# JOURNAL *of the*

# BOSTON SOCIETY
# OF
# CIVIL ENGINEERS

JANUARY - 1947

VOLUME XXXIV NUMBER I

# BOSTON SOCIETY OF CIVIL ENGINEERS

## OFFICERS, 1946-1947

PRESIDENT

GEORGE A. SAMPSON

VICE-PRESIDENTS

HARVEY B. KINNISON
(Term expires March, 1947)

FREDERIC N. WEAVER
(Term expires March, 1948)

SECRETARY

EVERETT N. HUTCHINS

TREASURER

CHESTER J. GINDER

DIRECTORS

MILES N. CLAIR
FRANCIS H. KINGSBURY
(Term expires March 1947)

FRANK L. FLOOD
DONALD W. TAYLOR
(Term expires March 1948)

PAST-PRESIDENTS

HOWARD M. TURNER
HARRY P. BURDEN
CARROLL A. FARWELL

SANITARY SECTION

WALTER E. MERRILL, Chairman — GEORGE C. HOUSER, Clerk

DESIGNERS SECTION

DEAN PEABODY, JR., Chairman — ERNEST L. SPENCER, Clerk

TRANSPORTATION SECTION

FRANCIS T. McAVOY, Chairman — JOHN F. SHEA, Clerk

HYDRAULICS SECTION

HAROLD A. THOMAS, JR., Chairman — JOHN G. W. THOMAS, Clerk

NORTHEASTERN UNIVERSITY SECTION

LOUIS L. LONETTA, Chairman — RICHARD W. NEWCOMB, Clerk

Librarian—THOMAS C. COLEMAN
Editor—EVERETT N. HUTCHINS
715 Tremont Temple, Boston, Mass.

JOURNAL OF THE

# BOSTON SOCIETY OF CIVIL ENGINEERS

Volume XXXIV JANUARY, 1947 Number 1

## CONTENTS

### PAPERS AND DISCUSSIONS



### OF GENERAL INTEREST




Entered as second-class matter, January 15, 1914, at the Post Office at Boston, Mass., under Act of August 24, 1912

Published four times a year, January, April, July and October, by the Society
715 Tremont Temple, Boston, Massachusetts

Subscription Price $4.00 a Year (4 Copies)
$1.00 a Copy

Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on July 16, 1918.

---



THE HEFFERNAN PRESS

WORCESTER, MASS.

JOURNAL OF THE

# BOSTON SOCIETY OF CIVIL ENGINEERS

Volume XXXIV JANUARY, 1947 Number 1

## ENGINEER SERVICES OF THE U. S. WATERWAYS EXPERIMENT STATION WITH SPECIAL REFERENCE TO THE MISSISSIPPI BASIN MODEL

BY COLONEL C. T. NEWTON, C.E.*

(Presented at a joint meeting of the Boston Society of Civil Engineers and the Northeastern Section American Society of Civil Engineers held on October 28, 1946.)

The United States Waterways Experiment Station, an agency of the Mississippi River Commission in the Engineer Department, is maintained for the purpose of carrying out special studies and investigations in hydraulics, soil mechanics and concrete, and for increasing professional knowledge in these and related fields. The Experiment Station started modestly in its present Vicksburg location in 1931 under the Mississippi River Commission—purely as a hydraulics laboratory. During succeeding years the Station broadened its hydraulic model activities to become the center of model investigation for the Engineer Department-at-Large. In the early 30's a soil mechanics laboratory was added, and this Department was broadened at the start of the war to include a flexible pavement laboratory for studying airplane landing-field surfaces. During the past few months the incorporation of the Engineer Department Concrete Testing Laboratory into the Waterways Experiment Station has been accomplished.

The Station is rapidly becoming a major center of professional research and study in most of the diverse engineering fields with which the Engineer Department is concerned. This evening I wish to point out how the Station renders engineering services in assisting and augmenting the activities of the major Engineer Offices of the Depart-

*Director, U. S. Waterways Experiment Station, Corps of Engineers, Vicksburg, Mississippi.

ment. As you know, the Engineer Department is charged with those Federal projects and works entailed by the problems of flood control and navigation. In practically any engineering project there are problems similar to those encountered in earlier works, and a review of the literature pertaining to these previous, similar problems can be exceedingly helpful to the responsible office in establishing criteria on which to base design. To facilitate this process the Engineer Department Research Center maintains in its library a voluminous collection of documents, reports and papers dealing with aspects of engineering problems in hydraulics, soil mechanics and concrete; this literature is made available to interested offices—by library loan—upon request. Upon request for general or specific information on some particular question, the Research Center staff will compile bibliographies, prepare translations of foreign papers, correspond actively with American and foreign source agencies, and otherwise strive to assemble data pertinent and relevant to the question at hand.

Initial site and location investigations, and analyses of local foundation and construction materials, are conducted by both the Soils and Concrete Divisions of the Station. An exhaustive file of geological data has been developed by a staff of geologists, presently located at Baton Rouge, Louisiana, who are constantly engaged in research and study to promote a greater knowledge of the geological characteristics of the alluvial valley of the Mississippi River.

In order to properly design an earth structure, or forecast the behavior of a foundation, it is necessary—and imperative—that a full knowledge be gained of soil characteristics at the site. For this purpose four mobile drill rigs, with experienced soils-sampling crews, are constantly active in the field, and are frequently called upon to make initial borings at selected project locations.

Aggregate samples forwarded to our Concrete Laboratory are given comprehensive tests to determine their suitability for use in proposed concrete structures. Petrographic examinations, including photomicrography, are made.

The development of sound, practical design, however, is the function in which the Experiment Station offers the greatest engineering service.

In the field of soil mechanics, an astute analysis of the soil characteristics forms the basis for any detailed plans or specifications for a foundation or an earth structure.

The hydraulic implications of the Rivers and Harbors and Flood Control activities of the Engineer Department are basic. In developing the design or plan for any hydraulic structure or improvement, the engineer is often confronted with a combination of forces and variables so formidable—and so little understood—that a purely mathematical solution is impossible. Here the engineer must of necessity revert to the only remaining expedient—experimentation. To experiment in the nature system would for obvious reasons be a tremendously costly, difficult and dangerous undertaking; but he can study his problem on a miniature system—the hydraulic model—which can be made to conform to the same physical laws, costing little, and in which the factors controlling fluid motion can be easily regulated. The basic design or plan is, of course, the responsibility of the initiating office, but the Experiment Station is organized and equipped to study any of the many hydraulic problems which prove to be unorthodox.

To date, over 250 model studies have been conducted by the Experiment Station for Engineer Offices and other agencies. These studies have included flood-control and navigation problems; all such types of hydraulic structures as spillways, stilling-basins, outlets and intake works, surge-tanks, drydocks, etc.; and special investigations of such phenomena as tides, wave-action, salt-water intrusion and shoaling.

In the field of concrete the Station does not concern itself with structural design, but is interested in concrete purely as a structural material. Determination of the proper mixture for any given set of conditions is a prime consideration. For any mass concrete structure planned by an Engineer Office, the specifications for the concrete mixture are developed with the assistance of the Concrete Laboratory. The procedure runs somewhat like this: A carload of aggregate is shipped in; water from the site is analyzed; proposed pouring and curing processes are reviewed; cement from the bidder is obtained and concrete samples are prepared and tested under conditions similar to those anticipated at the project location.

The foregoing comments have presented some examples whereby the Station assists in the accomplishment of specific and active engineering works. We like to think we also contribute to improving general engineering knowledge and in the solution of miscellaneous problems.

The Instrumentation Branch has developed pressure cells for the indication of positive and negative pressures in gates, on sea walls, and in earth structures; it has built a mechanism for recording wave phenomena—information that is essential in designing harbor or shore protective works.

The concrete laboratory was a pioneer in developing air-entrained admixtures, and in perfecting laboratory technique to rapidly test concrete resistance to alternate freezing and thawing.

That laboratory maintains an exposure station near Eastport, Maine, where specimens are subjected to the rigors of freezing and thawing occasioned by the large tidal action in that vicinity.

The Concrete Laboratory maintains a core drilling rig to obtain specimens from existing structures. Tests of such specimens, together with a knowledge of conditions under which placed, enables long range evaluation of design and adds materially to professional experience.

