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Nouveaux matériaux pour modèles, ayant des caractéristiques physiques et mécaniques remarquables (très faible module d'élasticité, etc.).

Nouveaux procédés techniques divers, non seulement pour vérifier l'état de contrainte, mais aussi pour déterminer à l'avance les formes et les dimensions les plus appropriées des structures.

Adaptation accrue de la technique des mesures sur modèles à la résolution de problèmes de connexion particulièrement ardus (dalles obliques continues, enca斯特rement élastique des barrages, affaissement des terrains de fondation, etc.).

On peut s'attendre à de nouveaux progrès rapides et intéressants.

4. Conclusion finale

Il est remarquable de constater que plusieurs problèmes particulièrement ardus ont été résolus par l'emploi successif de plusieurs méthodes essentiellement différentes, par combinaison appropriée dans chaque cas des procédés analytiques rigoureux, de ceux de la statique appliquée et du calcul numérique ainsi que de la mesure sur modèles réduits.

Cette façon de procéder a le grand avantage d'assurer avec un très haut degré d'approximation les résultats acquis, et la comparaison par différents procédés est non seulement extrêmement instructive, mais aussi essentielle.

Cette voie est, à just titre, suivie de plus en plus fréquemment.

1. Analytical methods

In spite of other methods for the investigation of the action of forces, calculation by the strict methods of mathematical analysis still retains an intrinsic value. The following advances may be placed to its credit in the developments which have taken place during the last few years.

The use of functions that are increasingly better adapted to limit conditions (slabs with elastically-fixed ends, buckling of thin walls, special orthogonal functions).

The introduction of methods of calculation by iteration for the solution of systems of differential equations (thin cylindrical shells).

The use of imaginary quantities in certain special connexion-problems (for example slabs, thin plates, etc.).

2. Methods of applied statics and numerical calculation

Progress has been achieved by the use of «static analogies» whereby one member is compared with another, which resembles it statically as closely as possible, but which is more readily accessible to calculation (wall of an arch dam replaced by a lattice consisting of arches and beams, cylindrical shells assimilated to a beam, etc. and conversely, for example, the slab joined to the lattices of the deck of a bridge replaced by an orthotropic slab).

The static equivalence may be either total or partial, and in the latter case, it necessitates a complementary investigation. This method is particularly well adapted to the usual manner of thinking of the engineer who, in each practical instance, must satisfy himself that it is justified.

The carrying out of the numerical calculation characterised by the discontinuous nature of the results, is derived mainly from the «calculation by finite differences». Perhaps the most significant feature of the development is the fact that, for a large number of problems, the calculation with «ordinary» differences does not provide the degree of accuracy required. Recourse must then be had to processes giving a close degree of approximation (extension of expressions of finite differences by Taylor's series, «nodal» loads, etc.).

3. Experimental methods (measurements on models)

The development is particularly striking in this field where the chief progress relates to the following points:

New materials for models which have outstanding physical and mechanical properties (very low modulus of elasticity, etc.).

Various new technical processes not only for verifying the state of stress, but also for determining beforehand the most suitable shapes and dimensions for the structures.

Increased adaptation of the method of measurement on models to the solution of particularly difficult connection problems (continuous skew slabs, non-rigid encastrement of dams, setting of foundation soils, etc.).

Further rapid and interesting progress may be anticipated.

4. Final conclusion.

It is noteworthy that a number of particularly difficult problems have been solved through the successive use of several fundamentally different methods, by a suitable combination, in each case, of strict mathematical analysis, of methods of applied statics and numerical calculation as well as of measurement on small-scale models.

This method of procedure has the great advantage of ensuring that the results obtained are correct to a very close degree of approximation and comparison of the results from different processes is not only extremely instructive, but is actually essential.

This procedure is quite rightly being followed to an ever increasing extent.

1. Analytische Methoden.

Trotz der Entwicklung anderer Methoden zur Erforschung des Kräftespiels behalten die strengen Berechnungsmethoden der mathematischen Analysis ihre wesentliche Bedeutung. Folgende Fortschritte können in der Entwicklung der letzten Jahre verzeichnet werden: