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Surveillance Programme for Stay Cables

Programme de surveillance des haubans

Überwachungsprogramm von Schrägseilen

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SUMMARY

It is not unusual for structures today to be required to have 120 years lifespans or more. This is not only an economical requirement of the developed countries, but also reflects the desire to build better quality structures. The way to meet this demand of modern construction is to develop maintenance and monitoring systems. Structures must provide all facilities to ease maintenance operations. This paper proposes a tentative surveillance programme which could be set up for stay cables through the example of the Normandy Bridge. The frequency of inspections, their nature and their contents are examined.

RÉSUMÉ

Les autorités publiques demandent aujourd'hui des durées de vie de 120 ans et plus. Au-delà de la nécessité économique des pays développés, il y a le désir de construire mieux et de meilleure qualité. Une réponse à cette exigence des constructions modernes est le développement des programmes de surveillance et de maintenance. Cet article envisage le cas des ponts à haubans, des haubans eux-mêmes, à travers l'exemple du pont de Normandie.

ZUSAMMENFASSUNG

Heutzutage verlangen die Behörden Lebensdauern von 120 Jahren oder mehr. Dies ist nicht erstaunlich; jenseits von den wirtschaftlichen Bedürfnissen der entwickelten Länder äussert sich tatsächlich der Wunsch, besser und mit einer zunehmender Qualität zu bauen. Die Entwicklung der Überwachungs -und Wartungsprogramme antwortet auf diese Forderung an die modernen Bauwerke. Dieser Artikel spricht von Schrägseilbrücken und Schrägseilen insbesondere am Beispiel der Normandie-Brücke.

1. INTRODUCTION

The need to maintain the existing infrastructures, of which bridges comprise an important part, induced many developed countries to conduct a survey of the bridge maintenance problem from both technical and economical point of view. It is of common understanding in Europe that the maintenance needs are given in terms of percentage of total bridge renewal value. Figures vary between 0.5 to 1.5% [1]. A simplified approach to this problem would lead to a lifespan of 170 years if the renewal percentage is 0.6 and 500 years if the percentage is only 0.2!. These figures indicate only one reason for having long lifespan. Since there are no products suppliers able to give a 100 or 120 years guarantee for their supply, we understand that monitoring and maintenance are a real need.

Large structures, like cable stayed bridges, which span estuaries or large rivers, have to be monitored and maintened.

2. CABLE STAYED BRIDGE SURVEILLANCE

2.1 General

The main reasons for maintenance of a cable stayed bridge are [2] [3] :

- to control the functional requirements and provide assurance that the structure is safe and fit for its designated use.

- to identify actual and potential sources of trouble and misuse at the earliest possible stage.

- to monitor the influence of the environment.

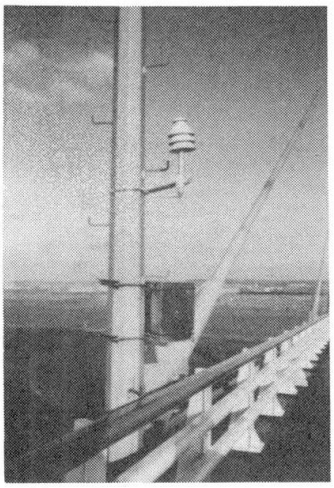
2.2 Monitoring of the Normandie bridge

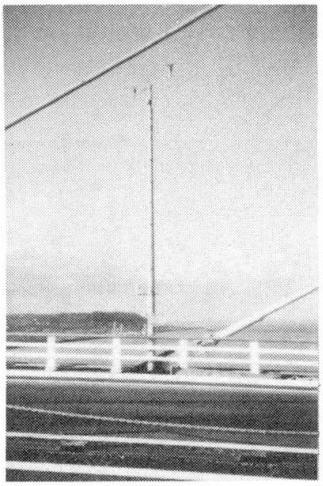
We are referring hereafter to the permanent surveillance of the bridge during operations. This does not cover the measures which were carried out during the various construction stages and during the static and dynamic testing.

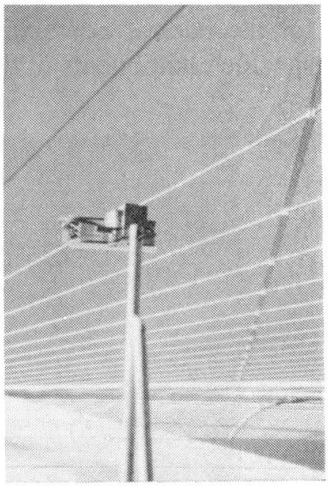
Measurement will be automatically recorded and stored in a computer centre close to the toll building. The following data will be measured and monitored:

- Wind speed at mid span (for traffic control).
- Temperature at 7 points of a steel deck cross section.
- Temperature at 7 points of a concrete deck cross section.
- Temperature at 8 points of a pylon cross section.
- Stress in the stay cables : 4 stay cables will be equipped.
- Temperature on one stay cable.
- Stresses in the steel deck at mid span (10 extensometers)
- Deflections and accelerations at pylon heads.
- Various accelerometers for vibration surveillance (pylon, deck and stay cables)
- Stresses in the steel deck at stay cable anchorage locations.

- Movements of expansion joints.
- Air humidity content in the steel box girder.







3. STAY CABLE MONITORING AND SURVEILLANCE

3.1 General

Instrumentation and permanent observation of the behaviour of large dams or nuclear plant facilities is common practice today. The same process used by American engineers from the U.S. Nuclear Regulatory Commission for the prestressing of the containment vessels is proposed to be used for the stay cables. This process would imply that arrangements be made during the construction study, so that expert appraisals can be carried out without any interruption to the structure's functioning.

The surveyed elements must be in easily dissociable simple units, so as to leave no doubt about the level of their characteristics during the surveillance, and therefore, the condition of the structure. The Freyssinet stay cable, with its individually protected strands, has been designed to be suitable for surveillance.

3.2 The Freyssinnet stay cable concept

This is a perfectly reversible assembly. Let us just recall that it can be installed and dismantled using only light equipment, with no interruption to traffic, and that no surveillance operation interferes with the bridge's serviceability.

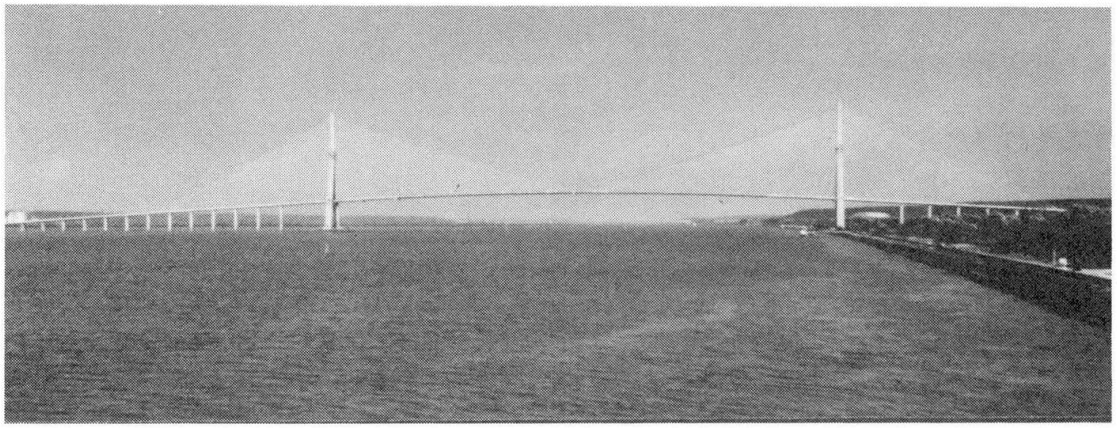
The surveillance is carried out on the three essential parts of a stay cable : the actual cable, the anchorage areas, the transition areas :

- The cable, composed of a bundle of parallel strands, with no rigid link between them, remains accessible to investigation on any strand : weighing, slackening, removal for detailed inspection.

- The anchorage areas are subjected to surveillance operations including external visual inspection, inspection of the anchorage, analysis of the wax, weighing of the stay cable, inspection of the adjustment threads.

- The transition areas are also subjected to a visual inspection prior to and after dismantling, and to an expert appraisal of certain materials (neoprene, mastic compound, plastic,....).

Basically the frequency of visits, their nature and the contents of the surveillance report must be defined. Right from the time of test-loading the bridge, surveillance operations for 1 year, 3 years, and 5 years later and thereafter every 5 years for the complete life of the bridge could be specified, as for the nuclear containment. A better approach would be to adapt the recurrence period to each specific components of the stay cable.

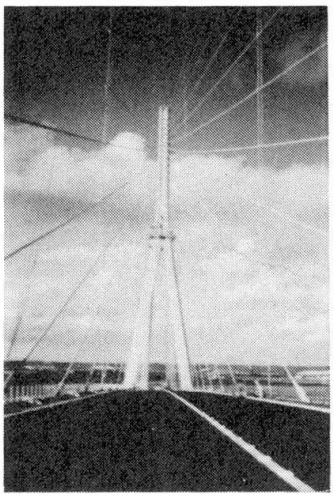


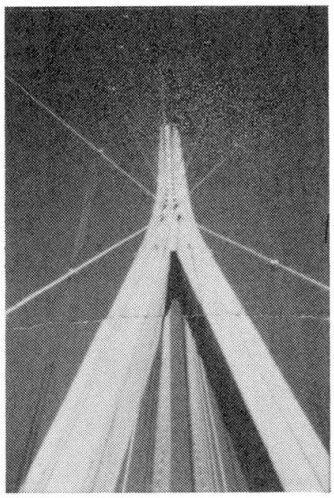
3.3 Proposed surveillance programme for Normandie bridge.

The following programme has been proposed :

MAINTENANCE PROGRAMME	FREQUENCY MONTH	QUANTITY %
1. DECK		
Guide pipe on steel deck	12	25
Deviator-guide on steel deck	60	25
Anti-vandalisme pipe	12	25
Lighting system	12	50
Damper	24	100
Injection caps on steel deck	12	25
Stay cable anchorage on steel deck	24	25
Anchorage of dampening ropes	24	25
Injection caps on concrete deck	30	25
Stay cable anchorage on concrete deck	36	25
2. PYLON		
Injection cap, adjusting nut	12	50
Stay cable anchorage	24	25
Tensioning systeme	12	100
External face of the pylone	48	100
Dampening ropes	12	25

SPECIAL PROCEDURES
Retensioning or detensioning of a stay cable Partial or total replacement of a stay cable Replacement of a dampening rope Replacement of aerodynamic sheath component Replacement of lighting collar Replacement of anti-vandalisme pipe





"Normandie bridge dampening ropes"

4. CONCLUSION

To conclude this paper, let us remember the new aspect which we wish to confer on surveillance, that is to adapt in relation to structural maintenance, a new state of mind, a new attitude, with the object of obtaining from owners an undertaking to include surveillance right from the origin of the project and to consider it as forming part of their investment and not just a badly defined maintenance cost which depends upon the manner in which the structure ages.

Surveillance, seen from this angle, is an intentional step which aims at preventing disorders and results in avoiding large repair works which cause interruption of traffic, particularly on large bridges. Its costs should be considered both in terms of service and good management with respect to public funds or in the interest of shareholders. But we should remember that no matter how perfect the project may be, the quality of behaviour in service of the structure, depends essentially on the treatment of finishing details, both in the design stage and during construction. Satisfactory durability depends on this, and it is illusive to count for inspection and surveillance afterwards if the construction has not been, first of all, carried out properly.

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