A full understanding of soil mechanics is still obscure. Much profound study is still indicated. The Soils Department is currently active on many of these subjects. In test areas on the Station grounds dozers and rollers are compacting varieties of soils under different controlled conditions to establish the most efficient field methods.

The war-time activated flexible pavement laboratory is still developing basic criteria for the design of sub-grade and surfaces for airfields—knowledge applicable to highway construction as well.

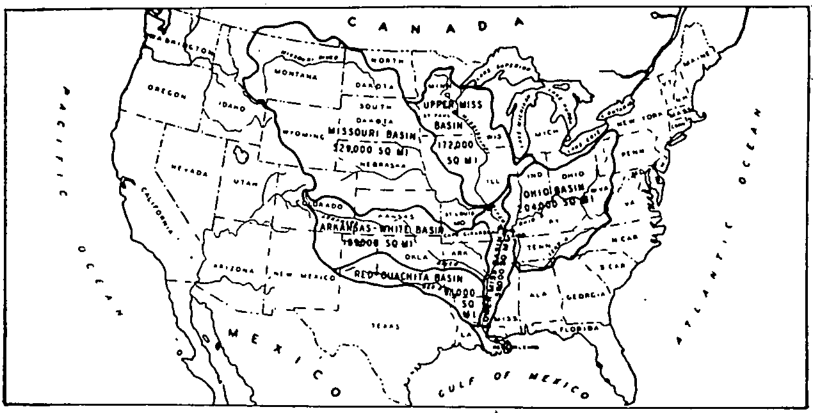
A special vacuum tank is under construction to study and analyze the effects of cavitation.

Most spectacular of all is the construction of the largest hydraulic model in the world. This, the Mississippi Basin Model, is to be the Corps of Engineers' novel tool for studying flood control in the entire drainage basin of the Mississippi River and for fixing and regulating the Lower Mississippi River channel itself.

To better understand the magnitude of the problems involved, let us review, for a moment, the size of the Mississippi Basin.

The Mississippi watershed, which covers an area of 1,250,000 square miles, is about 20 times as large as New England. It extends from the Rocky Mountains to the Appalachians, from just above the Canadian border to the Gulf of Mexico. At its most easterly point the divide of this watershed is within about 250 miles of the Atlantic Ocean while its most westerly limits are within about 500 miles of the Pacific. This watershed contains all or part of 31 states and two Canadian provinces and it occupies 41 per cent of the area of the continental United States. It is exceeded in size only by the Amazon and Congo watersheds.

The watershed of the Mississippi River system is divided naturally into six major basins: the Upper Mississippi, the Missouri, the Ohio, the Arkansas-White, the Red-Ouachita, and the Lower Mississippi River (see Fig. 1). The first three, that is the Upper Missis-




THE SIX MAJOR DRAINAGE BASINS OF THE MISSISSIPPI RIVER WATERSHED

FIG. 1.

sippi, the Missouri, and the Ohio basins contain about 900,000 square miles, or nearly 75 per cent of the entire drainage basin.

In a recent large flood year, these three basins contributed about 65 per cent of the flow. In 1937, the Ohio alone contributed just over 90 per cent, a considerable variation.

In considering this huge basin as a whole with its 15,000 miles of rivers, its hundreds of miles of levees, and its 250 reservoirs, it is apparent that many complex problems will face our engineers in their development of flood control measures. In particular, consider the problem of operating such a large number of reservoirs from the point of view of the proper coordination of the release of flood waters. It was this very problem that inspired Major General Reybold, who just retired as Chief of Engineers, U. S. Army, to consider the need for a hydraulic model of the entire basin.

In 1942, the Waterways Experiment Station was directed to make preliminary studies of such an undertaking.. Construction was initiated by the Station in 1943 at Clinton, Mississippi, about 40 miles east of Vicksburg. Estimated to cost over $3,000,000 this model will have three principal purposes:

1. To determine methods of coordinating the operation of reservoirs to accomplish the maximum flood protection under various combinations of flood flow.
2. To determine the undesirable conditions which might result from non-coordinated or misdirected use of any part of the reservoir system, particularly as regards untimely release of impounded water.
3. To determine what general flood control works in the shape of levees or storage basins are necessary and what improvements might be desirable at existing flood control works.

