A BIBLIOGRAPHY CONCERNED WITH THE EFFECT OF FLOOR SLABS, WITH AND WITHOUT SPANDRELS, ON THE MOMENT IN COLUMNS DUE TO VERTICAL OR LATERAL LOADS

by

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Thesis submitted to the Graduate Faculty of the
Virginia Polytechnic Institute
in candidacy for the degree of

MASTER OF SCIENCE
IN
ARCHITECTURAL ENGINEERING

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June 1951

Blacksburg, Virginia

PREFACE

The Engineering Index was the primary reference for the articles listed in this bibliography. There are a few articles included which have been taken from various engineering experiment station bulletins. In order to determine the extent of coverage of the Engineering Index, several of the articles which appeared as experiment station bulletins were cross-checked and found listed in the Index. While it is possible that some significant articles may have been omitted from the Index, it is hoped that they were of less importance than any of those which have been listed.

The first volume of the Engineering Index appeared in 1884, therefore this bibliography will be limited to those articles listed in the issues of 1884 to May 1951 inclusive.

All of the articles published in the United States, Canada and England, and which were found to be on the campus, were read in a cursory manner in order to determine their applicability to the problem. In each case where the article was read, written additions were made to the abstracts in order that they might be more helpful to anyone using the bibliography. The part of the abstract enclosed with quotation marks was taken from the Index, the rest of the information was added.

Photographic copies and English translations of all of the articles listed may be obtained from the publishers of the Engineering Index.

It is hoped that this compilation of works on the integral action of beams, columns and slabs will prove helpful to anyone interested in this subject.

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II. INTRODUCTION

"Faulty analysis or a design based on ready-made, easily-applied, rule-of-thumb methods of computation can no longer be tolerated, from the standpoint of economy as well as of structural adequacy."[1]

The structural designer must therefore attempt to increase his knowledge of the interaction of the component elements of structures. He should consider the restraint which beams exert on slabs when the slabs are subjected to vertical loads, the restraint which columns exert on beams, the restraint which slabs exert on columns and beams when the structure is subjected to either vertical or horizonal loads, etc.

There are methods of analysis available to the designer which enable him to predict with fair accuracy, and within certain limits, the action of the component members of some structural forms. In many cases these methods have been verified by tests and may therefore be considered adequate. But the fact that existing standards governing present day design are safe, does by no means indicate that they are the ultimate insofar as efficient use of materials and shapes are concerned. In fact, tests of structures designed in accordance with various code requirements, seem to indicate that the structures are being improperly designed.

The validity of any formulas, or methods of design should be proven by actual tests where possible. The theoretical work on any subject and

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1. A. Amerikian

the experimental work must complement each other, otherwise there will be no justification for the use of any resulting formulas. It is this process that must be followed if we are to arrive at safe and efficient structures.

The purpose of this thesis is to aid in research concerned with the phase of structural engineering that relates to the modifying action of slabs on the connected columns or beams under various loading conditions.

An ideal slab form would be one in which the underside follows the form of a curve so that it is thicker at the supports, where it should be, and thinner through the central portion where both moment and shear resistance requirements are smaller. The slab would follow the curves commonly seen in use in the haunched beam. A slab of this type would be advantageous not only structurally, but aesthetically as well. But a slab having a curved underside is not a practical one in that it would incur greater costs in forming than might be saved in concrete and steel through its use.

The haunching of the slab might also be accomplished by a series of steps rather than the curve. This again would require difficult forming, and hence result in no overall economy of construction.

The next step might logically be the "slab band",[2] which is nothing

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2. Fred N. Severud

more than a shallow wide beam, hence incurring no more expense with respect to forming than do the conventional systems presently in use, yet being more economical with respect to the quantity of concrete and steel required. The "slab band" eliminates the deep beam, which in turn allows more usable space within the structure.

The "slab band" has been used as a method of framing in a number of structures, and has been found to be both structurally and economically adequate. But until the relationship between beams, slabs and columns under loads can be found more exactly, the question of structural and economical efficiency of any type of framing in which the slab performs an important stabilizing function will remain unanswered.

It is hoped that this thesis will be a step in that direction.

III. BIBLIOGRAPHY

Analysis, Theoretical

Plates

Die Spannungen in auf Biegung Beanspructen Stein Oder Betonplatten
(The Stresses in Stone or Concrete Plates Subject to Bending)
Professor Hofmann, Deutsche Bauzeitung, Dec. 1897

"The stresses in stone or concrete plates subject to bending. A mathematical investigation, with application to practical examples."

Stresses in Concrete Floors
W. Dunn, Jl. Royal Inst. Brit. Archs., May 1900

"The bending stresses in flat rectangular concrete floors. Explains formulae given in English books on Applied Mechanics, and gives a diagram for finding approximate maximum stresses on flat rectangular plates uniformly loaded."

Concrete-Iron Floor Construction
S. Rappaport, Schweizerische Bauzeitung, Nov. 1901

"A discussion of the stresses in floor construction, showing the lateral strains induced upon the walls of the building."

Concrete-Steel Floor Panels
S. E. Slocum, Engineering News, July 1904, pp 22-24

"The strength of flat-plates, with an application to concrete-steel floor panels. Develops a rational theory of stress distribution involving only elementary mathematical principles, and

Analysis, Theoretical

Plates

applying the results to the case of a crete-steel floor panel in actual use."

Does not consider torsion in supporting beams; uses various combinations of strips in order to determine deflections, deflection of supporting beams considered.

Note sur la Participation du Hourdis a la Resistance des Nervures dans les Constructions en Beton Arme

(Note on the Participation of the Ceiling to the Strength of the Girders in Reinforced Concrete Construction)

Henry Lossier, Schweiz Bauzeitung, Sept. 1904

"The relation of the ceiling to the strength of the girders in reinforced concrete construction. An examination of floor and ceiling construction in reinforced concrete, showing the extent to which the ceiling itself aids in supporting the load."

Graphische Berechnung des Widerstands-Momentes von Eisenbeton-Platten und Plattenbalken

(Reinforced Concrete Plates and Plate Girders)

P. Weisko, Beton u Eisen, No. 9, Sept. 1905

"Graphical calculation of the moment of resistance of reinforced-concrete plates and plate girders. Mathematical discussion."

Beitrag Zur Berechnung der Hauptunterzuge von Eisenbeton-Balkendecken

(Calculation of Reinforced Concrete Floors)

Analysis, Theoretical

Plates

S. C. Drach, Zeitschr d Oest Ing u Arch Vereines, Jan. 1907

Mathematical analysis of the stresses in concrete floors, longitudinally and transversely strengthened. Diagrams.

Continuity in Reinforced Concrete Beams and Slabs

M. E. Thomas, Engineering-Contracting, Feb. 1910

"What Consideration should be given to continuity in reinforced concrete beams and slabs. Discusses the reason for the variation existing in present practice of calculating bending moments and what are the theoretical moments that would guide a designer." Author indicates that continuity should be considered; paper does not appear to be a very enlightening reference at the present time.—

A Simple Method of Computing the Strength of Flat Reinforced Concrete Plates

Angus McMillan, Engineering-Contracting, March 1910

"Gives a description of the different methods used to compute the stresses in the "mushroom floor" designed by C. A. P. Turner." Author gives only empirical formulas; admits that slabs are over-designed, but safe; paper does not appear to be a very enlightening reference at this time; indicates that at that time problem of plate action was being considered.—

Analysis, Theoretical

Plates

Methods of Computing Reinforced Concrete Flat Slabs

Louis F. Drayton, Engineering-Contracting, Nov. 1910, pp 376-377

"Read before the National Cement Users Association, states the views of the author in regard to the form the surface takes, and explains methods of calculation."

Author recommends the use of strips in analysis of slabs; empirical formulas; paper does not appear to be a particularly enlightening one.-

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The Calculation of Plates, Supported by Four Columns

L. J. Mensch, Engineering-Contracting, Dec. 1910 pp 569-571

"Read before the National Association of Cement Users. Compares the theory of plates supported by four columns with the theory, practice, and tests of round and square plates. Mathematical."

Author seems to recognize problem of plate action; of the earlier papers on this problem, this paper appears to be one of the more interesting and possibly pertinent ones.-

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Untersuchung Eines Stockwerkrahmens

(A Study of Floor Framing)

Hans Leitner, Beton und Eisen, Sept 1912

"Mathematical investigations on the subject of wall stresses in reinforced concrete floors. Diagrams."

Analysis, Theoretical

Plates

Concrete Slabs

John Krippner, Engineering Record, June 1914, pp 731-732

"Girderless concrete slabs. Gives a proposed exact method of finding coefficient of bending moments of external forces." Author assumes three different loading areas for each column; treats areas as cantilever sections and completes solution for moment coefficients; solution mathematical.

Valeurs Maxima de la Tension Pres de la Face Inferieure d'une Plaque Carree Supportant une Charge Unique Concentree en Son Centre

(Maximum Tension in Square Plate Carrying Load Concentrated at Center)

M. Mesnager, Comptes rendus des seances de l'Academie des Sciences, Vol. 168, Feb. 1919, pp 392-395

"Mechanical theory of plate supported at its periphery, taking into account thickness of plate."

Die Theorie Elastischer Gewebe und Ihre Anwendung auf die Berechnung Elastischer Platten

(Theory of Elastic Netting and its Application to the Calculation of Elastic Plates)

H. Marcus, Armierter Beton, Vol. 12, Aug. & Oct. 1919, pp 181-190 & pp 245-250

Analysis, Theoretical

Plates

Aug.

"Discussion of plates having uniform loading."

Oct.

"Results of tests to confirm theory of flexibility of elastic plates. Discusses stresses in plates based on fracture theories, value of previously outlined plate tests, and tests with mild steel plates."

Die Theorie Elastischer Gewebe und Ihre Anwendung auf die Berechnung Elastischer Platten

(The Theory of Elastic Netting and its Application in the Calculation of Elastic Plates)

M. Marcus, Armierter Beton, Vol. 12, Nov. 1919, pp 281-289

"Writer discusses technical research methods for investigation of the plate theory, and the conditions under which problem can be solved."

Solution Elementaire de la Plaque Rectangulaire Encastree Portant une Charge Uniformement Repartie ou Concentree en Son Centre

(Elementary Solution of Fixed Rectangular Plate Carrying Load Uniformly Distributed or Concentrated at its Center)

M. Mesnager, Comptes redus des Seances de l'Academie des Sciences, Vol. 169, Dec. 1919, pp 1081-1083

Analysis, Theoretical

Plates

"Derivation of trigonometric series by considering components in various directions of vertical deflection of plate."

The Strength and Stiffness of Flat Plates

F. H. Hummel, Mechanical World, Vol. 67, March 1920, pp 172-173

"Table giving maximum deflection at center, stress at center and maximum stress in plate for plates of different forms and dimensions."

Theorie Rationelle des Hourdis en Beton Arme, Consideres Comme des Plaques Minces, d'une Simple Anistropie Orthogonale

(Calculation of Stresses in Reinforced Concrete Floors by Considering these as Thin Plates of Simple Orthogonal Anisotropy)

M. T. Huber, Comptes rendus des Seances de l'Academie des Sciences, Vol. 170, March 1920, pp 511-513

"Solution of differential equation of elastic surface."

Krydsarmerede Jaernbetonpladers Styrke

(The Strength of Reinforced Concrete Slabs with Cross-Reinforcement)

N. J. Nielsen, Ingenioren, Vol. 29, Nov. 1920, pp 723-728

"It is shown that the ultimate stresses in reinforced concrete can be calculated by means of differential equations. Numerical examples for square and rectangular plates."

Analysis, Theoretical

Plates

Uber die Spannungsverteilung in Einer Durch Eine Einzelkraft Belasteten Rechteckigen Platte

(Distribution of Stress in a Rectangular Plate Subjected to a Concentrated Load)

A. Nadai, Bauingenieur, Vol. 2, Jan. 1921, pp 11-16

"A simple analysis of stress is developed. Basic principles for a graphic method for determing stress in rectangle."

Recherches sur les Plaques Rectangulaires Minces

(Researches on Thin Rectangular Plates)

M. Pigeaud, Annales des Ponts et Chaussees, Vol. 60, Jan.-Feb 1921, pp 5-47

"Formulas for determing stresses."

Uber die Biegung der Rechteckigen Platte Durch Einzellasten

(The Deflection of a Rectangular Plate Under Single Loads)

A. Nadai, Bauingenieur, Vol. 2, June 1921, pp 299-304

"Determination of deflection and distribution of stress in a fixed-in plate strip with concentrated load. Application to different cases of stress in rectangular plates."

Berechnung der Bruchspannungen in Kreuzarmieter Eisenbetonplatten

(Calculation of the Breaking Stresses in Reinforced Concrete Plates

Analysis, Theoretical

Plates

With Cross-Reinforcement)

N. J. Nielsen, Bauingenieur, Vol. 2, Aug. 1921, pp 412-417

"Results of investigations show that breaking stresses can be determined with sufficient accuracy by means of differential equations; in presenting ratios between moments and deflections, breaking stresses must be simultaneously determined in two or more sections."

A Method of Calculating the Strength of Slabs

A. Ingerslev, Engineering, Vol. 112, Aug. 1921, pp 209-211 & pp 245-246

"It is shown that, with one assumption granted, it is possible to devise formulas for strength which shall be applicable to any type of loading and to different shapes of slab."

Edge conditions constant along individual edges for all cases considered; Paper appears possibly to be applicable to mathematical research.—

Two-Dimensional Stresses in Rectangular Plates

C. E. Inglis, Engineering, Vol. 112, Oct. 1921, pp 523-524

"Outlines general analytical method for investigating two-dimensinal distribution of stress set up in rectangular plate by stresses applied along its edges in any arbitrary manner."

Variations in edge conditions along particular edges considered;

Analysis, Theoretical

Plates

paper appears to be an applicable reference for mathematical research.—

Zur Berechnung der Pilzdecke

(Calculation of Flat Slab Floors)

K. Hruban, Beton u Eisen, Vol. 20, Oct. & Nov. 1921, pp 187-188 & pp 200-202

"Investigation of calculations heretofore used, and description of new method in which variability of height of plate is taken into consideration."

Berechnung von Eisenbetonplatten Unter Gleichzeitiger Berucksichtigung der Kontinuitat und der Teilweisen Einspannung

(Calculation of Reinforced Concrete Slabs with Simultaneous Consideration of Continuity and Partial Bracing)

A. Fruchthandler, Beton u Eisen, Vol. 20, Oct. & Nov. 1921, pp 184-187 & pp 202-205

"Calculation of partially braced plate extending over three or four fields of uniform width."

Ueber die Biegung der Allseitig Unterstutzten Rechteckigen Platte Unter Wirkung Einer Einzellast

(The Bending of a Rectangular Plate Supported on all sides and Subjected to a Single Load)

S. Timoschenko, Bauingenieur, Vol. 3, Jan. 1922, pp 51-54

Analysis, Theoretical

Plates

"Explains how to solve problem of deflection of rectangular plate braced on two opposite sides and supported on the two other sides."

Biegung Durchlaufender Platten und Rechteckiger Platten Mit Freien Rondern

(The Deflection of Continuous Plates and Rectangular Plates with Free Edges)

A. Nadai, Zeitschrift fur Angewandte Mathematik und Mechanik, Vol. 2, Feb. 1922, pp 1-26

also (abstract) Zeitschrift des Vereines deutscher Ingenieure, Vol. 66, Sept. 1922, pp 848-849

"Deals with girderless ceilings supported by columns in a rectangularly arranged trellis work of points. Discusses deformation and stress of such continuous plates and state of bending in separate points on edge of unsupported rectangular plates."

Verfahren Zur Angenaherten Statischen Berechnung Biegefester Rechteckiger Platten

(Method for Approximate Static Calculation of the Bending Stress of Rectangular Plates)

L. Hotopp, Beton u Eisen, Vol. 21, April & May 1922, pp 95-97 & pp 116-119

"Discusses distribution of stresses and gives examples and calculations."

Analysis, Theoretical

Plates

Over een Nieuwe Methode ter Berekening van Vlakke Platen Met Toepassing op Eenige Voor de Techniek Belangrijke Belastingsgevallen
(New Methods for Calculating Loads on Flat Plates)
C. B. Biezeno & J. J. Koch, Ingenieur, Vol. 37, Dec. 1922, pp 25-36

"Discusses stresses in fixed plates under various loads."

Rectangular Slabs

A. Ingerslev, Concrete and Constructional Engineering, Vol. 18, Jan. 1923 pp 51-56 & pp 57-59

"Solution by elementary calculus of problem as regards determination of bending moment and stresses at any point of slab. Abstract of paper read before Institute of Structural Engineers."

Eisenbewehrte Platten bei Allgemeinem Biegungszustande
(Reinforced Concrete Slabs Under Flexure)
H. Leitz, Bautechnik, Vol. 1, April 1923, pp 155-157

"Interior forces; determination of cross-sectional stresses from changes in form of slabs."

Die Theorie der Kreuzweise Bewehrten Eisenbetonplatten Nebst Anwendungen auf Mehrere Bautechnisch Wichtige Aufgaben Uber Rechteckige Platten
(Theory of Transversely Reinforced Concrete Slabs and its Application to Rectangular Slabs)

Analysis, Theoretical

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M. T. Huber, Bauingenieur, Vol. 4, June & July 1923, pp 354-360 & pp 392-395

"Calculation of bending and torsional strength; adaptability of known theoretical solutions to isotropic slabs; difficulties in application of general theory to reinforced concrete slabs."

Die Formanderungen und die Spannungen von Durch Laufenden Platten

(Deformations and Stresses of Continuous Plates)

A. Nadai, Bauingenieur, Vol. 5, March 1924, pp 102-107

"Calculation of deformation and stress in slabs which have individual loads at regularly arranged points."

Uber die Biegung Einer Rechteckigen Platte von Ungleicher Biegungssteifkeit in der Langsund Querrichtung bei Einspannungsfreier Stutsung des Randes

(Deflection of a Rectangular Plate of Different Stiffness Against Bending in Longitudinal and Transverse Direction, The Edges being Supported but not Clamped in)

M. T. Huber, Bauingenieur, Vol. 5, May 1924, pp 259-263 & pp 305-311

"Exact solution of problem in case of sinusoidal distribution of load and approximate solution in case of uniform load. Exact general solution by means of double infinite series. Consideration of concrete slabs with transverse reinforcement."

Analysis, Theoretical

Plates

Die Vereinfachte Berechnung Biegsamer Platten

(Simplified Calculation of Flexible Slabs)

H. Marcus, Bauingenieur, Vol. 5, Oct. & Nov. 1924, pp 660-666 & pp 702-711

"Discusses calculation of ceilings, reinforcements, etc. Describes new method of approximation and gives examples to show its accuracy. Deals with slabs supported on 1, 2, or 3 sides, and fixed on 3, 2 and 1, continuous slabs, etc."

Nota Sobre el Calculo de Forjados de Hormigon Armado

(Calculation of Reinforced Concrete Slabs)

F. F. Alvarez, Revista de Obras Publicas, Vol. 72, Dec. 1924, pp 420-422

"Details of simple method for calculating slabs fixed at both ends and under uniform load."

Die Drillungs-Momente bei Kreuzweise Bewehrten Platten

(Torsional Moments in Slabs Reinforced at Right Angles)

Leitz, Bautechnik, Vol. 3, Nov. 1925, pp 717-719

"Discusses torsional moment introduced for first time in new German reinforced concrete regulations in connection with crosswise reinforcing; method of dealing with it in calculations."

Notas Sobre O Calculo das Pecas de Cimento Armado Submettidas a Flexao Simples

Analysis, Theoretical

Plates

(Calculation of Reinforced Concrete Slabs Under Simple Flexure)

S. Cunha, Revista Brasileir de Engenharia

Vol. 10	Dec. 1925	pp 241-244
Vol. 11	Jan. 1926	pp 6- 10

"Resistance at moment of flexure; formulas to be used in various cases; determination of maximum loads on concrete and reinforcement."

Calcul des Plaques Rectangulaires Planes

(Calculating Flat Rectangular Plates)

R. Lemaitre, Revue Universelle des Mines, Vol.9, Jan. 1926, pp 58-80

"Calculation of plates supported at their circumference and subjected to uniform load per unit."

Plattenberechnung fur Eine Durch Sinuslinien Begrenzte Belastung

(Calculations of Plates of Reinforced Concrete for a Load Limited by Sinusoidal Curves)

K. Hager, Beton U. Eisen, Vol. 25, Jan. 1926, pp 23-25

"By dividing plate into strips, author develops differential equations for integration; shows effect of anistropy and torsion moments."

Vereinfachte Strenge Losung der Biegungsaufgabe Einer Rechteckigen Eisenbeton Platte, etc.

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(Simplified Rigid Solution of Problem of Bending of a Rectangular Reinforced Concrete Plate with Rectilinear Free Support of all the Edges)
M. T. Huber, Bauingenieur, Vol. 7, Feb. 1926, pp 121-127, 152-154, 170-175

"On basis of author's previous differential equation for bending surface of orthotropic plate, he now develops strict solution by means of infinite series, for (1) uniform load of longitudinal strip of plate, and (2) single load at any point of plate; comparison with results of tests by German committee for reinforced concrete."

Uber Rechteckige Platten, die Langs Zweier Gegenuberliegenden Seiten auf Biegsamen Tragern Ruhen
(On Rectangular Plates Supported by Two Elastic Girders at Opposite Sides)
E. Muller, Zeitschrift fur Angewandte Mathematik u. Mechanik, Vol. 6, Oct. 1926, pp 355-366

"Investigates effect of rectangular plates on magnitude of flexure, bending moments, torsion moments and bearing pressures, and how to obtain these magnitudes."

Der Einflus Einer Hohl Korpereinlage Oder Kassettenausbildung bei Pilzdecken und Anderen Eisenbetonplatten
(Effect of Paneled Development of Flat Slab Floors and Other Reinforced

Analysis, Theoretical

Plates

Concrete Slabs)

M. Lewe, Bauingenieur, Vol. 7, Nov. 1926, pp 898-901

"Develops formulas for calculation for rectangular slabs uniformly loaded, with and without paneling; flat slab floor of indefinite extension in both directions."

The Strength of Rectangular Concrete Slabs

R. W. Chapman, Institution of Engineers of Australia, Vol. 8, 1927, pp 255-282

"Attempt is made to make available in form suitable for practical use, results of calculations of mathematicians that have been used only to slight extent in design; results for concentrated loads given are it is believed new; only case of slab simply supported round its edges is considered, and results of computation for practical use are presented in tabular form."

The Calculation of Flat Plates by the Elastic Web Method

J. A. Wise, ACI - Proceedings, Feb. and March 1928, Vol. 24, pp 408-423

"Theory of elastic web and its analogy to equilibrium polygon is developed as well as its application to calculation of stresses and strains in flat plates; probable accuracy of this method is discussed as well as its applicability to design of reinforced concrete slabs; deflections and moments in beams; basic equation for solution of

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flat plates; elastic web with rectangular meshes; application to solution of square plates."

Paper only concerned with square and rectangular slabs freely supported at four edges, but method may be applied to almost any condition of support and of loading; method is not original, but a reprint in English of the Marcus method; make use of difference equations; seems to be an applicable reference for mathematical solution.

The Bending of Centrally-Loaded Isotropic Rectangular Plates Supported at Two Opposite Edges

A. E. H. Love, Royal Society Proceedings, Vol. 118, April 1928, pp 427-440

"Mathematical treatment"

Concentrated Loads on a Reinforced Concrete Slab

L. G. Wills, Institution of Civil Engineers, Selected Engineering Papers, No. 63, 1928

"Author applies to problem of concentrated load supported by reinforced concrete slab a method of calculating bending moment that represents more accurately state of loaded slab than do methods generally in use; objection to this method is that it does not correspond in principle with conditions of loaded slab and hence it cannot take into account all factors that ought to affect design,

Analysis, Theoretical

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such as bending moments set up in planes parallel to supporting edges."

The Effective Width of a Plate Supported by a Beam

A. B. Miller, Institution of Civil Engineers, Selected Engineering Papers, No. 83, 1929, pp 3-30

"Theoretical mathematical analysis endeavoring to determine what part of plate width is to be inserted in calculation of moment of inertia of system composed of plate attached to stiffening member or girder and subjected to bending moment; review of research by Von Karman and W. Metzer; comparison of theoretical and experimental values, effective widths of thin plates; approximate formulas for longitudinal stress; criterion of effective width."

Die Momente Durchlaufender Platten und Bewehrung

(Moments of Continuous Slab and Reinforcement)

Schneemann, Zement, Vol. 19, May 1930, pp 447-499

"Moments in case of approximate calculation of continuous slabs are shown and it is demonstrated that provision of girder moments up to one-fifth of girder width, according to German code for reinforced concrete , is too little."

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Inquiry into Stresses in Reinforced Concrete Slabs and Their Correct Reinforcement

B. N. Dey, Association of Engineers Journal, Vol. 4, June-Sept. 1930 pp 52-57 & pp 57-58

"Attempt is made to analyze mathematically various stresses induced in slab; conclusions are borne out by actual experiments carried out at various European Universities; appendix contains note on theories of Bach, Grashof, Rankine and French government rule, relating to strength of reinforced concrete slabs."

Die Knickspannungen von Eingespannten Rechteckigen Platten

(The Buckling Stresses in Fixed Rectangular Plates)

F. Schleicher, Mittsilungen aus dem Forschungsanstalten, Vol. 1, Dec. 1931, pp 186-193

"Mathematical investigation of buckling stresses in rectangular plates, in which accuracy of Hookes law is assumed."

Uber die Knickung von Rechteckigen Platten bei Schubbeanspruchung

(On the Buckling of Rectangular Plates Under Shear Stresses)

S. Bergmann & H. Reissner, Zeitschrift fuer Flugtechnik und Motorluftschiffahrt, Vol. 23, Jan. 1932, pp 6-12

"Mathematical analysis of buckling phenomena in rectangular plates under shear stresses."

Analysis, Theoretical

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Plaques Minces Rectangulaires Soumises a des Forces Variables

(Thin Rectangular Plates Subjected to Variable Forces)

M. Sonier, Academie des Sciences, Comptes Rendus des Seances, Vol. 194, Feb. 1932, pp 436-439

"Theoretical mathematical discussion of stresses in, and deflection of thin rectangular plates freely supported along perimeter and subjected to variable forces."

Die Bauliche Aufnahme der Randdrillungsmomente Vierseitig Gelagerter Platten

(The Constructional Survey of Moments in Plates)

H. Craemer, Beton und Eisen, Vol. 31, March 1932, pp 95-107

"Discussion of stresses along periphery of rectangular slabs supported along all sides or only along two parallel sides; methods of taking care of moments along periphery of such slabs, simply supported or variously fixed along periphery."

Statische Untersuchung Quadratischer, Allseitig Elastisch Eingespannter Platten

(Statistical Investigation of Square Plates Elastically Fixed on All Sides)

M. Ritter, Schweiz Bauzeitung, Vol. 99, March 1932, pp 131-135

Analysis, Theoretical

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"Theoretical mathematical analysis of stresses in square plates elastically fixed along entire perimeter."

Calcul des Dalles Superposees et Solidaires

(Design of Superposed and Monolithic Slabs)

A. Sterling, Revue Universelle des Mines, Vol. 7, June 1932, pp 507-514

"Analysis of stresses, methods of design of simply supported and monolithic floor slabs built of reinforced concrete; numerical examples."

Stresses in Long Rectangular Plates with Uniform Lateral Loading

S. Way, ASME, Advance Paper for Meeting, June 1932

"Theoretical mathematical analysis of stresses and deflections in plates, initially flat, supported at edges and subjected to uniformly distributed load normal to surface; plates with simply supported and built in edges; effect of elastically supported edges; Timoshenko's approximate method; use of curve for design; numerical examples."

Theory and Experiment for Rectangular Plate Placed on Elastic Beams

G. Fujii, Society of Mechanical Engineers Journal (Japan), Vol. 35, July & Oct. 1932, pp 709-717 & pp 1061-1068

July:

"Example of solutions for stresses of rectangular plate under

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uniformly distributed load, two opposite sides of which are placed freely on strong supports and remaining two sides on elastic beams; calculated results were confirmed by experiments."

Oct.:

"Example of solutions for stresses of rectangular plate under concentric load, two opposite sides of which are placed freely on strong supports and remaining two sides on elastic beams; calculated results confirmed by experiments. (In Japanese)"

Versuche zur Spannungsermittlung in Rechteckigen Scheiben Nach Einem Neuen Verfahren

(Investigation of Stress-Determination in Rectangular Plates, According to a New Method)

H. Grassberger, Zeitschrift fuer Oesterreichischen Ingenieur und Architekten Vereines, Vol. 84, July 1932, pp 132-135 & pp 153-157

"Outline of newly modified method of determining stresses in rectangular plates; method is practically identical with that of Wison and Gore described in Engineering 1905, except that deformation in rubber model is measured from photographs; results of original tests; precision of process and its application."

Das Ausknickigen von Allseitig Befestigten und Gedrueckten Rechteckigen Platten

Analysis, Theoretical

Plates

(The Warping of Rectangular Plates Fixed and Subjected to Pressure on All Sides)

K. Sezawa, Zeitschrift fuer Angewandte Mathematik und Mechanik, Vol. 12, Aug. 1932, pp 227-229

"Approximate computation of buckling limit of rectangular plates fixed and subjected to pressure along all its edges."

Theory and Experiment on Rectangular Plate Clamped at Periphery and Supported by Many Elastic Beams under Uniformly Distributed Load.

C. Fujii, Society of Mechanical Engineers Journal, Japan, Vol. 35, Sept. 1932, pp 924-931

"In Japanese with English abstract."

Spannungen in Durchlaufenden Scheiben bei Vollbelastung Saemtlicher Felder

(Stresses in Continuous Slabs with Full Loading on All Panels)

H. Craemer, Beton und Eisen, Vol. 32, Aug. 1933, pp 233-237

"Mathematical analysis of stresses in continuous slabs carrying full load on all spans."

Zur Torsion von Rechteckigen Platten

(On the Torsion of Rectangular Plates)

M. Ono, Society of Mechanical Engineers Journal, Japan

Analysis, Theoretical

Plates

Vol. 36	Oct. 1933	pp 694-699
Vol. 37	June 1934	pp 379-387

Oct.

"Torsion of rectangular plates; method of calculation, taking into consideration influence of end supports, this factor being of importance with short plates, particularly if plate is braced; bending theory of plates is used in calculation. (In Japanese with annotation in German)"

June:

"Calculation of deformation and stresses of plates subjected to torsion by external moment and drawn and compressed by external normal force. (In Japanese with English abstract)"

Der Bruch von Eisenbetonplatten

(Breaking of Reinforced Concrete Plates)

M. Bergstraesser, Bauingenieur, Vol. 14, Nov. 1933, pp 555-558

"Theoretical mathematical analysis of stresses and formation of cracks in square and circular reinforced concrete slabs."

Uniqueness of Solution of Problems of Elasticity Connected with Bending of Thin Plates Under Normal Pressures

B. Sen, London, Edinburgh and Dublin Philosophical Magazine and Journal of Science, Vol. 16, Nov. 1933, pp 975-979

Analysis, Theoretical

Plates

"Simple method used to show that solution of problem of plate bent by transverse loads is unique in character when edge is clamped or supported; when edge is free, solution is indeterminate in sense that two values of displacements satisfying equilibrium equations, etc., may differ by expression which is linear function of coordinates."

Beitrag zur Theorie der Pilzdecken

(Contribution to the Theory of "Mushroom Systems")

S. Woinowsky - Krieger, Zeitschrift fuer Angewandte Mathematik und Mechanik, Vol. 14, Feb. 1934, pp 13-18

"Mathematical theory of "mushroom system" based on M. Levy's general method; solutions in simple series for infinite flat slabs; applicability of method to calculation of bounded flat slabs."

Spannungen in Durchlaufenden Scheiben bei Vollbelastung Saemtlicher Felder

(Stresses in Continuous Slabs With Full Loading of All Panels)

F. Dischinger & R. Bertsch, Beton und Eisen, Vol. 33, May 1934, pp 161-162

"Stresses in continuous slabs carrying full load. Discussion of article by H. Craemer indexed in Engineering Index, 1933 p 258 from issue of Aug 1933, reply by Craemer."

Analysis, Theoretical

Plates

Energy Method of Solving Problem of Thin Plate in Equilibrium

T. Uematu, Society of Mechanical Engineers Journal, Japan, Vol. 37, Sept. 1934, pp 589-592

"Deflection of thin plate under uniformly distributed lateral load can be obtained approximately by means of energy method; author explains imaginary lateral load which is necessary to produce deflection obtained and points out defect of energy method for such problems by several examples. (In Japanese)"

Zur Frage der Bemessung der Pilzdecken

(On the Question of the Measurement of Mushroom Slabs)

M. Steuermann, Beton und Eisen, Vol. 33, Sept. 1934, pp 273-274

"Comparative study of methods of determination of moments of mushroom slab systems with special reference to American specifications and to author's method developed in connection with design for meat refrigerating plants in USSR."

Reinforced Concrete Slabs Supported on Four Sides

E. Mirabelli, Boston Society of Civil Engineers Journal, Vol. 21, Oct. 1934 pp 318-335

"Development of simple approximate equations which may serve as basis for safe and economical design; discussion of "plate action"; cases considered are for uniformly distributed load only, and

Analysis, Theoretical

Plates

for adjacent spans of same size or nearly same size."

Effect of Torsional Resistance of Beams on Slabs

E. Friedman & B. Germansky, Concrete and Constructional Engineering, Vol. 29, Nov. 1934, pp 673-676

"Theoretical mathematical discussion."

Stress in Thin Plates Due to Deformation at its Periphery

T. Uematu, Society of Mechanical Engineers Journal, Japan, Vol. 37, Dec. 1934, pp 853-859

"Solutions for such problems are illustrated with respect to plates of rectangular and circular form under various boundary conditions. (In Japanese)"

Knickung der Rechteckigen Platte bei Veraenderlicher Randbelastung (Buckling of Rectangular Plates Subjected to Variable Marginal Loading)

S. Ban, Association Internationale des Ponts et Charpentes-Memoirs, Vol. 3, 1935, pp 1-18

"Theoretical mathematical discussion of buckling of rectangular plates subjected to variable marginal loading, based on Hencky's method of flexible articulated chain, requiring no assumption with regard to curvature of buckling surface and always giving good approximation. (In German with brief abstracts in French and English, pp 17-18)"

Analysis, Theoretical

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Knickung der Rechteckigen Platten bei Veraenderlicher Randbelastung
(Buckling of Rectangular Plates With Non-Uniform Loading Along the Edges)
S. Ban, Kyoto Imperial University College of Engineering Memoirs, Vol. 8, March 1935, pp 155-163

Theoretical mathematical discussion of buckling of rectangular plates with non-uniform loading along periphery; methods of differential equations and least work. (German)

Buckling and Failure of Thin Rectangular Plates in Compression
M. Yamamoto & K. Kondo, Tokyo Imperial University Aeronautical Research Institute Report, Vol. 10, April 1935

Theoretical mathematical analysis, including results of tests; equations of equilibrium of plate; solution for case when plate is simply supported at its four edges; load and stress distribution; failure of plate. (Brief abstract in Japanese)

Beitrag zur Knicktheorie Duenner Platten
(Contribution to the Theory of Buckling of Thin Plates)
K. Sattler, Mitteilungen aus den Forschungsanstalten GHH-Konzern, Vol. 3, July 1935, pp 257-279

*Contribution to theory of buckling of thin plates; calculation of critical buckling load for plate under concentrated single load;

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derivation of buckling equation for any given cross-section; specific examples of calculation of stresses and investigation of buckling, including investigation of longitudinal girder in large bridge."

Distribution of Concentrated Loads in Reinforced Concrete Slabs

C. V. Rundell, Engineer, Vol. 160, Aug. 1935, pp 161-162

"Reasonings governing author's theory, being based upon root principles, may be effectively applied to all structures, as theory takes into account all variables of slab thickness, steel and concrete working stresses, size of rods employed, and all other features embodied in design of structures."

Paper appears to be concerned more with design procedure than analysis.—

Slabs Supported on Four Sides

J. Di Stasio & M. P. Van Buren, ACI Journal, Vol. 7, Jan-Feb. 1936

pp 350-364

"Regulations and basic formulas prescribed by American Concrete Institute Committee 501; mathematical analysis of Two-way slabs; equivalent uniform load method; distribution of total panel load; bending-moment coefficients; slab shear and intensity of loading; plate action; minimum thickness; supporting beams; comparisons with other methods. Bibliography."

Analysis, Theoretical

Plates

This paper does not seem to be a particularly significant reference for research work, either theoretical or mathematical.

Biegungs - Beulung der Rechteckplatten Mit Eingespannten Laengsraendern

(Bending and Warping of Rectangular Plates With Fixed Longitudinal Edges)

K. Noelke, Bauingenieur, Vol. 17, April 1936, pp 111

"Theoretical mathematical analysis of buckling stresses in rectangular plates, longitudinally clamped."

Beulsppannungen von Rechteckplatten Mit Laengssteifen bei Gleichmaessiger Druckbeanspruchung

(Buckling Stresses in Rectangular Plates Reinforced with Longitudinal Ribs and Subjected to Uniform Compression)

R. Barbre, Bauingenieur, Vol. 17, June 1936, pp 268-273

"Theoretical mathematical study of buckling stresses in rectangular plates reinforced with longitudinal ribs and subjected to uniform compression along axis; numerical examples."

Stability of Rectangular Plates Elastically Supported at Edges

A. J. Miles, ASME Transactions (Journal of Applied Mechanics) Vol. 3, June 1936, pp A47-A52

Analysis, Theoretical

Plates

"Exact solutions of stability problems involve solution of fourth order partial differential equations in conjunction with certain boundary conditions; equations contain, as parameters, ratio of stiffness of beam to stiffness of plate and ratio of cross-sectional area of beam to cross-sectional area of plate, as well as the number of half waves into which wave buckles."

A set of curves, provided for solution of these transcendental equations; critical load also given; loads applied are in plane of the plate; solutions not included for variation of edge conditions along any one particular edge; article does not appear to be a particularly useful reference.—

Stress and Deflection of Rectangular Plates

I. A. Wojtaszak, ASME-Transactions (Journal of Applied Mechanics)

Vol. 3, June 1936, pp A71-A73

"Data on plates for several types of loading and edge conditions."

Rectangular plate of uniform thickness; deflection considered no greater than about one half thickness of the plate; numerical example given; edge conditions are constant along individual edges.

Calcul des Plaques Rectangulaires Flechies Par les Series Simples

(Analysis of Rectangular Plates Bent by Simple Series)

F. Keelhoff, Annales des Travaux Publics de Belgique, Vol. 37, June 1936

pp 291-316

Analysis, Theoretical

Plates

"Analysis of stresses in simply supported and in partly or totally fixed rectangular plates subjected to bending."

Stabilitaet Ebener Rechteckbleche Unter Biegung und Schub
(Stability of Flat Rectangular Plates Under Flexure and Shear)
O. Stein, Bauingenieur, Vol. 17, July 1936, pp 308-311

"Theoretical mathematical discussion of stability of flat rectangular plates subjected simultaneously to flexure and shear."

Stresses and Deflections in Flat Plates
R. J. Roark, Product Engineering, Vol. 7, July 1936, pp 252-254 & pp 283-284

"Tabulation of equations for plates of different shapes, supports and loadings.

All formulas are based on mathematical analysis; some of equations have been verified experimentally; derivations of formulas not given; paper does not appear to be a particularly helpful reference for research.

Buckling of Rectangular Plate with Four Clamped Edges Reexamined with Improved Theory
K. Sezawa & W. Watanabe, Tokyo Imperial University-Aeronautical Research Institute - Report, Vol. 11, Aug. 1936, pp 407-418

Analysis, Theoretical

Plates

"Reexamination of problem and improvement of theory published by K. Sezawa entitled "On Buckling under Edge Thrusts of Rectangular Plate Clamped at Four Edges," (In English, with brief Japanese abstract)

Note sur les Abaques Pour le Calcul des Dalles en Beton Arme
(Notes on Plates with Reference to the Design of Slabs of Reinforced Concrete)
Chesnot, Annales des Ponts et Chaussees, Vol. 106, Aug. 1936, pp 251-253

"Application of theory of plates proposed by Pigeaud, to construction of alignment charts for design of reinforced concrete slabs."

Analysis of Plate Examples by Difference Methods and Superposition Method
D. L. Holl, ASME Transactions (Journal of Applied Mechanics), Vol. 3, Sept. 1936, pp A81-A90

"Author applies membrane analogs of H. Marcus to some elementary cases of thin homogeneous isotropic square plates having central point loads and various boundary conditions; two theorems by which analogy is made possible."

Principle of superposition of deflection surfaces or equivalent stress systems utilized; boundary conditions include the case of plate supported by corner posts only; solutions appear to be an applicable reference for mathematical research.

Analysis, Theoretical

Plates

Stability of Rectangular Plates Under Shear and Boundary Forces

S. Way, ASME Transactions (Journal of Applied Mechanics), Vol. 3, Dec. 1936, pp A131-A135

"Two problems in buckling of plates discussed; first is that of plate having two stiffners, and second is that of plate loaded by uniform edge shear and linearly distributed tension and compression at ends; in both cases edges are assumed to be simply supported."

Energy method is employed in solution; paper seems more applicable to airplane structures.

Analysis of Thin Rectangular Plates Supported on Opposite Edges

D. L. Holl, Iowa State College of Agriculture and Mechanical Arts-Engineering Experiment Station Bulletin No. 129, Vol. 35, Dec. 1936

"Analytical studies of homogeneous plates with special reference to reinforced concrete slab, uniformly loaded plates with two pinned edges; loads on central axis of plate with pinned free edges; plates clamped at two opposite edges; comparison of analysis with experiments."

Discussion of effective width; torsional moments considered; conclusions; article appears to be excellent reference for theoretical research.

Analysis, Theoretical

Plates

Strackenlasten auf Elastisch Biegsamen Platten im Sonderfall Quadratischer Seitenverhaeltnisse

(Continuous Loads on Elastically Flexible Plates in Special Cases of Quadratic Side-Ratios)

Foersterling, Beton und Eisen, Vol. 36, May 1937, pp 148-150

"Derivation of approximate equations of moments due to continuous loads acting on square areas of square slabs supported along their perimeter."

Buckling of Compressed Rectangular Plates with Built-In Edges

J. L. Maulbetsch, ASME Transactions (Journal of Applied Mechanics) Vol. 4, June 1937, pp A59- A62

"Results of study made of two approximate methods available for determining buckling load of compressed rectangular plates with built-in edges; one method gives values larger than true buckling load, while other method gives values smaller than this load, thus permitting estimate of approximation of solution. Bibliography."

Loads are in plane of plate; solution mathematical; paper appears to be applicable to airplane structures.

Stresses and Deflections in Loaded Rectangular Plates on Elastic Foundations

G. Murphy, Iowa State College of Agriculture and Mechanical Arts -

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Engineering Experiment Station Bulletin No. 135, Vol. 36, June 1937

"Mathematical method of determining stresses and deflections in rectangular plates supported on elastic foundations, with particular reference to plates which deflect free from foundation under action load; comparisons of analytical results with measured results from tests on steel plates supported on rubber foundations."

Explanation of the use of influence values for determining stresses and deflections at several points in the loaded plate; variable stiffness of supports considered; article appears to be an excellent reference for theoretical research.—

Stabilitaet der Gleichmaessig Gedrueckten Rechteckplatte Mit Steifenkreuz (Stability of Uniformly Compressed Rectangular Plates with Crosswise Stiffening)

H. Froehlich, Bauingenieur, Vol. 18, Oct. 1937, pp 673-682

"Theoretical mathematical discussion of elastic stability of crosswisely stiffened rectangular plate subjected to uniform compression: numerical examples. Bibliography."

Remark on Theory of Bending of Plates of Variable Thickness

H. E. Reissner, Journal of Mathematics and Physics, Vol. 16, Oct. 1937 pp 43-45

"Theoretical mathematical discussion presenting simplification of

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solution, given by R. G. Olsson, of differential equation of plates of linearly varying stiffness."

Calculation of Maximum Deflection, Moment, and Shear for Uniformly Loaded Rectangular Plate with Clamped Edges

I. A. Wojtaszak, ASME-Transactions (Journal of Applied Mechanics), Vol. 4, Dec. 1937, pp A173-A176

"Problem of rectangular plate with four clamped edges solved by H. Hencky, refined calculations being made only for case of square plate; calculations for several ratios of sides of plate, using Hencky's equations."

Curves for coefficients included; paper limited to only one set of edge conditions.

Solutions for Certain Rectangular Slabs Continuous Over Flexible Supports

V. P. Jensen, Bulletin No. 303, University of Illinois, 1938

Paper contains solutions for slabs having various edge conditions; solutions are mathematical; formulas are not suitable for direct use in design, although several illustrative curves and tables are given; effect of continuity of slabs and flexibility of supporting members considered; results obtained using the classical procedure of obtaining a solution of the deflected middle surface of the slab; article appears to be applicable reference to mathematical research.

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Plates

A Distribution Procedure for the Analysis of Slabs Continuous Over Flexible Beams

N. M. Newmark, Bulletin No. 304, University of Illinois, 1938

Paper explains a method of analysis for certain types of continuous slabs subjected to concentrated or distributed loads, with particular references to wheel loads on bridge slabs; method of analysis is applicable to any rectangular slab simply supported on two opposite edges, with any type of support on the other two edges, and continuous over any number and spacing of rigid or flexible simple beams transverse to the simply-supported edges; paper appears applicable to mathematical research.

La Piastra Rettangolare Appogiata Lungo Due Latie Caricata Uniformemente in Modo Simmetrico

(Rectangular Plate Supported On Two Sides Loaded Uniformly and Symmetrically)

M. Salvadori, Ingegnere, Vol. 16, Feb. 1938, pp 49-59

"Analysis of stresses in rectangular plate supported along two of its sides, carrying symetrical uniform loading."

Moments in Flat Slabs

P. G. Bowie, Structural Engineer, Vol. 16, Jan. 1938, pp 2-13

also Structural Engineer, Vol. 16, Nov. 1938, pp 386-392 & p 399, Dec. 1938, p 426

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Plates

"Outline of author's original empirical method of design of flat reinforced concrete slabs supported directly on columns; effect of column cap; degree of fixation; bending in columns; concentrated loads; before Institution of Structural Engineers."

Sulla Stabilita Trasversale Delle Lastre

(On the Transverse Stability of Rectangular Plates)

C. Chemello, Annali dei Lavori Pubblici, Vol. 76, March 1938, pp 212-221

"Theoretical mathematical analysis of transverse elastic stability of rectangular plates loaded along their perimeter, parallel to their own plane."

Moments in Flat Slabs of Various Types

ASCE-Proceedings, Vol. 64, March 1938, pp 527-537, and June 1938 (discussion) pp 1304-1306

"1937 Progress report of sub-committee (F) of committee of Structural Division of American Society of Civil Engineers; masonry and reinforced concrete; development of design coefficients in accordance with current flat slab design practice."

Moment coefficients given for various slab and column arrangements, column sizes and slab types; derivation of formulas for coefficients not given.

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Participation de la Dalle a la Resistance des Poutres a T

(Participation of Slabs in Carrying of Loads on T-Beams)

F. Guerrini, Travaux, Vol. 22, May 1938, pp 229-231

"Theoretical mathematical discussion on participation of slabs in carrying of loads on T beams."

Ueber Einige Fragen der Z Spannungsverteilung in Dreieck-und Rechtecksscheiben

(On Some Questions of Distribution of Stresses in Triangular and Rectangular Slabs)

H. Bay, Bauingenieur, Vol. 19, June 1938, pp 349-356

"Theoretical mathematical discussion of distribution of stresses in triangular and rectangular slabs, stresses being within plane of slab, with special reference to wing walls of bridges; precise and approximate analysis; photoelastic tests of models."

Superfici d'Influesa per i Momenti in Piastre Retangolari Incastrate o Semincastrate al Contorno

(Influence Surfaces for the Moments in Rectangular Plates, Set in or Semi-set in at the Perimeter)

A. Galli, Annali dei Lavori Pubblici, Vol. 76, Nov. 1938, pp 960-968

"Theoretical mathematical study of influence surfaces for moments in rectangular plates fixed or semi-fixed along perimeter."

Analysis, Theoretical

Plates

Tables of Moments and Deflections for Rectangular Plate Fixed on All Edges and Carrying Uniformly Distributed Load

T. H. Evans, ASME-Transactions (Journal of Applied Mechanics), Vol. 6, March 1939, pp A7-A10

Reference to article by I. A. Wojtaszak, indexed in Engineering Index 1938 p 921, from issue of Dec. 1937, which dealt with problem of rectangular plate with four clamped edges solved by H. Hencky; in present paper maximum moments and deflections for all side ratios between I.0 and 2.0 by intervals of 0.1, determined following Hencky's procedure; mathematical formulas.

Solution illustrated, covers only the clamped edge condition; short cut on usual trial and error process of solving groups of simultaneous equations used; paper does not appear to be a particularly helpful reference for mathematical research.

Continuous Frame Analysis of Flat Slabs

D. Peabody Jr., Boston Society of Civil Engineers-Journal, Vol. 26, July 1939, pp 183-207

Theoretical mathematical analysis of reinforced concrete flat slabs of unequal spans treated as elastic frame; obtaining negative moments on column center lines; critical moments.

Analysis, Theoretical

Plates

Deflection of Rectangular Plate Which is Simultaneously Subjected to Plane Stress and Uniformly Distributed Load

S. Iwato, Society of Mechanical Engineers, Japan-Transactions, Vol. 5, Aug. 1939, pp 1-68-74

"Study of deflection of plate when pair of its parallel sides is free from plane stress, while plate is assumed to be freely supported along its each edge; formulas given. (In Japanese with English Abstract, p 8-76-77)"

Stability of Rectangular Plates with Longitudinal or Transverse Stiffeners under Uniform Compression

R. Barbre, NACA-Technical Memo No. 904, August 1939

"Complete buckling conditions of stiffened plates developed for uniform compression; plates with one or two longitudinal or transverse stiffeners at any point are discussed with reference to buckling conditions and evaluated for different cases. From Ingenieur Archiv, Nov. 1937."

All solutions have been computed for loads in the plane of the plate, and for a varying number of stiffeners; solution seems applicable to airplane structures.

Clamped Rectangular Plates with Central Concentrated Load

D. Young, ASME-Transactions (Journal of Applied Mechanics), Vol. 6,

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Plates

Sept. 1939, pp A114-A116

Method of solution for rectangular plates with clamped edges developed by S. P. Timoshenko; this paper gives results of calculations using this method for maximum deflection, moment and edge shears for rectangular plates of various proportions with all four edges clamped and loaded by single concentrated load at center.

Solution is limited to one particular case of edge conditions; paper does not appear to be a particularly helpful reference for mathematical research.

Solution of Rectangular Clamped Plate with Lateral Load by Generalized Energy Method

G. Pickett, ASME-Transactions (Journal of Applied Mechanics), Vol. 6, Dec. 1939, pp A168-A170

Formulas by which energy method may be readily applied for obtaining moments and deflections for any lateral load on clamped rectangular plate given; mathematical computations illustrating application of formulas; accuracy of method compared to others, and its limitations discussed. Bibliography.

Edge conditions do not correspond to any existing in floor slabs; solution does not give good results for concentrated loads; paper does not appear to be a particularly helpful reference for mathematical research.

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Plates

Theory of Plates and Shells

S. Timoshenko, McGraw-Hill Book Company, New York 1940

"Volume concerned with problems of deformation encountered by designer of ship hulls, laterally loaded concrete slabs, thin walled tanks, boilers and other structures in which thickness of material is small in comparison with other dimensions. Engineering Society Library, New York."

Analysis of Plates Fixed Along All Edges and Provided with Stiffening Ribs

B. I. Slyepov, Sudostronie, Vol. 10, 1940, pp 440-442

"Theoretical mathematical analysis of stresses in rectangular and square plates fixed along entire perimeter and reinforced with stiffening ribs. (In Russian)"

Investigation of Sheet - Stiffener Panels Subjected to Compression Loads with Particular Reference to Torsionally Weak Stiffeners

L. G. Dunn, NACA-Technical Note No. 752, Feb. 1940

"Analytical methods developed make it possible for designer to predict buckling stress and maximum wave amplitude of sheet in stiffened panel combinations; scope of tests was insufficient to formulate general design criteria but results are presented as guide for design and type of theoretical and experimental work

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needed. Bibliography."

Paper is primarily concerned with aircraft structures; effort to determine effective widths; possibly applicable to mathematical or experimental research.

Problem of Buckling of Elastic Plates of Variable Thickness

R. G. Olsson & E. Reissner, Journal of Mathematics and Physics, Vol. 19, April 1940, pp 131-139

"Theoretical mathematical discussion of elastic stability of rectangular plate uniformly stressed in its plane and freely supported along edges, while its stiffness varies linearly in direction parallel to one pair of edges."

Chart for Critical Compressive Stress of Flat Rectangular Plates

H. N. Hill, NACA-Technical Notes, No. 773, Aug. 1940

"Chart presented for coefficient K in formula for critical compressive stress for plates uniformly compressed in one direction; chart applies to various combinations of fixed, simply supported, and free edges."

Solution for plates with loads in plane of plate, varying edge conditions, but none with varying conditions along each edge; mathematical derivation.

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What do we Know About Concrete Slabs?

N. M. Newmark, Civil Engineering (New York), Vol. 10, Sept. 1940, pp 559-562

"Review of analytical considerations and experimental results; typical distribution of moments in slabs; reserve strength of reinforced concrete slab; stages in their behavior; cracks in rectangular slabs. Bibliography."

Author presents discussion based upon various theoretical and experimental results; paper appears to be an excellent reference for both experimental and theoretical research.

Dalles ou Poutres Rectangulaires en Beton Doublement Arme Sollicitees en Flexion Simple

(Slabs on Rectangular Beams of Doubly Reinforced Concrete Subjected to Simple Bending)

O. D'Heygers, Annales des Travau Publics de Belgique, Vol. 41, Oct. 1940 pp 727-746

"Theoretical mathematical analysis of stresses in doubly reinforced concrete slabs or rectangular beams subjected to simple bending. (In French and Flemish)"

Analysis of Clamped Rectangular Plates

D. Young, ASME-Transactions (Journal of Applied Mechanics) Vol. 7,

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Dec. 1940, pp A139-A142

Also Vol. 18, Dec. 1941, pp A184-A186

"Paper attempts to solve problem of bending action of rectangular plates clamped at all four edges and subjected to lateral loading; analytical in nature, author's investigation is based on ordinary theory of bending of thin plates as treated in Lagrange's equation of middle surface; superposition method used and applied to loadings not hitherto studied."

Numerical calculations have been carried out for several loadings; values for deflections, moments, and shears at critical points are given; solution limited to only one particular set of boundary conditions.

Biegung der Rechteckplatte Bei Linear Veraenderlicher Steifigkeit und Beliebiger Belastung

(Bending of Rectangular Plate Under Conditions of Linearly Variable Rigidity and any Given Load)

R. G. Olsson, Bauingenieur, Vol. 22, Jan. 1941, pp 10-13

"Bending of rectangular plate under conditions of linearly variable rigidity and any given load; with aid of method of variation of constants, it is shown how, with linearly variable plate stiffness, integrals for overcoming function of error of differential equation

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can be determined by means of simple quadratures; these integrals are discussed for constant and triangular load; examples given."

Un Nuovo Metodo di Calcolo Delle Lastre Piane a Spessore Constant
(A New Method of Calculating Stressed Plates of Constant Thickness)
L. Kambo, Ricerche di Ingegneria, Vol. 9, Jan-Feb. 1941, pp 1-25

"Theoretical mathematical discussion of new methods for computing stresses in plane plates of uniform thickness."

Moments in Continuous Rectangular Slabs on Rigid Supports
L. C. Maugh & C. W. Pan, ASCE-Proceedings, Vol. 67, May 1941, pp 739-752
also (discussion) June 1941, pp 1193-1195, & Sept. 1941, pp 1278-1282

"Theoretical mathematical analysis of slabs supported on four sides and continuous over supports, so arranged that equations providing continuity between panels can be expressed in terms of restraining moment at middle of each support; computations simplified by using sine distribution for edge moments and by establishing continuity between panels only at middle of support; diagrams."

Approximations used in the solution are based on assumptions that more nearly represent the fundamental structural action than does the use of hypothetical beam strips; equations are solved by successive approximations; torsional stiffness of supporting beams considered; variations in moments along individual edges of slabs considered;

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article appears to be an applicable reference for a mathematical solution.

Note on Calculation of Influence Surface in Plates by Use of Difference Equations

N. M. Newmark, ASME-Transactions (Journal of Applied Mechanics), Vol. 8, June 1941, p A92

"Method described permits calculation directly of particular effect due to unit loads at various nodal points; it can be obtained as deflection of structure due to certain system of loads which is very simply determined."

Article appears to be an applicable reference to mathematical research.

Notes on Analysis and Design of Rectangular Reinforced Concrete Slabs Supported on Four Sides

S. D. Lash, Engineering Journal, Vol. 24, Sept. 1941, pp 422-430

"Mathematical analysis of rectangular plates considered, and values of bending moments and shearing forces for various conditions of edge restraint given; analysis is used to determine moment coefficients for reinforced concrete slabs supported on four edges and reinforced in two directions. Bibliography."

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Non-Linear Boundary Value Problem of Buckled Plate

K. O. Friedriches & J. J. Stoker, American Journal of Mathematics, Vol. 63 Oct. 1941, pp 839-888

"Development of methods for solving non-linear boundary value problem concerning buckling of thin elastic plate under forces acting in plane of plate."

Derivation of Equations of Equilibrium of Thin Plate

H. Jeffreys, London, Edinburgh & Dublin Philosophical Magazine & Journal of Science, Vol. 32, Nov. 1941, pp 365-368

"Problem is treated mathematically with help of principle of virtual work and tensor notation; this method shortens considerably standard treatment which is very complicated."

On Stability of Thin Anisotropic Plates of Variable Rigidity

P. G. Shuleshko, Prikladnaya Matematika i Mekhanika, Vol. 6, 1942, pp 139-150

"Expression for complete potential energy; differential equation of elastic surface of plate and boundary conditions for anisotropic non-homogeneous plates with variable rigidity; assuming that middle surface of plate is at same time surface of both elastic and geometric symmetry. Bibliography. (In Russian with brief English abstract)"

Analysis, Theoretical

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On Theory of Thick Plates

A. I. Lourve, Prikladnaya Matematika i Mekhanika, Vol. 6, 1942, pp 151-168

"Solution of differential equations of theory of elasticity in displacements is presented as power series; exact solutions of equations of theory of elasticity, with butt-ends left free of stresses are given. Bibliography. (In Russian with brief English abstract)"

Critical Compressive Stress for Flat Rectangular Plates Supported Along Edges and Elastically Restrained Against Rotation Along Unloaded Edges

E. E. Lundquist & E. Z. Stowell, NACA-Report No. 733, 1942

"Chart presented, and mathematical derivations of formulas required in construction of chart are given."

Applied loads are in plane of plate; edge conditions do not vary along any one particular edge; solution seems applicable to airplane structures.

Restraint Provided Flat Rectangular Plate By Sturdy Stiffener Along Edge of Plate

E. E. Lundquist & E. Z. Stowell, NACA-Report, No. 735, 1942

"Sturdy stiffener is defined as stiffener of such proportions that it does not suffer cross-sectional distortion when moments are applied to some part of cross-section; when such stiffener is attached to one edge of plate, it will resist rotation of that edge

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of plate by means of its torsional properties; formula given for restraint coefficient provided plate by such stiffener. Bibliography."

Formulas used in this paper are only applicable when stiffeners suffer no cross-sectional distortion; this requirement seems to indicate that solution is applicable to airplane structures.

Bending of Rectangular Plates with Large Deflection

S. Levy, NACA-Report No. 737, 1942

"Solution of Von Karman's fundamental equations for large deflections of plates is presented for case of simply supported rectangular plate under combined edge compression and lateral loading."

Paper also includes solution for deflection of simply supported square plate, and compares results with experimental results; the results agreed closely; solutions are for deflections which are equal to thickness of plate, and may therefore not be applicable to building slabs."

Square Plate with Clamped Edges Under Normal Pressure Producing Large Deflections

S. Levy, NACA-Report, No. 740, 1942

"Values of bending stress at center of plate and at midpoint of edge are given for center deflections up to 1.9 times plate thickness; shape of deflected surface is given for low pressures and for

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highest pressure considered."

Mathematical solution; the edge conditions were constant along the clamped edges; solutions given for both large and small deflections; method of solution may be applicable to floor slabs.

Stress Concentrations in Plates Loaded Over Small Areas

H. M. Westergaard, ASCE-Proceedings, Vol. 68, April 1942. pp 509-534 Sept. pp 1225-1231, Oct. pp 1433-1438, & Nov. pp 1629-1645

"Examples presented which demonstrate how place coefficients may be obtained from solutions already available for loads concentrated at specific point; area coefficients derived in twelve cases; numerical example shows use of place coefficients in determining stresses in concrete pavement on elastic subgrade under wheel load."

Paper seems applicable only to such structures as concrete pavements, basement floors and side walks; solution is mathematical.

On Equlibrium of Plates

A. C. Stevenson, London, Edinburgh & Dublin Philosophical Magazine & Journal of Science, Vol. 32, Sept. 1942, pp 639-661

"Specifications of stresses in plates; paper gives treatment of equations of equilibrium of thick or thin plates by making use of equations of elasticity in complex variables; considers semi-inverse method in theory of plates by method of complex potentials,

and illustrates method by examples."

Rectangular Plates With Stiffeners

J. Ratzerdorfer, Aircraft Engineering, Vol. 14, Sept. 1942, pp 260-263

"Theoretical mathematical discussion on buckling of simply supported plates under compressive stress."

Buckling of Rectangular Plates With Built-In Edges

S. Levy, ASME-Transactions (Journal of Applied Mechanics), Vol. 9, Dec. 1942, pp 171-174

"Paper presents exact solution in terms of infinite series of problem of buckling by compressive forces in one direction of rectangular plate with built-in edges (zero slope, zero displacement in direction normal to plane of plate); comparison of work with other authors. Bibliography."

Applied loads are in plane of plate; solution presented limited to one particular set of edge conditions; paper does not appear to be a particularly helpful reference for mathematical research.

Sur la Solution Donnee par Navier au Probleme de la Flexion

(On the Solution Given by Navier to the Problem of Bending)

J. Courbon, Genie Civil, Vol. 120, Feb. 1943, pp 41-42

"Navier's solution of bending problem of rectangular plates; analytical study proves that solution is correct and that results

Analysis, Theoretical

Plates

given in article by E. Doucet in Dec. 1942 issue are erroneous."

On Deflection of Anisotropic Thin Plate

V. Markovin, Brown University-Quarterly of Applied Mathematics, Vol. 1, July 1943, pp 116-129

"Problem of finding solution to differential equation satisfying prescribed conditions at boundary of neutral surface of plate." Solution based on assumptions of thin plate theory; possibly an applicable reference for mathematical research.

Tables of Stiffness and Carry-Over Factor for Flat Rectangular Plates Under Compression

W. D. Krell, NACA-Wartime Report, No. L-398 (Advance Restricted Report 3K27 Nov. 1943)

Tables of stiffness and carry-over factor are presented for infinitely long flat plates subjected to a uniformly distributed longitudinal compressive load; the tables are intended for use in solving problems in the stability of structures composed of plates under compression; tables are given for various edge conditions, but not with variation along any one particular edge; plate also considered infinitely long; formulas for various factors are given, but not derivations.

Intrinsic Theory of Thin Shells and Plates

Wei-Zang Chien, Brown University-Quarterly of Applied Mathematics

Analysis, Theoretical

Plates

Vol. 1	Jan. 1944	pp 297-327
Vol. 2	April 1944	pp 43-59

Jan:

"Systematic treatment of general problem of thin shell, which includes problem of thin plate as special case."

April:

"Method of approximation based upon thinness of plate is developed; it is found that thin plate problems may be classified into twelve types, in each case involving solution of set of partial differential equations, different for different types."

Applicable references to mathematical research.-

On Bending of Clamped Plate

A. Weinstein & D. H. Rock, Brown University-Quarterly of Applied Mathematics Vol. 2, Oct. 1944, pp 262-266

"Theoretical mathematical study containing application of recently developed variational method to boundary value problem of clamped plate of arbitrary shape."

Treats only particular case of plate with clamped edges, but article may be applicable reference to mathematical research.-

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Degree of Clamping of Reinforced Concrete Slabs at Extreme Beams

A. Shmelkes, Association of Engineers and Architects in Palestine-Journal

Analysis, Theoretical

Plates

Vol. 6, Nov. 1944, pp 10-11

"Method for computing clamping moment, bases upon identity between angle of deflection of slab at beam and angle of torsion of beam itself at point considered. (In Hebrew with brief English abstract)"

Concentrated-Force Problems in Plane Strain, Plane Stress, and Transverse Bending of Plates

P. S. Symonds, ASME-Advance Paper, No. 44, p A18, for meeting Nov.-Dec. 1944

"General method is described for solution of problems of transverse bending of thin plates acted on by concentrated normal forces and of problems of plane stress or plain strain, in which concentrated forces are applied to boundaries."

Solution by Polynomials of Plane Problem of Theory of Elasticity for Rectangular Anisotropic Plates

A. A. Kurdiumov, Prikladnaya Matematika i Mekhanika, Vol. 9, 1945, pp 339-342

"Problem reduced to system of differential equations of 4th order, with certain boundary conditions; as illustration, case of cantilever is considered, under action of uniformly distributed load, and concentrated force at end. (In Russian)"

Analysis, Theoretical

Plates

Effect of Transverse Shear Deformation on Bending of Elastic Plates

E. Reissner, ASME-Transactions (Journal of Applied Mechanics), Vol. 67, 1945, pp A69-A77

"System of Equations developed for theory of bending thin elastic plates, which takes into account transverse shear deformability of plate; results are applied to problem of torsion of rectangular plate, to problems of plain bending and pure twisting of infinite plate with circular hole. Bibliography."

Treats problem in the determination of the reactions along the edges of a simply supported rectangular plate, where classical theory leads to concentrated reactions at the corners of the plate; these concentrated reactions will not occur in the solution of the foregoing problem by means of the theory given in the present paper; possibly applicable to mathematical research.—

Slabs Supported on Four Sides

R. L. Bertin, J. Di Stasio & M. P. Van Buren, ACI-Journal, Vol. 16, June 1945, pp 537-555

"Suggested changes in American Concrete Institute Building Regulations for reinforced concrete; analysis of typical series of floor panels given to illustrate facility effected under suggested changes."

Changes are suggested, based upon close agreement between these

Analysis, Theoretical

Plates

changes and the methods of Marcus, and of Westergaard; tables show comparison of moment coefficients; slabs are considered to be two-way; article indicates that the work of Marcus & Westergaard should be more thoroughly investigated as references to mathematical research.—

Medverkande Bredden hos Tvasidigt Upplagda Rektangulara Plattor av Armerad Betong

(Effective Width of Rectangular Slab of Reinforced Concrete Supported on Two Sides)

A. Holmberg, Betong, Vol. 31, 1946, pp 124-145

"Effective width of rectangular slab of reinforced concrete supported on two sides; under assumption of concentrated load, calculation is based on theory of elasticity; if load is distributed over small area, K. W. Johansen's theory is applied. (In Swedish with English Summary)"

Ausbeulen der auf Einseitigen, Gleichmessig Verteilten Druck Beanspruchten Platten

(Warping of Plates Subjected to Unilaterally Uniformly Distributed Pressure)

C. F. Kollbrunner, Mitteilungen aus dem Institut fuer Baustatik an der Eidgenoessische Technische Hochschule in Surich, No. 17, 1946

"Warping of plates subjected to unilaterally uniform pressure in

Analysis, Theoretical

Plates

elastic and plastic sphere; theory of F. Bleich for anisotropic plates and of E. Chwalla for isotropic plates; description of test apparatus and method; theoretical evaluation of results of derivation of differential equation for warping of thin plates supported in different ways."

El Empotramiento Elastico de las Losas Rectangulares de Hormigon con Armaduras Cruzadas

(Elastic Core of Rectangular Concrete Slabs with Crossed Reinforcement)

G. C. B. Hartmann, Ciencia y Tecnica, Vol. 106, May 1946, pp 370-402

"Elastic core of rectangular concrete slabs with crossed reinforcements; importance of knowing as exactly as possible, negative moments of reinforcing members; method of calculation developed."

Effect of Small Deviation From Flatness on Effective Width and Buckling of Plates in Compression

Pai C. Hu, E. E. Lundquist & S. B. Batdorf, NACA-Technical Note No. 1124, Sept. 1946

"Conclusions are based on analysis of simulated test data calculated by large deflection theory and apply to elastic behavior of simply supported square plates under compression. Bibliography."

Solution concerned with loads in plane of plate; paper includes a discussion of "Southwell plot method" of predicting theoretical

Analysis, Theoretical

Plates

critical stresses for perfectly flat plates from experimental observation on actual plates.

Elastic Stresses Produced in Thick Plate by Application of Pressure to its Free Surfaces

I. N. Sneddon, Cambridge Philosophical Society-Proceedings, Vol. 42, Oct. 1946, pp 260-271

"Study of stress distribution in semi-infinite solid deformed by pressure of rigid body on part of plane boundary, remainder of plane being free; problem is solved by method of Hankel transforms, & Terezawa's solution is obtained as a special case of more general theory. Bibliography."

Critical Combination of Shear and Direct Stress for Simply Supported Rectangular Flat Plates

S. B. Batdorf & M. Stein, NACA-Technical Notes, No. 1223, March 1947

"Critical combinations of stress for several length width ratios were determined to accuracy of about 1% by use of tenth order determinants in conjunction with modified matrix iteration method. Bibliography."

Solution also made use of the energy method; edge conditions are not varied along any one particular edge; solution does illustrate use of matrix iteration method for solving simultaneous linear

Analysis, Theoretical

Plates

algebraic equations associated with buckling of flat plates.

Bending of Clamped Plates

W. B. Stiles, ASME-Transactions (Journal of Applied Mechanics)

Vol. 14 March 1947 pp A55-A62

(discussion) Sept. pp A254-A256

"Exact solution of thin rectangular plates clamped on all or part of boundary, requires solution of two infinite sets of simultaneous equations in two sets of unknowns; method of obtaining approximate solution based upon minimization of energy and requiring solution of first equations of single infinite set of simultaneous equations is described and illustrated."

