

magnitudes must be interpolated from the theoretical curve at one inch intervals. Had a grid beam width of 0.874 in. been selected, this interpolation could have been avoided. However, the selection of smaller grid beams would result in the calculation of more joint displacements, in order to define the elastically deformed surface of the slab over the same general area. The solution of more than twelve simultaneous equations by ordinary methods was not considered feasible.

In the previous analysis no modification was applied to the concentrated load in order to determine deflections and moments near the concentration. Westergaard has suggested the use of an equivalent diameter of a circular load to avoid the singularity existing in the ordinary slab equation at the point of application of the load. In a grid system, no such discontinuity exists and deflections can be obtained under concentrated loads in a man-

ner similar to that employed in ordinary beam theory.

CONCLUSIONS

The adaptation of the moment distribution method to the analysis of slabs is done with the realization that the physical characteristics of the grid system are different from those of the homogeneous and continuous slab. Nevertheless, the grid analysis procedure seems to compare favorably with other known methods of determining deflections. The accuracy of the analysis is necessarily dependent on the number of grid beams used to approximate the slab.

As indicated by the example in this paper, the investigation of slabs on elastic foundations does not present any technique not already understood by the average structural engineer. Conceivably, these same techniques can be employed in the analysis of elastically supported finite slabs with thickened edges.

REPORT OF COMMITTEE ON BRIDGE DESIGN

G. S. PAXSON, *Chairman, Bridge Engineer, Oregon State Highway Department*

The Bridge Committee of the Division of Design was formed this year (1949). The membership at the present time consists of Mr. Raymond Archibald of the Bureau of Public Roads, Mr. James P. Exum of the consulting firm of Howard, Needles, Tammen & Bergendoff, Mr. E. L. Erickson of the Bureau of Public Roads, Mr. T. R. Higgins of the American Institute of Steel Construction, Mr. R. Robinson Rowe of the California State Highway Department, Professor C. P. Siess of the University of Illinois, and Mr. G. S. Paxson of the Oregon State Highway Department as chairman. In forming this committee it was the intention to have representatives of State highway departments, the Federal Bureau of Public Roads, universities, consulting engineers, and commercial interests intimately connected with bridge projects.

The first meeting of the Committee which was held in Washington, D. C. on May 2, 1950 was largely concerned with formulating objectives for the work of the Committee and preliminary arrangements for the presentation of a program at the 30th annual meeting.

The broad general objectives of the Committee are:

1. To keep track of current structural research and to encourage publication of the results. A large amount of work is done each year by universities, various highway departments, and city and county organizations. Too often this research work is undertaken in connection with some specific project and the result having served its purpose is filed away and forgotten. Much of it has value and is well worth general distribution.

2. To act as a clearing house for suggestions for needed structural research and to help, in so far as possible, in arranging for sponsorship for worth-while projects. Many problems, on which information is needed, are not, in themselves, of sufficient magnitude to justify the expense of a major research program. These same problems, however, are common to many organizations and, by a combination of the resources of these organizations and a sharing in the cost of the work, much information could be obtained at a nominal cost to each of the interested parties.

3. To arrange for observers on research done by commercial organizations. Manufacturers of materials, equipment, or parts used in construction do considerable research on their own products. Much of this research is very carefully done and rarely reported. This commercial research, however, has been in the past too often discounted as sales propaganda. It is the thought of this committee that, if outside organizations—such as the state highway bridge departments or the universities—could supply an observer to watch the tests and certify as to the adequacy of the report, much more value could be had from this type of research. At the present time three of the manufacturers of open grid steel decking are sponsoring a series of tests at the Oregon State College designed to furnish information on which to base a specification for the use of this particular product. The Oregon State Highway Department is furnishing an observer and at the conclusion of the tests will be able to report on the adequacy of the tests and the validity of the conclusions.

4. To arrange for presentation of research reports at Highway Research Board meetings. Structural work represents a considerable fraction of the expenditures on highways, and it is only proper that a section of the Department of Design should present each year at the annual meeting a limited number of research papers for the benefit of those interested in structural work and for publication in the *Proceedings* of the Highway Research Board.

The Bridge Design Committee has, through correspondence, assembled a considerable list of structural research projects now underway at various places in the United States. This list is by no means complete, and the Committee would appreciate help in making it more complete. It is not the intention to give a summary of the projects, but only to list them and to mention where the research is going on. Those particularly interested in the subject can undoubtedly secure more detailed data from those in charge of the particular project.

For several years a continuing research project has been going on at the University of Illinois on the distribution of stress in concrete slab bridges that is sponsored jointly by the university, the Illinois Division of Highways, and the U. S. Bureau of Public Roads. Results of the investigation have been pub-

lished from time to time in bulletins from the University of Illinois and a summary has also appeared in the Transactions of the American Society of Civil Engineers. Work on the theoretical aspect of this same subject is also going on at the Virginia Polytechnic Institute.

