Zeitschrift: IABSE reports of the working commissions = Rapports des commissions de travail AIPC = IVBH Berichte der Arbeitskommissionen

Band: 6 (1970)

Artikel: Comments to Theme I

Autor: Reese, R.C.

DOI: https://doi.org/10.5169/seals-7776

Comments to Theme I
Remarques sur le thème I
Bemerkungen zum Thema I

R. C. REESE
USA

As one of the instigators of this conference, it seems appropriate to follow Professor Wastlund's remarks with a short summary of what I thought might result from our discussions here.

Many writers have illustrated the damaging failures that can result from designs which do not make adequate provision for the effects of creep, shrinkage and temperature changes. Whole buildings have literally torn themselves apart. Precast post-tensioned tees have had the ends of the webs pulled away from the rest of the beams. Supporting shelves have been separated from the sides of main girders. Columns have bowed, cracked and completely failed. The list could be greatly extended and usually results in excessive expenditures where fairly inexpensive precautions could have originally been adopted.

There seem to be at least three procedures that can be followed. One is to cut structures into independent, completely separated units of moderate length within which experience has demonstrated that the volumetric changes can be accommodated. Another is to attempt to estimate the magnitude of the forces developed by such volumetric reductions and provide reinforcement to transfer these forces properly from one end to the other. Then there are unusual solutions such as precompressing the structure by means of a prestressed peripheral beam endeavoring to match the precompression with the internal tensions from the effects of creep, shrinkage and temperature change. The first is almost entirely a matter of experience and judgment. It is hoped that the last two can supplement such experience and judgment with definite mathematical techniques.

The design of structural frameworks to accommodate gravity loads has become a very elaborate technical procedure. Whether slope deflections, moment distribution or matrices are used, engineers all over the world can communicate freely, knowing that the techniques themselves are well understood and that one need only discuss the numerical details. Shelves full of text books, building codes, the work of ACI 318, CEB/FIP, and hosts of others all deal with intricate and highly detailed procedures for properly providing support for gravity loads. These references also caution that the effects of creep, shrinkage, temperature changes shall be properly accounted for. Even such climatological phenomena as snow, wind, earthquake, and now blast have good appraisals of the loading conditions and use pretty much the same procedures and strength levels so designers can communicate very well.

For the effects of creep, shrinkage and temperature, codes and authorities usually dismiss the entire subject with a caution to "consider them.".

Although my personal contact with the problem goes back longer than I care to disclose, it was in 1941 when designing a storage structure for an ordnance depot involving double 20-ton cranes in a building 540 by 1470 feet (165 x 448 meters) that we were really put on our mettle to develop mathematical techniques to deal with creep, shrinkage and temperature. This study arose not so much from the technical aspects as from the fact that the completed design was over a million dollars less expensive than competing designs and so it became imperative to investigate some of these unusual situations instead of relying entirely upon past experience. They worked!

Even after the parameters have been isolated and their relative effects evaluated and after coefficients for the volumetric changes have been determined on moderate-size specimens under strict laboratory control, there is still the problem of determining what are appropriate values for inclusion in design calculations since exposures vary within the length of the structure. Should the type of mix, kind of aggregate, make of cement, order of placement or any other parameters be found to contribute heavily, they should be taken into account. If they play a minor part, they might be combined into a single factor.

As an example, knowing the behavior of a cylinder or bar of concrete in a closely controlled storage, what should one use for concrete placed at different times under different temperature and humidity conditions (over which the designer has little control), assembled rigidly into a completed structure, exposed conceivably to ice and snow at one end and possibly the direct rays of the sun on the other?

To get a step further, if the bases of all of the columns in a one-story structure were on ball bearings, the volumetric changes of the roof system would have little effect. It is only when the columns are anchored and forced to bend that they provide restraint for the shrinking roof system. Need the characteristics of the subgrade be determined? If the column can tilt its foundation more readily than it can itself be sprung, the restraint is lessened. If the spandrel beams are free to slide and roll over on stiffly anchored columns, relief will be afforded.

The hope, then, was that, by comparing the experiences of a considerable number of design engineers, it would be possible to establish the more important parameters, gain some idea of the probable spread in practical structures (possibly having to divide into different climatic zones), somewhat resolve the questions of tilting, springing, bowing and so forth and conceivably aim for an eventual mathematical procedure that could be as well agreed upon as moment distribution. Such a method would considerably simplify the work not only of the designer but of the code writer and particularly of insurers who must pass upon the responsibilites for faulty designs.

These were the aims and goals with which this seminar set out. You can judge the progress made. It was excellent at the companion ACI meeting in New York last spring, as Bob Philleo will report this afternoon.