Solutions are obtained for a rectangular clamped plate supporting a uniform or central point load; for square plate clamped on two adjacent edges and pinned on the other two edges with either a uniform or a central point load; analytical results compared with experimentally determined deflections and stresses.

On Bending of Elastic Plates

E. Reissner, Brown University-Quarterly of Applied Mathematics, Vol. 5, April 1947, pp 55-68

"Earlier work on theory of bending of thin elastic plates with reference to question of boundary conditions prescribed along edges

Analysis, Theoretical

Plates

of plate; derivations in simpler and more general form; while previously isotropic homogeneous material was assumed, plates of homogeneous or non-homogeneous construction are now considered, with elastic properties which are different in parallel and perpendicular planes. Bibliography."

Contribution au Problem Lineaire de Flexion d'une Plaque Elastique
(Contribution to the Linear Problem of Bending of an Elastic Plate)
L. Bolle, Bulletin Technique de la Suisse Romande, Vol. 73, Oct. 1947, pp 281-285 & pp 293-296

"Contribution to linear flexural problem of elastic plate; development of theory since 1813 when Lagrange introduced equation of partial derivatives of 4th order; deformation of plate; analysis of results and application to solid circular plate and to torsional problems; method leads to same results as by application of Saint Venant's theory. Bibliography."

Effective Width of Elastically Supported Flat Plates
G. Gerard, Journal of Aeronautical Sciences, Vol. 14, Nov. 1947, pp 625-626

"Letter to editor discussing paper indexed in Engineering Index 1946, p 865 from Oct. 1946 issue."

Analysis, Theoretical

Plates

Principles of Moment Distribution Applied to Stability of Structure Composed of Bars or Plates

E. E. Lundquist, E. Z. Stowell & E. H. Schuette, NACA-Report No. 809, 1945, (released 1948)

"Principle of H. Cross method of moment distribution, previously applied to stability of structures composed of bars under axial load, are applied to stability of structures composed of long plates under longitudinal load. Bibliography."

A brief theoretical treatment of the subject, including illustrative examples; derivation of formulas for various factors is given; solution considers plates to be infinitely long; it appears that a variation of this method may be applicable to continuous floor slabs.

Method for Solving Partial Differential Equations with Application to Rectangular Plates

S. T. A. Odman, Tekniska Hogskolan i Stockholm-Meddelanden, No. 10, 1948

"Method consists in transforming equation into two ordinary differential equations; relation between these two is expressed by separate equation termed characteristic equation; application to free vibration of square plate with all edges built-in. (In English)"

Grundlegende Betrachtungen zum Ausbeulen der Platten und Schalen im Plastischen Bereich

(Basic Considerations of the Warping of Plates and Shells in the Plastic Range)

Analysis, Theoretical

Plates

P. P. Bijlaard, Zurich-Eidgenoessische Technische Hochschule-Institute fuer Baustatik-Mitteilungen, No. 21, 1948

"Buckling of plates and shells in state of plasticity; differential equations based on stress distribution; buckling stresses derived from this theory agree with tests made by C. F. Kollbrunner on plates subjected to uniformly distributed pressure acting at one side; application to steel plates."

Nonlinear Large Deflection Boundary Value Problems of Rectangular Plates

Chi-Teh Wang, NACA-Technical Note, No. 1425, March 1948

"Relaxation and successive approximation method used to solve T. Von Karman's equations as applied to initially flat rectangular plates with large deflections under either normal pressure or combined normal pressure and side thrust; several specific cases analyzed. Bibliography."

Solution is concerned with solution of differential equations governing nonlinear terms, which are introduced because of large deflections; small deflections involve only linear terms; paper states that solutions offered in it are applicable to practically any boundary conditions; paper seems applicable to mathematical solution of floor slab problem.

Analysis, Theoretical

Plates

Square Plates Fixed at Points

C. J. Thorne, ASME-Transactions (Journal of Applied Mechanics), Vol. 15, March 1948, pp 73-79

"Deflection functions for plates with symmetric loads as sum of biharmonic polynomials with coefficients determined by slopes and deflections at five equally spaced points on each edge; coefficients given numerically for point load and uniform load, for zero slope and deflection at five points, for tangential slope at two points not specified, for particular slope, and for particular deflection at midpoint of edges."

Deflection curves are plotted at the edges, the center line, and the diagonal; slopes plotted at edges; moments and stresses given at mid-point of the edges.

General Approximation Method in Theory of Plates of Small Deflection

M. Z. Krzywohlocki, Brown University-Quarterly of Applied Mathematics, Vol. 6, April 1948, pp 31-52

"Treatment is given entirely independent of shape of plate; its success depends, however, on type of loading; if there is no lateral load, i.e., if forces act in plane of plate, method is successful independently of whether forces are distributed uniformly or not; if there is lateral load, method is not always successful.

Analysis, Theoretical

Plates

Bibliography."

Possibly applicable mathematical reference.

Direct Determination of Bending and Twisting Moments in Thin Elastic Plates

H. J. Greenberg & W. Prager, American Journal of Mathematics, Vol. 70, Oct. 1948, pp 749-763

"Other investigators have regarded state of stress in body of given shape as point in function space, and employ concept of strain energy to establish metric; extension of this analysis is presented; application to example of clamped square plate."

Rektangular Platte Med Rektangular Last av Godtycklig Utstrackning (Rectangular Plate With Rectangular Load on Area of Any Extent)

S. Tornqvist, Betong, Vol. 34, 1949, pp 79-97, (discussion) pp 205-210

"Rectangular plate subjected to load acting on rectangular area of any extent; one edge or two opposite edges free or elastically supported; method introduces concept of "width of distribution" by diagrams; combined structural action of plate and edge beam in moment distribution; calculations carried out by assuming linear stress variation in accordance with theory of elasticity. Bibliography."

Analysis, Theoretical

Plates

Etude de L'influence du Poids Propre sur la Stabilite d'une Plaque Rectangulaire

(Study of the Influence of Calculated Weight on the Stability of a Rectangular Plate)

H. Favre, Schweiz Bauzeitung, Vol. 67, Jan. 1949, pp 34-35, pp 57-58

"Study of influence of weight on stability of rectangular plate; approximations lead to solution of algebraic equation of infinite degree; deformation caused by buckling."

Shearing Displacement of Rectangular Plate

E. H. Mann, Cambridge Philosophical Society-Proceedings, Vol. 45, April 1949, pp 258-262

"Problem of plate stressed by uniform longitudinal relative displacement of two opposite edges, other pair of sides remaining free; more rapid and accurate solution presented; general form of solution given for plate of any dimensions; plates of sides in ratio 2:1 considered in more detail."

Stabilitaet Rechteckiger, Durch Linear Verteilte Randkraefte Beanspruchter Platten im Elastischen Bereich

(Stability in Elastic Range of Rectangular Plates Subjected to Forces Linearly Distributed Along Edges)

C. F. Kollbrunner & G. Herrmann, Schweiz Bauzeitung, Vol. 67, May 1949, pp 307-309

Analysis, Theoretical

Plates

"Stability in elastic region of rectangular slabs subjected to forces linearly distributed along edges; study of pure bending under different edge conditions for non loaded sides."

Theories of Plastic Buckling

S. B. Batdorf, Journal of the Aeronautical Sciences, Vol. 16, July 1949, pp 405-406

"New theory of plasticity developed which is of neither flow nor deformation type; it is based upon concept of slip, and its formulation was guided more by physical, and less by mathematical, considerations than previous theories; theory accounts for apparent contradictions alluded to and justifies use of deformation theory in analysis of plastic buckling of plates. Bibliography."

Applicable reference to mathematical or experimental research.

Theory of Tests on Plastic Stability of Plates and Shells

P. P. Bijlaard, Journal of the Aeronautical Sciences, Vol. 16, Sept. 1949, pp 529-541

"Buckling superimposes additional state of stress on original one; assuming that plastic deformation is governed only by amount of elastic shearing energy at point in question, it is shown that assumption of "plastic deformation" leads to smaller buckling stresses than that of "plastic flow." Bibliography."

Analysis, Theoretical

Plates

Loadings are in plane of plates; edge conditions do not vary along any one, or set of particular edges; possibly applicable to mathematical research.-

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On Calculation of Buckling Stress of Rectangular Plate by Deflection Method

M. Naruoka, Kyoto University Faculty of Engineering-Memoirs, Vol. 12, Jan. 1950, pp 60-89

Development of formula by slope deflection method for calculation of stress in case when rectangular plate is simply supported on two sides perpendicular to direction of normal forces and has various boundary conditions on other two sides. (In English)

Rational Analysis and Design of Two-Way Concrete Slabs

C. P. Siess & N. M. Newmark, ACI-Journal, Vol. 20, Dec. 1948 pp 273-303 also University of Illinois-Eng. Exp. Station Bulletin Series No. 385, Feb. 1950

A new method for the design of two-way building slabs is proposed; step by step development is described; new moment distribution procedure is used to compute moments in a number of rectangular slabs continuous over rigid beams; analysis includes such variables as; ratio of sides, effect of discontinuous edges, torsional stiffness of beam, various types of loading and combinations of panels

Analysis, Theoretical

Plates

of various sizes and shapes; conclusions are stated; article appears to be an excellent reference for mathematical research.

Solution of Elastic Plate Problems by Electrical Analogies

R. H. MacNeal, ASME-Advance Paper, No. 50, SA-23, for meeting, June 1950

"Dynamic analogy method for solution of elastic plate problems is described; electrical circuits are developed which can be set up and studied on electric analogy computer to aid solution of problems involving deflections under constant load, transient vibrations, or normal modes; results obtained for rectangular cantilever plate." Method of applying boundary conditions to plates with irregular edges is given; paper appears to be an applicable reference to mathematical research.

Slabs Spanning in Two Directions Analyzed by Consideration of Pattern of Fractures

H. Craemer, Concrete and Constructional Engineering, Vol. 45, Aug. 1950, pp 279-282

"Application of plastic theory to analysis, by consideration of pattern formed by fractures, of slabs spanning in two directions."

Application of Relaxation Methods to Freely Supported Flat Slabs

W. T. Marshall, Engineering, Vol. 170, Sept. 1950, pp 239-242

"Explanation of how R. Southwell's relaxation method can be applied

Analysis, Theoretical

Plates

to solution of flat slab; problem considered is that of "simply supported" slab, i.e., one which simply rests on all its supports and to which no edge bending moment is applied."
Equations hold for any type of loading, only two conditions can be specified at the boundary of a slab; charts; paper appears to be an applicable reference for mathematical research.

On Analogies Relating Flexure Extension of Flat Plates

R. V. Southwell, Quarterly Journal of Mechanics and Applied Mathematics, Vol. 3, Sept. 1950, pp 257-270

"Two previously described analogies relating flexure and extension are combined in inclusive statement covering perforated (multiply connected) plates; reasons are stated for believing that "2-diagram technique" is preferable in problems governed by "mixed" boundary conditions."

Some Thin Plate Problems by Sine Transform

L. I. Deverall & C. J. Thorne, ASME-Advance Paper, A-13, for meeting, Nov.-Dec. 1950

"General expression for deflection of thin rectangular plates are obtained for cases in which two opposite edges have arbitrary but given deflections and moments; sine transform is used as part of method of solution, since solutions can be found for arbitrary load

Analysis, Theoretical

Plates

for each set of edge conditions at other two edges."

Six general solutions are given which arise from all possible combinations of physically important edge conditions at the other two edges; solution can be found by integration or by the use of a table of sine transforms; paper appears to be possibly applicable to mathematical research.—

Ueber den Verlauf der Biegemomentenhauptlinien fuer Dvenne Platten

(Concerning the Main Bending Moment Lines for Thin Plates)

A. Mehmel & H. Beck, Bauingenieus, Vol. 25, May & July 1950, pp 235-238

"Course of main bending moment lines for thin plates; differential equation; square and rectangular plates subjected to different loads; indeterminate points of plate; diagrammatic drawings."

Analysis, Theoretical

Beams, Columns, Walls

Slab Deflection and Subsidence of Column Supports in a Flow Test of International Hall, Chicago

H. T. Eddy, Franklin Institute Journal, Dec. 1916, pp 761-769

"Report of tests made Sept. 1913."

Paper discusses elastic and plastic action of slabs and columns; calculation of moments due to column shortening; discussion of deflection recovery.

Buckling of Elastic Structures (Columns)

H. M. Westergaard, ASCE-Proceedings, Vol. 47, Nov. 1921, pp 455-533, also Vol. 48, Jan., Feb. & May 1922, pp 103-110, 373-383, & 1265-1268

"Investigation deals with structural actions in which stresses are not proportional to loads, although proportional limit of material has not been exceeded and deflections remain small. Describes astatic and in particular, heterostatic action. Deals also with columns carrying axial and transverse loads at same time. Formulas are given for buckling of slabs and systems of crossing beams. Classified bibliography."

Paper deals with mathematical solution for buckling of plates due to loads normal to or in the plane of the slab; arrives at formulas for moments for various loadings and shapes; paper appears to be applicable reference for mathematical solution.

Analysis, Theoretical

Beams, Columns, Walls

Formanderung und Beanspruchung Trager Loser Decken

(Deformation and Loading of Girderless Ceilings)

J. Krebitz, Zeitschrift des Oesterreichische Ingenieur und Architekten Vereines, Vol. 74, Nov. 1922, pp 194-197 & 200-201

"Develops formulas and makes calculations, especially as to deformation of a rectangular floor supported on three points."

Spannungen in Wandartigen Balken Bei Feldweise Wechselnder Belastung

(Stresses in Wall-Like Beams)

H. Craemer, Zeitschrift fuer Angewandte Mathematik und Mechanik, Vol. 10, May-June 1930, pp 209-218

"Review of Navier and Mesnager theories of bending as applied to this case; author's original solution of problem with special reference to design of walls of bunkers."

Deflection of Reinforced Concrete Members

T. D. Mylrea, ACI-Journal, Vol. 2, Dec. 1930, pp 351-357

"Study of beam and slab type of construction; types of formulas; assumptions and their effects; observations on available data; comparison of actual and computed deflections; beams of unusual shape."

Paper does not appear to be particularly significant with regard to either mathematical or experimental work.

Analysis, Theoretical

Beams, Columns, Walls

Tragwerke auf Elastische Nachgiebiger Unterlage

(Supporting Elements on Elastically Yielding Foundations)

P. Nemenyi, Zeitschrift fuer Angewandte Mathematik und Mechanik, Vol. 11, Dec. 1931, pp 450-463

"Theoretical mathematical discussion of stress in beams, plates and foundation slabs supported on elastically yielding foundations, with special reference to Schwedler's theory."

Calcul des Parois Planes et des Poutres-Cloisons en Beton Arme

(Analysis of Plane Walls and of Partition-Beams of Reinforced Concrete)

R. L. Hermite, Genie Civil, Vol. 102, April 1933, pp 393-397

"Mathematical theoretical analysis of design of plane walls, also of reinforced concrete walls acting as girders."

La Participation des Hourdis a la Resistance des Nervures en Beton Arme

(The Participation of Rough-Walling in the Resistance of the Ribbing in Reinforced Concrete)

H. Lossier, Genie Civil, Vol. 104, Feb. 1934, pp 108-112

"Theoretical mathematical study of participation of horizontal sections in carrying of loads by reinforced concrete floor slabs supported on girders assumed to act as T Beams."

Analysis, Theoretical

Beams, Columns, Walls

La Torsion des Poutres dans les Constructions en Beton Arme

(Torsion of Beams in Reinforced Concrete Constructions)

H. Durnerin, Travaux, Vol. 19, Jan.-Feb. 1935, pp 39-45, pp 84-89

"Necessity of considering torsional stresses in design of reinforced concrete beams for certain structures such as stairways, corbels, water towers etc.; computations of bending and torsional moments in annular foundation for water tower; theory of ring carrying projecting loads."

Der Einfluss Verwindefester Unterzuege auf die Beanspruchung Durchlaufender Eisenbetonplatten

(Influence of Torsion Resisting Girders on Stresses in Continuous Reinforced Concrete Slabs)

Craemer, Zement, Vol. 26, Dec. 1937, pp 831-835

"Influence of torsion resisting girders on stresses in continuous reinforced concrete slabs; method of calculation employing three-moments differential equation and supplementary moments differential equations; example of application."

Lateral Instability of Yielded Mild Steel Beams of Rectangular Cross-Section

B. G. Neal, Royal Society of London-Philosophical Transactions, Vol. 242, Jan. 1950, pp 197-242

Analysis, Theoretical

Beams, Columns, Walls

"Lateral buckling in deep beams studied from theoretical and experimental standpoint; consideration of initial secondary flexural rigidity, initial torsional rigidity and conditions causing lateral instability; method enabling critical load causing lateral buckling, to be predicted for cases in which beam has partially yielded. Bibliography."

Analysis of Three-Dimensional Beam-and-Girder Framing

P. M. Ferguson, ACI-Journal, Vol. 22, Sept. 1950, pp 61-72

"Beam and girder floors with some beams carried directly by columns and others supported on girders is cited as practical problem in frame analysis that must include torsional stiffness of girder; curves showing how moments coefficients vary with torsional stiffness are developed for a few simple cases in interior panels; practical calculation form is set up for use with moment distribution method in solving three-dimensional problems."

Solution involves three dimensional moment distribution; slab action not considered in solution, but article appears to be a fairly good reference for mathematical research in that torsion in beams has been considered.

Torsion in Continuous Structures

A. Chronowicz, Concrete and Constructional Engineering, Vol. 45, Oct. 1950, pp 363-365

Analysis, Theoretical

Beams, Columns, Walls

"Development of formulas for torsional rigidity of reinforced concrete; application described with numerical examples."

Analysis, Experimental

Plates

Carrying Capacity of Reinforced-Concrete Floor Construction

A. E. Lindall & G. R. Heckle, Engineering Record, July 1907, pp 73-74

"Gives a record of a test on a full sized panel."

Results of tests indicated that formulas for moments then in use did not even approximately represent the carrying capacity of floor slabs, wl/10, wl/8 and wl/12; article indicates that problem was being considered at that time.

A Unique Type of Reinforced Concrete Construction

Theodore S. Condron, Journal of the Western Society of Engineers, Dec. 1909, pp 824-849

"Brief illustrated descriptions of seven types of reinforced concrete floor construction, especially explaining the advantages of the paneled slabs without girders or beams. General discussion."

Several models were constructed and tested; load deflection curves plotted; discussion of methods of reinforcing; no mathematical methods of analysis included.

Experimental Study of Stresses in Flat Slabs

Frank J. Trelease, Engineering Record, March 1912

"From a paper before the National Association of Cement Users. Describes experiments. Illustrated."

Analysis, Experimental

Plates

A Comparative Test of Two Full-Sized Reinforced Concrete Flat Slab Panels

Henry T. Eddy, Engineering News, March 1913, pp 624-628

"Describes a comparative test of a Norcross slab and a Turner "Mushroom" slab. Illustrated."

Test results are concerned with comparison of two methods of design; conclusions and recommendations based upon test results.

Tests of Reinforced Concrete Slabs Under Concentrated Loading

Engineering Record, Aug. 1913, pp 154-156

"Abstract of papers, and discussion, on the determination of the effective width of concrete slabs, presented before the American Society for Testing Materials."

Description of specimens; results of tests; curves of deflection; description of failure of slabs; conclusions not very definite; discussion of tests by W. A. Slater included.

Steel Stresses in Flat Slabs

H. T. Eddy, ASCE-Proceedings, Jan. 1914

"A discussion of tests for actual stresses in several large buildings, as compared with computed theoretical stresses of reinforced concrete slabs."

Analysis, Experimental

Plates

The Effective Width of Reinforced Concrete Slabs Supporting Concentrated Loads

C. R. Young, Engineering News, July 1914, pp 244-246

"Describes experimental results and gives an analysis of the problem and working formulae derived."

Discusses tests and results on concrete slabs; tests discussed have been listed in this bibliography under respective authors.

Tests of Reinforced Concrete Flat Slab Structures

A. N. Talbot & W. A. Slater, Bulletin No. 64 University of Illinois, 1916.

Presents results of tests made on four reinforced concrete buildings and one reinforced concrete test structure; data obtained on bending action of supporting columns; efforts made to find distribution of stress in the bands of reinforcement both laterally and longitudinally; description of methods used; load deformation diagrams; summaries of individual tests; general comments; reference applicable to experimental research.

Plattenversuche des Deutschen Ausschusses Fur Eisenbeton

(Investigations of Plates of the German Commission for Reinforced Concrete)

Hager, Beton und Eisen, Jan. 1916

Analysis, Experimental

Plates

"Results of experiments of German Reinforced Concrete Commission on strength of slabs. Illustrated."

Analysis and Tests Held to Show Advantages of New Flat-Slab Reinforcement

E. Sinulski, Engineering Record, Feb. 1916, Serial, 1st part, pp 217-219, 2nd part, pp 247-250

"Stress conditions; deflection contours. Illustrated."

Investigation of action of multiply reinforced concrete flat slabs under load; theoretical analysis presented; deflections and stresses measured; illustration of placing of reinforcing steel; computes moment coefficients; stress diagrams for all specimens tested; conclusions; possibly a good reference for experimental research.

Tests of Mushroom Flat Slab in Seattle Warehouse

D. E. Hooker, Engineering Record, May 1916, pp 647-649

"Test of mushroom flat slabs in Seattle warehouse shows high local stresses. Extensometer measurements under live loads. Illustrated."

Diagrams of stresses in slabs and columns; stresses wall panels, and columns; possible reference for experimental research.

Second Test of Seattle Flat-Slab Warehouse Shows Some Decrease in Stresses

Engineering News-Record, April 1917

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"Official test of mushroom flat-slab floor. Illustrated." Diagrams of stresses in slabs; wall column stresses; comparison with first test; conclusions and recommendations; D. E. Hooker, who conducted tests recommended disapproval of mushroom system as was designed.

Deflection and Wall Girder Tests on Floor of a Flat-Slab Concrete Building

C. E. Locke, Engineering News, Feb. 1917

"Tests on the large Pierce-Arrow Building at Buffalo, N.Y. Illustrated."

Deflection measurements; data on column bending and wall-girder stresses; tests indicate torsional rigidity of beams.

Test of a Flat Slab Floor of the Western Newspaper Union Building

A. N. Talbot & H. F. Gonnerman, Bulletin No. 106 University of Illinois, also Engineering and Contracting, Nov. 1917, By J. E. Love

The results of a test made on a four-way reinforced concrete flat slab floor of the Western Newspaper Union Building in Chicago, in 1917. A load of 913 lbs. per sq. ft. was applied over four panels. The building was nine years old at the time of the test, and was torn down after the testing was completed. The test load applied was much greater in proportion to the design load than had been used in previous tests of buildings. The stresses obtained in the

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reinforcing bars and concrete were much higher than had been obtained in previous tests on other buildings. There are better methods now available for determining deflections than were used in these tests.

Notes on the Test of a Girderless Floor

F. Gillespie and T. D. Mylrea, Journal Engineering Institute of Canada, Vol. 2, April 1919, pp 300-317

"Tests conducted on flat slabs in Toronto factory by City Architect's Department in conjunction with Department of Applied Mechanics, University of Toronto."

Moments and Stresses in Slabs

Westergaard & Slater, ACI-Proceedings, Vol. 17, 1921, pp 415-538

Paper presents information which correlates the results of tests of a fairly large number of slab structures with the results of analysis; paper divided into three parts; (a) analysis of moments and stresses in slabs, (b) study of the relation between the observed and the computed steel stresses in reinforced concrete beams, made for the purpose of assisting in the interpretation of slab tests, (c) a study of the test results for flat slabs with a a view of comparing the moments of the observed steel stresses with the bending moments indicated by the analysis; paper appears to be

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an applicable reference to both mathematical and experimental research.

Lastverteilung bei Zweiseitig Aufliegenden Eisenbetonplatten Mit Konzentrierter Belastung

(Load Distribution in Reinforced Concrete Plates Supported on Both Sides and Under Concentrated Load)

W. Petry, Beton und Eisen, Vol. 20, March 1921, pp 60-62

"Results of tests carried out by German Committee for Reinforced Concrete in material testing station of Stuttgart Technical Academy."

Rektangulaere Jaernbetonplader, Simpelt Understottede Langs to Modstaaende Sider, Koncentreret Belastning

(Rectangular Reinforced Concrete Slabs Under Centered Load)

N. J. Nielsen, Ingenioren, Vol. 30, Dec. 1921, pp 721-726

"Discusses testing of slabs of various dimensions supported along sides and loaded at a given point within rectangle."

Theorie der Plattenbiegung und Ihre Experimentelle Bestatigung

(The Theory of Plate Bending and Its Experimental Confirmation)

A. Nadai, Zeitschrift fur Angerwandte Mathemtik und Mechanik, Vol. 2, Oct. 1922, pp 381-398

"Tests with glass and sheet-metal plates; notes on concrete plates."

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Losas de Concreto Armado, con Apoyo Perimetral

(Reinforced Concrete Slabs of Perimetric Support)

M. M. yRivera, Revista Mexicana de Ingenieria y Arquitectura, Vol. 1, April 1923, pp 55-65

"Results obtained with various types of reinforcement, showing that these slabs give good security under load."

Tests on Full-Size Slabs

Concrete & Constructional Engineering, Vol. 22, April 1927, pp 252-254

"Account of research work carried out by O. Graf at Technical High School at Stuttgart on strength of rectangular slabs of large scantling reinforced in different manners and submitted to uniform loading; results indicate that design of mesh reinforced slabs as commonly carried out is open to question."

Concentrated Loads on Reinforced Concrete Slabs

E. S. Andrews, Concrete & Constructional Engineering, Vol. 22, May 1927, pp 297-302

"Discussion on their distribution."

Versuche Mit Freiaufliegenden Rechteckigen Platten Unter Einzelkraft Belastung

(Experiments with Simply Supported Rectangular Plates Carrying Single Concentrated Loads)

M. Bergstaesser, Forschungsarbeiten auf Dem Gebiete Des Ingenieurwesens

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Vol. 302, 1928

"Report from department of applied mechanics of University of Goettingen; fundamental equations of theory of plates; Nadai solution; details of experimental equipment and methods for testing square and rectangular glass plates; results of tests compared with computations based on Nadai Theory."

Messungen an Tragerlosen Pilzdecken

(Tests of Floors of Girderless Mushroom Construction)

E. Probst, Bauingenieur, Vol. 12, Feb. 1931, pp 105-106

"Report on experimental determination of moments in reinforced concrete mushroom floor system of Building, occupying area of 50 m. by 100 m., with pillars spaced 5.84 and 6.15 m. apart; comparison of empirical results with values derived from theoretical formulas."

Belastungsversuche an Einer Pilzdecke

(Loading Tests of Floor of Mushroom Construction)

M. Genel, Beton und Eisen, Vol. 30, Sept. 1931, pp 328-332

"Mathematical analysis of tests made in Triest on warehouse floor, measuring 20 m. by 24.4 m., with columns placed 5 m. apart, to check design based on Marcus method."

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Deflection of Certain Rectangular Reinforced Concrete Slabs Freely Supported Along Two Parallel Edges

J. F. Baker, Concrete and Constructional Engineering, Vol. 27, Dec. 1932, pp 691-708

"Tests on slabs under uniformly distributed loads and under central concentrated load; comparison of observed and calculated deflections; deflections before cracks appeared were very close to those of thin plates of homogeneous material similarly loaded; value of Poisson's ratio was not far from zero."

Some Experiments on Reinforced Concrete Slabs

R. H. Squire, Junior Institution of Engineers Journal and Record of Transactions, Vol. 44, Part II, Aug. 1933, pp 447-457, also Quarry and Roadmaking, Vol. 38, Oct. 1933, pp 401-406

"Tests of scale models, using homemade testing apparatus."

Concentrated Loads on Slabs

C. T. Morris, Bulletin No. 80 Ohio State University, Jan. 1934

Tests of slabs simply supported along two edges loaded with various combinations of concentrated loads; moment curves plotted and compared with those of Westergaard; effect of transverse beams considered. Bibliography; paper appears to be applicable reference for experimental research.

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Test of Flat Steel-Plate Floor Under Loads

L. B. Tuckerman, A. H. Stang & W. R. Osgood, U. S. Bureau of Standards Journal of Research, Vol. 12, March 1934, pp 363-377, also American Welding Society Journal, Vol. 13, June 1934, pp 24-25

"In cooperation with American Institute of Steel Construction, Incorporated, flat steel-plate floor was tested under loads to determine its strength and whether floor behaved as unit when loads were applied."

Description of construction and of methods of testing; Conclusions; applicable reference for experimental research.

Shear in Slabs Under Concentrated Loads

M. G. Spangler, Civil Engineering (New York), Vol. 4, Nov. 1934, pp 590-594, also Vol. 5, Feb. 1935, pp 103-106

"Experimental determination of distribution of pressures in 20 individual slabs tested at Iowa State College; effect of concentrated load acting near one of supports; distribution of reaction found to be independent of load applied; effective width changed by plastic flow under sustained load; reaction by friction method."

Article contains illustrations of experimental set-up; comparisons with analytical results for effective width of slab; experimental work disagrees with plate theory under certain loading conditions; article appears to be an applicable reference for experimental research.

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Thin Flat Slab Floors Prove Rigid Under Tests

W. H. Wheeler, Engineering News-Record, Vol. 116, Jan. 1936, pp 49-50

"Results of tests of two panels of first floor of office building portion of Minneapolis armory; floor slab deflections."

Possible reference for experimental research.

Rechnerische und Experimentelle Ermittlung der Durchbiegungen und Spannungen von Quadratischen Platten, etc.

(Numerical and Experimental Determination of Deformations and Stresses of Square Plates)

R. Kaiser, Zeitschrift fuer Angewandte Mathematik und Mechanik, Vol. 16, April 1936, pp 73-98

"Theoretical and experimental study, made at Achen Institute of Technology, on stresses and deformations of square plates simply supported along their edges and subjected to uniformly distributed loads and great deflections."

Distribution of Shearing Stresses in Concrete Floor Slabs Under Concentrated Loads.

M. G. Spangler, Iowa State College Engineering Experiment Station Bulletin 126, April 1936, Also Engineering News Record, Vol. 117, Aug. 1936, pp 308

"Iowa Engineering Experiment Station experiments intended to provide basis for determining effective width for maximum shearing stresses in concrete slabs under concentrated loads; data con-

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cerning 20 different rectangular slabs ranging in thickness from 2½ to 6½ inches, in width from 5 to 7½ feet, and in span from 3½ to 10 feet; development of empirical working formulas.

Slabs simply supported on two opposite edges and free on the other two edges; method of testing and type of apparatus included; principles evolved may be applied to any combination of concentrated loading; conclusions; comparison of experimental results with thin-plate theory; paper appears to be a good reference for experimental research.

Ueber die Nutzbreite bei Steineisendecken Mit Einzellast

(Concerning the Range of Usefulness of Concrete-Steel Slabs "ith Single Load)

M. Herrmann, Bauingenieur, Vol. 117, May 1936, pp 206-211

"Results of tests of concrete-steel slabs carrying single concentrated load, made at Materials Testing Bureau of Dahlem near Berlin, for determination of effective width."

Die Versuchspiladecke in Baku

(Experiments on Mushroom Floors in Baku)

M. Steuerrmann, Beton und Eisen, Vol. 35, Nov. 1936, pp 357-363, & Nov. 1936, pp 374-376

"Mathematical analysis of results of large scale tests, at Baku, USSR, of experimental reinforced concrete mushroom floor systems,

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300 sq. m. in area, supported on 16 columns; floor slab was subjected to water load of over 3 m. head."

Behavior of Rectangular Plates under Concentrated Load

R. G. Sturn & R. L. Moore, ASME-Transactions (Journal of Applied Mechanics), Vol. 4, June 1937, pp A-75-A-85

"Summary of experimental and analytical research on flat plates, conducted at Aluminum Research Laboratories; experimental work included tests on number of different sizes of aluminum alloy plates, ranging from 1/8 inch to 1 inch thickness, loaded on spans of from 48 to 384 times thickness."

The effect of degree of load concentration, types of edge support, and position of load upon stresses and deflections were principal variables studied; paper appears to be excellent reference for experimental research.

Structural Behavior of Battle-Deck Floor Systems

I. Lyse & I. E. Madsen, ASCE-Proceedings, Vol. 64, Jan. 1938, pp 99-121, (discussions) June, pp 1226-1231 & Sept., pp 1531-1532, also Vol. 65, Jan. 1939, pp 107-108

"Results of two years of experimental investigations of behavior of battledeck flooring; four one-third sized models and one full sized floor panel, designed on basis of results obtained on

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preliminary models, were tested under action of concentrated wheel load; test results gave basis of rational design method for battle-deck floor systems."

Investigation limited to study of stresses in plate and action of stringers relative to battle-deck flooring for highway bridges; article seems to be an applicable reference to experimental work.

Studies in Reinforced Concrete - VIII. Strength and Deformation of Some Reinforced Concrete Slabs Subjected to Concentrated Loading

F. G. Thomas, (Great Britain), Department of Science and Industrial Research - Building Research - Technical Paper No. 25, 1939

"Investigation to determine whether plate theory is reasonable and safe guide for use in design of bridge deck slabs subjected to point loading; elastic theory of plate action; design of test slabs; tests results at low loads and high loads after incidence of cracking. Bibliography."

Tests of Plaster Model Slabs Subjected to Concentrated Loads

N. M. Newmark & H. A. Lepper, Bulletin No. 313, University of Illinois, 1939

The purpose of the research described in this paper was to supplement analyses by special theories for a number of cases of loading of rectangular slabs; slabs of plaster, generally 1 inch thick and of 12 inch span loaded with concentrated loads were tested; appli-

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cability of the plaster-model method to the determination of stresses in elastic slabs was demonstrated; results of tests; significance of test results; paper appears applicable to experimental research.

Meting van Doorbuigingen en Spanningen van Een Gewapend Betonplaat, Waarop Geconcentreerde Lasten Werden Aangebracht

(Measurement of Bending and Stresses of Reinforced Concrete Slabs Carrying Concentrated Loads)

H. J. Kist, Ingenieur, Vol. 54, April 1939, pp Bt. 33-35, (discussion) Bt. 35-36

"Measurement of deflection and stresses of reinforced concrete slabs carrying concentrated loads; comparison of test results obtained by Netherlands Commission."

Tests of Reinforced Concrete Slabs Subjected to Concentrated Loads

F. E. Richart & R. W. Kluge, University of Illinois Engineering Experiment Station - Bulletin 314, Vol. 36, June 1939

"Test forming part of investigation of reinforced concrete slabs subjected to concentrated loads, to secure information needed for more effective design of highway bridge floor slabs; difference between measured and calculated quantities; effect of size and shape of bearing area; consistency of slab behavior; tests of long rectangular slabs simply supported on two long edges; tests of

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square slabs."

Method of testing illustrated and described; paper appears to be applicable for experimental research.

Some Tests on Reinforced Concrete Slabs With Fixed Edges and Uniformly Loaded

L. G. Simms, Structural Engineer, Vol. 18, April 1940, pp 562-576

"Tests by Building Research Station on Reinforced Concrete slabs fixed along all sides and subjected to uniform loading; tests on duplicate square slabs, each of 6 foot side and 4 inch thick, fixed on all sides; tests on rectangular slab 12 feet long, 6 feet wide and 4 inches thick fixed on all sides; ratio of theoretical failing loads and actual maximum loads of concrete slabs."

Bending Tests on Panels of Stiffened Flat Sheet

E. C. Hartman & R. L. Moore, Aluminum Company of America - Aluminum Research Laboratories-Technical Paper, No. 4, 1941

"Results of tests in which sheet thickness, size and shape of stiffener, and stiffener spacing and span were varied to determine influence of factors on effective widths of sheet, and in which sheet thickness and type and spacing of connection between sheet and stiffeners were principal variables considered; rules for design of stiffened flat sheet to resist bending, based on results of investigation described."

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Extension of Photoelastic Method of Stress Measurement to Plates in Transverse Bending

J. N. Goodier & G. H. Lee, ASME-Transactions (Journal of Applied Mechanics) Vol. 8, March 1941, pp A27-A29

"Photoelastic method for models in plane stress extended to plates bent transversely by cementing together two similar plates with thin layer of reflecting material between them; light transverses twice one half of full plate thickness so that net optical effect is obtained; measurements on semi-circular notches in strip under pure bending; difficulties and potentialities of method. Bibliography."

Paper possibly applicable to experimental research.

Normal-Pressure Tests of Rectangular Plates

W. Ramberg, A. E. McPherson & S. Levy, NACA-Report, No. 748, 1942

"Results of tests made of 56 rectangular plates with clamped edges and of 5 plates with freely supported edges; pressure was applied and center deflection and permanent set at center were measured; for some of plates, strains and contours were measured in addition."

The paper seems to be a good reference for experimental work, in spite of the fact that the tests carried out were done so in connection with seaplanes; diagrams of apparatus shown; deflection

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diagrams and strain diagrams for some of plates are shown.

Photoelastic Analysis of Transverse Bending of Plates in Standard Transmission Polariscope

D. C. Drucker, ASME-Transactions (Journal of Applied Mechanics) Vol. 9 Dec. 1942, pp A161-A164

"Ideas of three dimensional photoelasticity are applied to analysis of plates under transverse bending, resulting in simple photoelastic method, employing standard two-dimensional transmission polariscope; procedure used is to "freeze" fairly high initial tension in bakelite or similar material, cut out model at some angle to direction of tension, bend, and observe; results of various tests given."

Results for thick and thin plates compared; method discussed may be applicable to experimental research.

Combined Action of Concrete Slabs and Supporting Structural Steel Beams

R. C. Manning, Engineering Journal, Vol. 29, March 1946, pp 149-153

"Article deals with tests of steel beams encased in concrete, to determine stresses and structural characteristics of combination; it is pointed out that general practice is to consider steel beam as only support of live and dead load, and that taking account of additional support of concrete effects substanial savings in material; details of tests by Canadian Institute of Steel Construction."

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Some Experiments on Distribution of Deflection and Stress in Thin Flat Plates

H. D. Conway & V. C. Davies, Sheet Metal Industries, Vol. 23, Nov. 1946, pp 2147-2151, Vol. 24, Feb. 1947, pp 355-363, May 1947, pp 993-997,999

"Plate problems in which edges are subjected to negligibly small fixing moment; circular plates loaded with uniform pressure and supported at four points equidistant from center; uniformly loaded plate with single central support; uniformly loaded plate on four supports; determining best positions of supports for minimum deflection and stress."

Investigation into Strength of Composite Reinforced Concrete Floor

E. H. Sidwell, Institution of Civil Engineer Journal, Vol. 30, April 1948, pp 188-192

"Description of full scale outdoor tests on panel of floor 13 feet by 14 feet, and laboratory tests on floor slabs and beams; tests of ten special beams with different systems of reinforcement at ends is also described; observations have been made with object of discovering extent to which composite floor acts as T-beam." Paper possibly applicable to experimental research.

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Korsarmerade Bettongplattor

(Concrete Slabs Reinforced in Two Directions)

H. Nylander, Betong, Vol. 35, 1950, pp 29-112

"Concrete slabs reinforced in two directions; ultimate load and resistance to bending; investigations consider square, freely supported slabs with and without reinforcement at corners, slabs fixed along two edges, and slabs fixed along two edges and subjected to long time loads; effect of shrinkage calculated on basis of theory of elasticity under selected conditions at supports."

Korsarmerade Betongplattor

(Concrete Slabs Reinforced in Two Directions)

H. Nylander, Betong, Vol. 35, 1950, pp 149-161

"Concrete slabs reinforced in two directions; transfer of moments due to formation of cracks; report on long time tests; actual support moments are smaller than those obtained by theory of elasticity; rigidity of system considerably reduced by formation of cracks; termination and anchorage of reinforcement; design considerations."

Pure Bending of Rectangular Plates

D. G. Ashwell & E. D. Greenwood, Engineering, Vol. 170, July 1950, pp 51-53 & pp 76-78

"Experiments carried out on mild steel plate to verify some of theoretical results; type of problem dealt with described by refer-

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ence to rectangular prismatic beam bent about principle axis of its cross section; determination of distortion suffered by cross section of plate when subjected to bending; optical method of testing gave much more satisfactory results than numerical method." Paper possibly applicable to experimental research.

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Tests of Reinforced Concrete Buildings Under Load

A. N. Talbot & W. A. Slater, Bulletin No. 64, University of Illinois Experiment Station, January 1913, also Engineering News, Dec. 1910, by A. R. Lord

Bulletin records results of three field tests made on reinforced concrete floor systems; deformations in parts of structure were measured; earliest known tests of this type made on reinforced concrete buildings; method of testing discussed; two types of floor systems were tested, beam and girder type, and flat slab type; discussion of stresses.

A Study of Loading Tests on Reinforced Concrete Structures

E. S. Andrews, Concrete and Constructional Engineering, Vol. 19, June & July 1924, pp 369-375 & pp 443-449

"Considers some of more prominent tests made by experimental engineers, and studies their principle results in light of ordinary methods of design, explaining how results may be interpreted.

June - A two-way hollow floor

July - British tests on one-way hollow tile floor."

British Investigations of Steel Structures

Engineering, Vol. 132, Sept. 1931, pp 348-352

"Account of work being carried out by Department of Scientific and Industrial Research, Steel Structures Committee, at Building Research

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Beams, Columns, Walls

Station at Garston; main projects being studied relate to loads on floors, strains in buildings, analysis of stress, specifications and properties of materials, properties of welded connections, and effects of vibration."

Paper possibly applicable to experimental research.

Experiments with Concrete in Torsion

P. Andersen, ASCE-Proceedings, Vol. 60, May 1934, pp 641-652, Discussions in Aug. pp 919-922, Oct. pp 1238-2343, Dec. pp 1502-1503, also Vol. 61, Jan.-Feb. 1935, pp 131-142 & pp 247-249

"General behavior in torsion of plain and reinforced concrete, its resistance against failure, and types of reinforcement that will increase its ultimate torsional strength; apparatus and test specimens; experiments cited were performed in 1932 and 1933 in Materials Testing Laboratory of University of Illinois, Urbana."

Paper is concerned only with torsion in the members, and the design of such members to resist it; not concerned with analysis as to how torsion is induced in members.

Les Essais sur Modeles en Beton Arme a Echelle Reduite

(Tests on Reduced Scale Models in Reinforced Concrete)

H. Lossier, Genie Civil, Vol. 106, Feb. 1935, pp 138-139

"Principles of testing reduced scale models of reinforced concrete structures; effect of scale reduction on relations between stresses

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and correct representation of strength characteristics of materials; limitations of model method of testing of concrete structures."

Current Studies at Lehigh University

I. Lyse, Engineering News-Record, Vol. 116, March 1936, pp 391-392, See also Engineering and Contract Record, Vol. 50, May 1936, pp 436-438

"Results of recent experimental studies on design of steel-plate floors, welded clip angles, shear and bending in welds, concrete shrinkage; concrete slab studies."

Gives basis for design of economical steel floor; investigation incomplete.

Experiments on Plain and Reinforced Concrete in Torsion

W. T. Marshall & N. R. Tembe, Structural Engineer, Vol. 19, Nov. 1941, pp 177-191, and (discussion) Vol. 20, March 1942, pp 38-44, & May, pp 68-69

"Report of tests on strength of concrete in torsion; tests on plain concrete show that concrete does not behave as elastic material but as one with both elastic and plastic properties; torsional rigidity of reinforced rectangular specimen is same as that for plain specimen of same dimensions, Bibliography. Before Institution of Structural Engineers."

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The Economic Design of Reinforced Concrete Floor Systems for Fire-Resisting Structures

John S. Sewell, ASCE - Proceedings, Dec. 1905

"Aims to present simple and accurate formulas, with methods of applying them, to designs of minimum cost, and to show the value of certain little used features of design, from a fire resisting and economical point of view."

Paper is concerned only with design, thickness of slab, placing and quantity of steel reinforcing.

Advance in Reinforced-Concrete Construction

C. A. P. Turner, Engineering News, Feb. 1909

"An argument for multiple-way reinforcement in floor slabs. An illustrated article describing this system and the advantages claimed."

Considers continuity in slabs and beams; critisizes design regulations then in use; discusses height limit of concrete buildings, safety factors, allowable steel stresses; illustrations of steel reinforcing.

Beitrag zur Berechnung und Dimensionierung Vierseitig Aufgelagerter Platten

(Calculation and Design of Rectangular Slabs Supported on All Four Sides)

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C. Abeles, Deutsche Bau, Serial 1st part, July 1909

"Calculation and design of rectangular slabs supported on all four sides. Mathematical solution."

Kreuzweise Bewehrte Eisen Betondecken

Concrete Floors with Crossed Reinforcement

H. Henningsen, Beton und Eisen, April 1910

"A mathematical discussion of the design of concrete floors with crossed reinforcement."

Berechnung Vierseitig Feiaufliegender Rechteckiger Platten Mit Gleichmassig Verteilter Belastung

(The Design of Reinforced Concrete Slabs for Uniformly Distributed Loads)

J. N. Dorner, Zeitschr d Oest Ing u Arch Ver, Oct. 1910

"Discusses results of tests on reinforced concrete slabs."

The Basis of Design for Flat Concrete Floor Slabs

Arthur R. Lord, Engineering Record, Dec. 1910, pp 737-738

"A discussion before the National Association of Cement Users. States evidence of tests made applicable to a consideration of the basis of design for reinforced concrete floor slabs."

States that strip method of analysis of beams is safe method; admits plate action of slabs, but does not submit any solution to problem.

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Contributo al Calcalo Practico Delle Piastre Appoggiate sul Contorno (The Design of Reinforced-Concrete Slabs Supported at Their Edges)

A. Donusso, Il Cemento, Serial, 1st part, Jan. 1911

"Reviews various theories and outlines the authors methods."

Report on Investigations of Theories for Flat-Slab Designing

G. C. Stone, Cornell Civil Engineer, May 1911

"A discussion of the various methods of flat slab floor construction in reinforced concrete."

The Practical Design of Reinforced Concrete Flat Slabs

Sanford E. Thompson, Canadian Engineer, Serial, 1st part, March 1912

"Read before the National Association of Cement Users. Considers the designing of flat slab floors for reinforced concrete structures."

Methods of Designing the Flat Slab System

W. G. Ure, Canadian Engineer, June 1913

"Discusses the fundamental principals upon which some of the methods are based, with a comparison of results. Illustrated."

The Designing of Reinforced Concrete Slabs Subjected to Bending and Compression

Anders Bull, Engineering and Contracting, May 1951, pp 454-456

Design, Theoretical

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"Explanation of method for accurately determining stresses." Paper is concerned entirely with design procedure, includes no analysis.

Slab Designed to Use Less Concrete is Verified by Experiments

R. B. Melvin, Cornell Civil Engineer, Dec. 1915

"Slab designed to use less concrete is verified by experiments. Opposed to commonly accepted theories."

Method of Designing a Rectangular Reinforced Concrete Flat Slab, Each Side of Which Rests on Either Rigid or Yielding Supports

A. C. Jannis, ASCE-Proceedings, Feb. 1916, (discussions) April 1916, May 1916, Aug. 1916, Sept. 1916, Nov. 1916

"Mathematical illustrated."

Paper deals with moments in slabs; shows comparison when beams considered rigid, and with beams deflecting; deflections of beams have only been approximated; paper and following discussions appear to be applicable references to mathematical research.

The Thickness of Flat Slab Floors

H. T. Eddy, Engineering and Contracting, July 1916, pp 88-90

"Method of computing the thickness of flat slab floors."

Author is concerned only with design principles; makes use of empirical formulas for design purposes; article does not appear

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to be a particularly pertinent one.

Diagrammes Donnant les Epaisseurs et les Reforcements des Dalles de Hourdis en Beton Arme

(Charts Giving Thickness and Reinforcement of Reinforced Concrete Floor Slabs)

H. Kampmann, Genie Civil, Vol. 76, March 1920, pp 312-314

"One chart gives thickness for slab of known length required to support known load, and another the reinforcement required for slab."

Flat Slab Floors Built Without Drops or Capitals

Engineering News-Record, Vol. 86, April 1921, pp 672-673

"Procedure Followed in construction of seven-story building in San Francisco."

All floor panels exactly alike; floor slab 6 inches thick; no method of analysis or design given; not a particularly good reference for research work.

Neuere Aufsfuhrungen Tragerloser Pilzdecken

(Modern Examples of Girderless Flat Slab Floors)

H. Marcus, Bauingenieur, Vol. 5, April 1924, pp 171-177

"Report on progress made in application and design of such floors."

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Zum Stand der Berechnung Kreuzweise Bewehrter Platten

(Calculation of Cross Wire Reinforced Slab)

Leitz, Bauingenieur, Vol. 6, Nov. 1925, pp 920-924

"Calculations based on theory of elasticity of isotropic and anisotropic slabs; coefficient of transverse extension, reinforcement for isotropic slabs in direction of principal tension, and for anisotropic slabs parallel to sides."

Berechnung Rechteckiger Platten Unter Wirkung Konzentrierter Belastung an Beliebiger Stelle und Biegungsversuch mit Quadratischer Platte

(The Design of Rectangular Plates with Concentrated Loading at any Point and Bending Test of a Square Plate)

T. Inada, Kyushu Imperial University College of Engineering Memoirs, Vol. 4, 1927, pp353-392

"Mathematical theory of rectangular plates; theory checked by bending test of square plate of ingot steel 900 x 900 x 10 mm. (In German)"

Reinforcement of Floor Slabs on the Basis of Deflections

T. A. Farrent, Commonwealth Engineer, Vol. 15, Dec. 1927, pp 182-183

"Problem of designing floor slab to be supported by framework of beams which is by no means rectangular or even circular; proportioning of steel; discussion of method."

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Design of Reinforced Concrete Slabs

J. A. Wise, ACI Proceedings, Vol. 25, 1929, pp 712-737 & 738-740

"Flat slabs or girderless floors are now generally designed under rules based on plate theory; these are not discussed in this paper which is limited to presentation of results of analysis for special cases; few examples of use of diagrams and tables given."

Very little explanation of how formulas arrived at; basis for various coefficients is the Elastic Web Method; considers simply supported rectangular slab with uniform load, and load increasing uniformly from one edge to the opposite edge.

Calcul des Plaques Rectangulaires Minces Appuyees a Leur Pourtour

(Design of Thin Rectangular Plates Supported Along Their Perimeter)

Pigeaud, Annales des Ponts et Chaussees, Partie Technique, Vol. 1, March - April 1929, pp 105-108

"General theoretical discussion supplementary to paper published in January issue of 1921, introducing series of graphical charts for determination of bending moments and other stresses."

Kurventafeln Fuer Kreuzbewehrte Platten Nach Marcus

(Graphical Charts for Design of Marcus Slabs with Longitudinal and Transverse Reinforcement)

J. Wachsmann & S. Cytryn, Bauingenieur, Vol. 10, Sept. 1929, pp 634-639

Design, Theoretical

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"Graphical charts for computation of moments, also nomogram and tables of moments; numerical examples illustrating their use."

Reinforced Concrete Design Simplified

J. R. Griffith, Concrete, Vol. 36, March 1930 pp 41-44, also Concrete, Vol. 37, Nov. 1930, pp 31-32

"Construction of charts for design of reinforced concrete slabs."

Design of Reinforced Concrete Slabs

W. L. Scott, Concrete and Constructional Engineering, Vol. 25, March & April 1930, pp 167-177 & pp 221-231

March:

"Theoretical mathematical analysis of thin rectangular slabs supported along their edges, with special reference to solution developed by Pigeaud; methods of calculating bending moments; calculation of shear on slab panels; effect of panel shapes and shapes of loaded areas."

April:

"Comparison of bending moments as load spread increases; numerical example illustrating use of graphs."

Design, Theoretical

Plates

Die Berechnung der Pilzdecken als Stellvertretender Rahman, etc.
(Design of Floors of Mushroom Construction as Equivalent Frames with Special Reference to Effective Bearing Area)
P. Podgajetz, Beton und Eisen, Vol. 30, Sept. 1931, pp 314-318

"Extension of basic assumptions made in Marcus method of design, applicable to all conceivable cases encountered in practice."

Berechnung der Biegsamer Platte auf Elastischer Unterlage
(Calculation of Flexible Plates on Elastic Bases)
C. Bueltzing, Beton und Eisen, Vol. 31, Feb. 1932, pp 46-48

"Derivation of formulas and construction of diagrams for design of flexible plate on elastic base."

Die Berechnung der Pilzdecken als Stellvertretender Rahmen Unter Beruecksichtigung der Wirksamen Stuetzflaeche
(Calculation of Mushroom Floors as Substitute Frames With Consideration of Their Effective Supporting Area)
P. Podgajetz, Beton und Eisen, Vol. 31, Dec. 1932, pp 377-384

"Theory of design of Mushroom floor systems, treating mushroom columns as framework substitutes and taking into account their effective supporting area; tables and examples."

