Comments of the author of the introductory report

VI

Remarques de l'auteur du rapport introductif
Bemerkungen des Verfassers des Einführungsberichtes
Comments by the author of the introductory report

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The main object of including theme VI — Dynamic loads in the frame of this Congress was to give the opportunity for discussing the general aspects and presenting data concerning an important class of loads that have in common their fast variation in time. The variability in time implies special methods of analysis and emphasizes the importance of the interaction loading — structural behaviour.

From a purely scientific point of view it would be desirable to deal with the problems of loading and structural behaviour separately. Often this is not possible due to the referred interaction. Also, in general, engineering problems present themselves altogether as the design of a special type of structure. Thus the description of the way the problem is solved involves both loading and structural behaviour. The presentation in separate of these two aspects is inconvenient for the authors.

From the 15 papers presented under theme VI, 12 deal specifically with different types of dynamic loading: 6 with wind, 2 with earthquakes, 3 with traffic and 1 with sonic boom. The 3 other papers deal with dynamic structural behaviour, particularly with the problems of interaction and damping.

However, most of the papers that deal specifically with loading also refer to structural behaviour. On the other hand several papers presented to the Congress under other themes that deal specifically with structural behaviour refer to load idealization also.

Since the general report was written, the idealization of dynamic loads progressed considerably. This progress is well expressed by the contributions presented to the Congress and by several other papers published in technical journals, in research series or included in the proceedings of specific symposia.

In what concerns wind loads, special reference is due to two simposia: one held in Canada [(1)] in September 1967, the other one held in Great Britain in April 1968 [(2)]. The papers included in these simposia use the modern concepts for wind idealization that were also followed in the general report, and include much valuable information for a better definition and understanding of wind action.

From the papers presented to the Congress, the one by Soboyejo [(3)] proposes to use for the maximum wind velocity a probability density function of the exponential type. This distribution is derived using the principal of maximum entropy. It would be of interest to discuss if this distribution gives a better approach than the distributions of extremes currently used [(4)].

The paper by Lewis and Waller [(5)] discusses the problem of gusting and vortex excitation of tall structures. The paper clearly shows the interest of the modern concepts of wind idealization for the technical solution of special problems.

The problem of vortex excitation of cylindrical bodies is dealt with by Hoyer and Hölzel [(6)] and by Novak [(7)]. The authors present a comprehensive review of the present state of the problem. The interest of this question is great since damage produced by vortex excitation may be important (2).

The use of Random Vibration Theory allows a useful unification of concepts. In the subcritical range the notion of Strouhal number can be improved by considering a narrow band power spectral density. In the supercritical range the power spectrum gets wider. Finally, in the transcritical range, a peak is again apparent associated with a distributed power spectrum.

In both papers the interest of further wind tunel tests is recognized. The importance of being able to control the turbulence in tunel tests is emphasized [(6)]. Measurement in the field conveniently interpreted, and including determination of space cross-correlations will also contribute to a better understanding of the problem. Although much progress was recently made, further research is necessary for a precise forecast of this type of loading.

The paper by Shears, Felippa, Clough and Penzien [(8)] is a good example of a complete analysis of a complicated design problem. In fact a guyed mast is represented by a non-linear several-degrees - of - freedom system acted by turbulent wind. Both the response to a deterministic loading and the stochastic behaviour are studied. In the last case the power spectrum and the cross-correlations of wind are considered. Vortex excitation is not referred to.

Another case of a study of a special type of structure under wind loading is presented by Murakami and Okubo [9]. It refers to a stayed girder bridge.

Double exponential extreme distribution is used for estimating the maximum wind velocity in the site. Wind tunel model tests, dynamic tests of the completed structure and a permanent system for the observation of the behaviour are described.

Several papers recently published (10 to 13) deal with improvements on the idealization of seismic loading. Other papers on the subject are to be presented at the IV World Conference on Earthquake Engineering to be held January 1969 in Santiago, Chile. The present main field of research concerns the stationarity of the time series that represent the soil acceleration. This is a controversial subject. The most satisfactory idealization shall not be one that allows to obtain simulated accelerograms very similar to real ones, but the one that allows to design structures that are conveniently safe. The problems of time duration, power spectrum shape, mean value of power spectral density of acceleration, its variation within an accelerogram, and its statistical distribution for different accelerograms, are intimately related and have to be considered together.