Recent experience by the railroads has stimulated great interest in the fatigue and impact stresses in structures, and a number of projects are now underway dealing with this matter. The California Division of Highways and the University of California are conducting tests on a steel girder bridge over San Leandro Creek near San Francisco. The test setup is very complete, and no expense is being spared in the gathering of as complete data as is possible. The Michigan State Highway Department is also conducting full-scale tests on impact, and the University of Illinois is making a theoretical study on the same matter.

The Pennsylvania Department of Highways and the United States Bureau of Public Roads arranged with the Association of American Railroads for a large number of stress measurements to be made on a truss bridge at Fort Loudon, Pennsylvania. The report is now being prepared and will soon be available. The Association of American Railroads has for several years been measuring stresses in railroad bridges of various types. Some of these measurements were made for the primary purpose of studying impact, while in other cases they were made to determine the adequacy of structures under normal traffic. Highway and railroad bridges have much in common, and the results of these railroad tests will be of considerable value to highway engineers.

The Column Research Council has sponsored a large number of projects dealing with various phases of the problems of column design. Theoretical investigation is underway at Brown University and laboratory testing is being done at Stanford University, the Pennsylvania State College, and by the Aluminum Company of America. Many data have been reported in publications of the Column Research Council.

The matter of torsion in steel girders is receiving the attention of engineering experiment stations at Lehigh University and at Swarthmore College. These projects are jointly sponsored by the Pennsylvania Department of Highways and the United States Bureau

of Public Roads. Cornell University is conducting an investigation on the buckling of riveted joint structures, sponsored jointly by the Column Research Council and by the United States Bureau of Public Roads.

A great deal of interest has been aroused lately by the proposed use of bolted connections as a substitute for rivets under some conditions. The Research Council on Riveted and Bolted Structural Joints is conducting experiments on such joints. The University of Illinois and Northwestern University are contributing by providing laboratory equipment and personnel.

The Association of American Railroads has become interested in the fatigue failures of floor beam hangers and has arranged with Purdue University to study this problem. A progress report has already appeared in the 1950 Proceedings A.R.E.A.

The investigation of vibration in suspension bridges due to wind action is continuing under auspices of the Advisory Board on Suspension Bridges. The University of Washington, through its structural research laboratory, has recently published a report of its wind tunnel tests. This report is unquestionably the most complete report of its kind. Other reports of the committee will be forthcoming from time to time. Tests are also underway at Princeton University on the effectiveness of different types of lateral bracing on the rigidity of suspension bridge stiffening trusses.

Two very valuable reports on the bearing values of piles have recently appeared. One of these, from the Nebraska Department of Roads and Irrigation, gives the results of loading tests on cast-in-place concrete piles, while the other from the American Railway Engineering Association gives the results on tests of steel and timber piles on the New Orleans, Texas and Mexico Railway in Louisiana.

The California Division of Highways is conducting an extensive survey on the performance of bank protection structures both along stream channels and on the ocean front. Publication of the results of these tests will be made by the California Division of Highways' monthly bulletin. The Iowa Highway

Commission and the United States Bureau of Public Roads are jointly sponsoring an investigation of the scour around bridge piers at the Iowa Institute of Hydraulic Research, and an investigation of the use of feasible materials to reduce scour around bridge piers is being carried on at the Rocky Mountain Hydraulic Laboratory in Colorado.

The Michigan State Highway Department is carrying on a program of tests on corrugated metal culvert material at the Department's laboratories on materials furnished by various manufacturers.

Considerable interest is being shown in the subject of prestressed concrete structures. A pedestrian overcrossing is now under construction in Los Angeles in which strain gauges are to be set on the reinforcing steel and in the concrete and complete records of strains kept. The University of California is participating in the research program.

For many years the proper value to be assigned wind forces in structural design has been the subject of much dispute. As an initial project of this committee arrangements have been made for some 16 states, the Territory of Hawaii, and the District of Columbia to cooperate in an investigation of wind loads. This investigation will be supervised by the Highway Research Board and will be conducted on scale models in a wind tunnel. It is hoped that this investigation will furnish a basis for a revision of present specifications along more logical lines.

The value of the work of this committee will depend almost entirely on the support given it by engineers and engineering organizations. The Committee will welcome any contributions to this work from any source. It will particularly welcome advice on research projects underway and will in turn endeavor to keep the membership advised on the progress of the projects. In this first half year of the life of the committee, cooperation given by engineering organizations throughout the country has been greatly appreciated, and it is our hope that full use of the facilities of the committee will be made by all concerned.