Design, Theoretical

Plates

Ausfuehrungen Vierseitig Gelagerter Faltwerkdaecher

(Design of Corrugated Floors Supported on All Four Sides)

H. Craemer, Beton und Eisen, Vol. 32, April 1933, pp 115-116

"Design of slabs of so called corrugated reinforced concrete floors supported on four sides."

Ein Beitrag Zur Allseitig Aufligenden Rechteckigen Platte

(A Contribution to the Subject of Rectangular Slabs Supported on All Sides)

K. Stadoer, Beton und Eisen, Vol. 32, July 1933, pp 207-209

"Design and tests of special types of rectangular slabs supported on all sides."

Design of Two-Way Slabs on Beams

E. H. Uhler, ACI Journal, Vol. 5, May-June 1934, pp 498-503

"Report of committee 302 concluding that formulas and tests are at variance; since Westergaards curves have rational background, writer recommends their use without modifications in building codes."

This paper does not appear to be very significant; experimental data limited, and at variance with other solutions, both experimental and theoretical.

Design, Theoretical

Plates

Berechnung der Biegsamen Platte auf Elastischer Unterlage

(Design of Flexible Concrete Slabs Resting on Elastic Foundations)

C. Bueltzing, Beton und Eisen, Vol. 33, June 1934, pp 188-190

"Design of flexible concrete slabs resting on elastic foundations; case of slab subjected to one moment at any point."

Bemessung Durch Einzellast Beanspruchter Steineisendecken

(Dimensioning of Concrete Steel Floors Stressed by Single Concentrated Load)

M. Herrmann, Tonindustrie - Zeitung, Vol. 60, June 1936, pp 633-634

"Dimensioning of concrete steel floors stressed by single concentrated load; results of tests made at Materials Testing Bureau at Berli-Dahlem for determination of effective width."

Ueber die Berechnung von Pilzdecken

(On the Calculation of Mushroom Slabs)

K. Grein, Forscherarbeiten auf dem Gebiete des Eisenbetons, No. 45, 1937

"Mathematical theory of design of mushroom system of concrete floors; use of continuous beams and fixed end columns; design by method of equivalent frames; design of steel reinforcement. Bibliography."

Design, Theoretical

Plates

Les Planchers - Champignons

(Mushroom Floors)

A. Moser, Technique des Travaux, Vol. 14, March 1938, pp 137-152

"Theory of design of reinforced concrete mushroom floor systems; recent European examples of this type of construction."

Calcul des Dalles en Champignon Rectangulaires Appuyees au Pourtour

(Analysis of Rectangular Mushroom Slabs Supported Along Perimeter)

F. Keelhoff, Annales des Travaux Publics de Belgique, Vol. 40, Oct. 1939, pp 691-732

"Theoretical mathematical discussion of design of rectangular mushroom slabs supported along perimeter."

Losas Planas de Hormigon Armado con Armaduras Cruzadas

(Plane Reinforced Concrete Slabs With Crossed Reinforcement)

W. S. Hill, Revista de Ingenieria, Vol. 34, July 1940, pp 201-216

"Flat slabs of reinforced concrete with crossed reinforcing members; author deals exclusively with rectangular slabs for tall buildings; mathematical discussion of design examples. Before 1st South American Engineering Congress at Santiago, Chile, Jan. 1939."

Design, Theoretical

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Calcul des Dalles en Champignon Rectangulaires Appuyees au Pourtour
(Designs of Rectangular Mushroom Slabs Supported on the Periphery)
F. Keelhoff, Annales des Travaux Publics de Belgique, Vol. 41, Dec. 1940, pp 801-811

"Theoretical mathematical discussion of design of rectangular mushroom slabs supported along perimeter on columns of circular cross section. (Concluded)"

Aplicacion de la Fotoelasticidad al Diseno de una Pieza en Hormigon Armado
(Application of Photoelasticity to the Design of Reinforced Concrete Slabs)
J. Ricaldoni, Montevideo Facultad de Ingenieria Boletin, Vol. 2, June 1941, pp 63-72

"Application of photoelasticity to design of slabs of reinforced concrete, discussed."

Kreuzweise Bewehrte Platten Ohne Drillingsbewehrung
(Plates Transversely Reinforced Without Triple Reinforcement)
R. Wilke, Bauingenieur, Vol. 22, Jan. 1941, pp 32-33

"Plates with transverse reinforcement; tables presented for direct determination of moments."

Design, Theoretical

Plates

Charts Aid in Determining Plate Thickness

J. Marin, Machine Design, Vol. 14, March 1942, pp 66-69

"Distortion energy theory is applied to problem of determining combined stresses of following cases; rectangular plate subjected to bending moments along edge; circular plate fixed at edge and uniformly loaded; circular plate simply supported and uniformly loaded; circular plate simply supported and uniformly loaded; and circular plate with central hole subjected to bending moments along edge; circular plate fixed at edge and uniformly loaded; circular plate simply supported and uniformly loaded; and circular plate with central hole subjected to bending moments along edge."

Concerning Rectangular Concrete Sections

W. S. Wilson, Surveyor, Vol. 101, August 1942, pp 279-280 & 297-298

"Fundamental formulas for design of thin concrete slabs subjected to bending and application of such formulas in cases which depart from usual working stresses."

Effective Teamwork in Building Design

F. N. Severud, Engineering News-Record, Vol. 133, Oct. 1944, pp 509-512

Author discusses various types of slab designs, briefly; compares distribution of moments for slab and slab band system with slab

Design, Theoretical

Plates

and beam system; indicates that slab band system gives better distribution of moments; no mathematical or theoretical discussion.

Ontwerp en Uitvoering van Paddestoelvloerem

(Design and Construction of Flat Slab Floors)

A. M. Haas, Ingenieur, Vol. 61, March 1949, pp BT 19-26, April 1949, pp BT 27-35, (discussion), pp BT 36

"Design and construction of flat slab floors; existing theories based upon assumption of plate of uniform thickness; better results expected with theory of varying thickness of column head published in 1948; tests with steel model contribute to better insight into behavior of flat slab floors; advantages of flat ceiling; illustrations."

Concentrated Loads on Slabs Spanning in Two Directions

L. Challen, Concrete and Constructional Engineering, Vol. 45, June 1950, pp 201-202

"Table presented to facilitate design of slabs spanning in two directions and carrying one or two loads symmetrically disposed; basis of calculation is combination of methods of Loeser and Marcus modified by author; numerical examples."

Design, Theoretical

Plates

Design of Flat Plates

F. A. Gerard, Structural Engineer, Vol. 28, July 1950, pp 165-172

"Rectangular plates subjected to uniformly distributed and to concentrated loads are dealt with; simple and clamped supports as well as plates on flexible beams and cantilever plates are considered."

Paper appears to be an applicable reference for mathematical research.

Design, Theoretical

Beams, Columns, Walls

The Design of Concrete Steel Beams and Slabs

Edward Godfrey, Engineering News, March 1906, pp 290-242

"Aims to show that formulas for concrete-steel beams or slabs can be made as simple as those for steel beams. Discusses principles of design."

Author makes various recommendations with regard to design; discusses results of tests; no mathematical solutions given; design formulas included.

Berechnung Durchgehender Trager und Decken aus Eisenbeton

(The Design of Continuous Beams and Slabs in Reinforced Concrete)

E. Elwitz, Beton und Eisen, Dec. 1908, Serial, 1st part

"The design of continuous beams and slabs in reinforced concrete. Mathematical."

Die Berechnung der Durch Kreuzweise Bewehrte Platten Belasteten Balken

(Design of Beams Supporting Diagonally Reinforced Concrete Slabs)

W. Kind, Bauingenieur, Vol. 8, Dec. 1927, pp 937-942

"Analyses distribution of slab loads on supporting rectangular frame of peripheral beams for following cases: (1) Simple beams (2) Continuous beams (3) girders on 3, 4 or 5 equally spaced supports; computation of shear reinforcement, design tables and numerical examples."

Design, Theoretical

Beams, Columns, Walls

Kreuzweise Gespannte Balkenkonstruktionen in der Praxis des Eisenbetonbaues

(Cross-Girder Systems in Reinforced Concrete Construction Practice)

S. Szegoe, Zement, Vol. 19, Jan. 1930, pp 34-37

"Features and advantages of several systems of cross-girder supports for square slabs, running diagonally or parallel to principal axis of slab."

Wirtschaftlicherer Entwurf Durch Ausnutzung der Scheibernwirkung von Eisenbetonwaenden und Decken

(More Economic Design by Utilization of Slabs in Reinforced Concrete Walls and Floors)

H. Craemer, Zement, Vol. 19, July 1930, pp 703-708

"Reciprocal influence of neighboring construction elements due to monolithic construction of reinforced concrete, resulting stress equalization and its economic importance; effect of self supporting slabs in silos; practical examples; in one case waste of over 300 cu. m. of reinforced concrete is shown in medium sized building."

Earthquake and Wind Design; Suggested Rationalization

J. J. Creskoff, Engineering News-Record, Vol. 113, Nov. 1934, pp 553-556

"Author points out fallacy of ignoring building walls and slabs and proposes simple analysis taking them into account and

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Beams, Columns, Walls

recognizing dynamic character of forces; numerical examples; Bibliography."

Use of Structural Walls in Resisting Earthquake Forces

A. G. McKay, Commonwealth Engineer, Vol. 23, July 1936, pp 363-371

"Principles of design of external walls, permanent partitions, elevator shafts, etc., to resist horizontal forces due to earthquakes; deflections due to bending; length of members and treatment of haunches; deflections due to shear; flexibility of floor; unsymmetrical resistance; tables of design data. Bibliography."

Flat Slabs and Supporting Columns and Walls Designed as Indeterminate Structural Frames.

H. D. Dewell & H. B. Hammill, ACI Journal, Vol. 9, Jan-Feb. 1938, pp 321-343

"Theoretical study of practicability of treating of flat slabs and their supporting columns and walls as indeterminate structural frames; moments in interior slabs and columns; moments in exterior slabs, wall columns and first interior columns." Frames are treated as being elastic; paper does not appear to be praticularly significant with regard to research, either mathematical or experimental.

Design, As Governed by Codes

Plates

Some Notes on Flat Slab Design

A. M. Wolf, Engineering and Contracting, March 1918, pp 307-310

"Thickness of slab, column heads, and bending in columns. Considers points of importance to designers. Illustrated."

Author discusses Chicago ruling on flat slab design; various aspects are only discussed, there are no mathematical solutions.

Computing Moments on Irregularly Spaced Flat-Slab Panels

S. Tait, Engineering News-Record, Vol. 80, April 1918, pp 652-654

"Analyzed by using 3 - moment theorem."

Author makes use of Clapeyron's Theorem of Three Moments; solution follows recommendations of code in effect at that time, analysis of various strips.

Design of Exterior Panels in Flat Slab Construction

A. M. Wolf, Engineering World, Vol. 14, Jan. 1919, pp 27-30, also Vol. 14, March 1919, pp 11-14

"Survey of requirements and rulings by various institutions. Details of spandrel strips in Flat - Slab floors; examples of typical interior and exterior panels in accordance with Acme design standards."

Die Grundlagen der Querschmittbemessumg Kreuzweise Bewehrter Platten (Bases for Dimensioning Cross Sections of Transversely Reinforced Slabs)

Design, As Governed by Codes

Plates

H. Marcus, Bauingenieur, Vol. 7, July 1926, pp 577-582, 600-604

"Explains bases of new German regulations; methods of calculating loads on reinforcements; dimensioning cross section of slabs supported all around; rigidity of slabs with reinforcement parallel to sides."

Die Wirksame Stutzflache der Tragerlosen Pilzdecken

(Effective Pressure Surfaces in Flat Slab Floors)

H. Marcus, Beton und Eisen, Vol. 25, Oct. 1926, pp 352-358, 370-377

"Compares American and German practice; new regulations of German Reinforced Concrete Committee; distribution of loads; effect of change in profile of columns; frames and their calculation; supporting width and length of spans."

Slabs Supported Upon Four Edges

E. S. Andrews, Structural Engineer, Vol. 5, May 1927, pp 151-154

"Calculations for reinforcement both ways; Grashof-Rankine theory; French gov't formula"

Planchers Champignons, Dalles Rectangulaires, Dalles Continues; Dispositions D'armatures

(Mushroom Floors, Rectangular Slabs, Continuous Slabs, Arrangement of Braces)

Travaux, Vol. 19, March 1935, pp 122-137

Design, As Governed by Codes

Plates

"Symposium by Lossier, Caminade and L'Hermite on theory of design and results of practical experience and tests of simple and continuous reinforced concrete slabs, with special reference to distribution of stresses and modes of failure; numerous examples from French practice."

Why "Slab - Band" Floors are Economical

F. N. Severud, Engineering News-Record, Vol. 137, Oct 1946, pp 526-528

"Facts and figures substantiating advantages of slab band concrete floor construction."

Author compares quantities used in slab and slab band with quantities used in slab and beam system; slab band found to be more economical; no analysis or design included in paper.

Erfordras en ny Konstuktionspraxis for Bostadsbajalklag

(Need for New Design Practice for Concrete Floor Slabs)

V. Hasselblad & T. E. Sundstrom, Betong, Vol. 34, 1949, pp 223-226, (discussion) pp 227-238

"Need for new design practice for concrete floor slabs in dwelling; in many houses in Sweden, concrete floor slabs which support partitions have undergone large plastic deformations; it is suggested that some parts of standards specifications relating to height of concrete slabs provided with 2-way reinforcement be rendered more severe."

Design, As Governed by Codes

Plates

Proposed Design Specifications for Two-Way Floor Slabs

N. M. Newmark & C. P. Siess, ACI Journal, Vol. 21, April 1950, pp 597-607, also Vol. 22, Dec. 1950, pp 608

"New design specification is proposed as replacement for methods currently contained in section 709 of American Concrete Institute Building Code; it is based on analysis of continuous rectangular slabs carrying uniformly distributed load; account is taken of continuity of slabs, of torsion stiffness and dflection." Coefficients are also obtained for slabs on bare steel beams, not integral with slabs; all formulas are based on previous work done by author; rational analysis and design of two-way concrete slabs.

IV. CONCLUSIONS

It is apparent from the listed articles that the plate action of floor slabs was considered, at least as early as 1900. This work indicates that the plate action was recognized, but there seemed to be no methods available for making use of this action in the analysis and design of slabs. The method which was commonly in use and which is still being used in accordance with current codes is the strip method, in spite of the fact that both experimental and theoretical research has found that analysis by the strip method is a very rough approximation. The resulting construction while usually safe, is not economical.

The continued research has led to a closer approximation of the true action of slabs under various loading conditions. The research has been both experimental and theoretical, with the majority of the work being theoretical in nature. Analyses have been made for uniform loads, concentrated loads, loads uniformly increasing from one edge to the other, and for moments applied to the various edges. The edge conditions of the slabs considered were those with all four edges fixed, two edges fixed and two free, three edges fixed and one free, various edges having varying degrees of fixedness, slabs continuous over supporting beams and columns, slabs supported only on four columns, etc. The methods of analysis include those in which approximate assumptions as to the effective width are made and then the slabs analyzed, variations of the moment distribution method, the theory of the elastic web, which is the Marcus method, the matrix iteration method for solving simultaneous linear algebraic equations

associated with the buckling of flat plates, the relaxation and successive approximation method used to solve equations as applied to deflections of rectangular plates, etc. But as yet no definite conclusions have been reached regarding the integral action of the slab and its supporting beams and columns.

The review of the literature indicates that the research connected with the particular subject of this bibliography leaves many questions regarding the integral action of slabs, beams and columns unanswered, and that investigations should be continued.

The author has considered the advisability of including a more detailed review of a few of what were considered the most significant articles. However, careful consideration of the problem of selecting such articles in any one phase of research indicates that such selection could only be made in terms of familiarity with all of the literature in that field. An attempt to achieve such familiarity seems beyond the scope of this thesis.

It is hoped that the brief synopses presented will serve to identify those articles which are applicable to the needs of the individual researcher and will facilitate his use of this bibliography.

V AUTHOR INDEX

VI. PUBLICATION INDEX

Academie des Sciences, Comptes rendus des Seances - Paris, France

Aeronautical Quarterly - London, England

Aircraft Engineering - London, England

Aluminum Company of America - Aluminum Research Laboratories - Technical Paper - Pittsburgh

American Architect and the Architectural Review - New York

American Concrete Institute Journal - Detroit

American Journal of Mathematics - Baltimore

American Society of Civil Engineers Proceedings - New York

American Society of Mechanical Engineers (Journal of Applied Mechanics) - New York

Annales des Ponts et Chaussees - Paris, France

Annales des Travaux Publics de Belgique - Brussels, Belgium

Annali dei Lavori Pubblici - Rome, Italy

Armierter Beton - Berlin, Germany

Association of Engineers and Architects in Palestine - Journal, Tel Aviv, Palestine

Association of Engineers (Journal) - Calcutta, India

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Brown University Quarterly of Applied Mathematics - Providence, Rhode Island

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Zement - Charlottenburg, Germany

Zurich. Eidogenoessische Technische Hochschule. Institut fuer Baustatik, Mitteilungen

VII. ACKNOWLEDGEMENTS

The author wishes to express his gratitude to Professor John F. Poulton for his assistance and supervision through-out the compilation of this work, to the staff of the Engineering Library for their aid in locating the various publications, to Professor F. T. Tilghman, Mrs. J. F. Poulton, Miss C. J. Mascaro and Miss G. L. Nothmann for the translations of the foreign titles, and to Professor Clinton H. Cowgill, Head of the Department of Architecture, for his sincere cooperation.