To this Congress no contribution was presented dealing with seismic load idealization. The paper by Agabein, Parmelee and Lee [14] deals with a related problem: soil-structre interaction. A square mesh finite elements model is used to reproduce the foundation of the building and the behaviour of shear type, 5, 10 and 15 stories, typical structures are studied. The influence of shear wave velocity and Poisson's ratio on the response to harmonic motion and to 1940 El-Centro accelerogram are analysed. Important difficulties arise in reproducing a half space by square finite elements. The authors overcome these difficulties using some complementary hypotheses, the validity of which is checked by comparing the results in a particular case with an analytical solution. The results show the importance of the interaction, but do not allow conclusions of general character.

The paper by Rumman and Maugh (15) deals with the seismic design of tall reinforced concrete chimneys. The provisions of a proposed ACI code are compared with the results of a model analysis. For performing the analysis 3 recorded accelerograms are used and the mean values of the results are taken. Such a procedure is often used as a design basis. Even so it is clear that it would be desirable to base the analysis on a more satisfactory load idealization. This is a fundamental problem that it would be of much interest to discuss. In the paper no reference is presented concerning the foundation deformability, that may much affect the dynamic behaviour of structures of cantilever type. On the other hand, simply to add the maxima of each mode to obtain the final response is in general too conservative. Finally, the definition of the ductility factor to be adopted in limit design of structures of this type is another important problem.

Three papers deal with the problem of dynamic effects due to traffic load.

Sidney Shore (16) describes the research that is going on at the University of Pennsylvania for the definition of impact factors in curved bridges. Codes indicate impact factor on straight bridges in function of the span only. It would be convenient to improve code expressions by including some of the more important variables and to extend such expressions to other cases, as the one of curved bridges, if possible using the same concepts.

The paper by Koloušek (17) refers to the dynamic analysis of a railway three-span precast prestressed bridge. Analytical results are compared with experimental ones. The method of analysis is the one developed by the author in some of his previous papers.

Fryba (18) uses the concepts of Random Vibration Theory to study traffic load in bridges. Two theoretical problems are considered. In the first one, a random concentrated load moves along a simply supported beam with constant velocity. In the second one the beam is acted by a distributed load that varies in function of time and of a coordinate system that moves at uniform velocity.

Further research, separately dealing with the problem of dynamic effects in road and railway bridges, based in modern concepts and intimately related to observed behaviour is recommended.

The dynamic effects on structures subjected to sonic boom are referred by Herrmann and Krajcinovic [19]. These authors propose to represent the short-time bi-triangular variation of pressure by a bipulse. They compute under which conditions the response due to the bipulse is larger than that due to an impulse.

Finally the papers by Illessy [20], Norzi [21] and Ohchi [22] do not deal with dynamic loads idealization but with dynamic structural behaviour only.

Illessy [20] advocates the use of analogue computers for studying dynamic structural behaviour. The principles of the method and the application to a Gerber truss bridge are given.

Norzi [21] dealing with the problem of damping of vibrations studies the relation between relaxation time and frequency. Influence of micro-structure, of initial static stresses and of asimmetry in the excitation of the vibrations is analysed.

Ohchi [22] deals with the problem of damping also. For multi-degree -of-freedom systems he proposes a damping matrix that is a linear function of mass and stiffness matrices. A more general form of the damping matrix is discussed and an example of dynamic analysis concerning suspension bridge is presented.

The definition of damping factors in one-degree - of - freedom systems and of damping matrices in multi-degree - of - freedom systems is a complicated problem. This is specially due to the difficulties of the experimental determination of numerical values.

As a general conclusion I would like to emphasize the importance of a conceptual correct and numerically accurate definition of dynamic loads. I thank all participants in the prepared discussion for their valuable contributions to this subject.

I ask the participants in the free discussion to concentrate on our main subject: the idealization of dynamic loads.

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