- Influence of the tendon construction (strand, bundle) , clamping and anchorage terminals.

- Influence of surface roughness and of metallic coating.

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