By means of this model, visual means will be provided to study these complex problems and thereby supplement studies made by arithmetical processes alone. Although engineering and meteorological science working together have succeeded in learning to predict river stages and discharges with fair accuracy, verification through experimental means is the logical procedure in the study of this large complex river system.

The feasibility of such a model study has been demonstrated by the Experiment Station at Vicksburg where, for the past ten years, an experimental model (Fig. 2) has been in operation for studying flood control problems in the Lower Mississippi River.

This model, built to a scale of 1:2000 horizontally and 1:100 vertically, reproduces a 600-mile stretch of the Lower Mississippi River from Helena, Arkansas, to Donaldsonville, Louisiana. It has proved invaluable by reproducing observed floods faithfully and enabling conditions to be portrayed for assumed flood discharges greater than have ever been experienced. It has helped to establish levee grades; to check the effect and results of cut-offs in the main channel; to determine storage volume in some backwater areas; and to show the value of floodways.

The Mississippi Basin Model (Fig. 3) at Clinton has the same scales as the model at Vicksburg, that is 1 foot horizontally = 2000 ft and 1 foot vertically = 100 ft. For a horizontal scale of 1:2000, the Mississippi River drainage basin of 1,250,000 square miles requires in the model an area of approximately 200 acres.

FIG. 2.—AERIAL VIEW OF MISSISSIPPI RIVER FLOOD CONTROL MODEL AT VICKSBURG.

The network of streams in nature of approximately 15,000 miles in length will be nearly 8 miles in length in the model. All existing and proposed flood control reservoirs, as well as levees, dikes, floodwalls, floodways and other pertinent works will be reproduced.

The size of some of the model streams may be judged by considering a stream the size of the Lower Mississippi River, which, in places, is one mile wide and varies from 50 to 150 feet in depth depending upon the stage. In the model such a stream would have a width of about 30 inches, exclusive of the overbank areas, and would have a depth of from 6 to 18 inches.

The model streams and all the overflow areas will be molded in concrete while the intervening topography will be covered with sod.

It is planned to operate the model either as a whole or in part. Normally, however, portions of the Mississippi River, the Upper and the Lower Ohio, or the Tennessee, or the Arkansas, or the Missouri will be tested independently to study local flood control problems.

Accordingly, the Mississippi Basin Model is, in a sense, many models in one.

In operation, flood flows will be introduced into streams at appropriate points by means of automatic inflow regulating devices. Water-surface profiles will be recorded electrically by sensitive mechanical gages located along the model streams in accordance with their positions in nature. Since there will be over 1500 gages and probably as many inflow points, the use of electrical recording instruments is mandatory. The data during a test will probably be recorded in one or more control houses.

You are probably wondering how the model discharge is determined and just how the scale ratios of 1:2000, and 1:100, are used. Fig. 4 shows the scale ratios for discharge, velocity, time and roughness. The theoretical ratios are: for discharge 1:2,000,000; for velocity 1:10; for time 1:200. The roughness ratio is not of particular value, since for non-uniform channels a hydraulic radius ratio must be determined for each representative reach. In practice, the roughness must be adjusted by trial and error.

Thus, for these ratios, it may be seen that a prototype discharge of 1,000,000 cubic feet per second requires 0.50 cubic feet per second

FIG. 3.—AERIAL VIEW OF MISSISSIPPI BASIN MODEL, MISSISSIPPI RIVER AND TRIBUTARIES AT CLINTON, MISSISSIPPI.

MISSISSIPPI RIVER FLOOD CONTROL MODEL

THEORETICAL SCALE VALUES

Velocity: $V_r = \sqrt{D_r} = 1:10$

Discharge: $Q_r = L_r D_r^{3/2} = 1:2.000.000$

Time: $T_r = \dfrac{\text{Volume scale}}{\text{Discharge scale}} = L_r D_r^{-1/2} = 1:200$

[or 1 day (prototype) = 7:12 minutes (model)]

Roughness: (Manning) Since $V_r = \sqrt{D_r} = \dfrac{1}{n_r} R_r^{2/3} S_r^{1/2}$

$\therefore \quad n_r = R_r^{2/3} L_r^{-1/2}$

For average $R_r = \dfrac{1}{150}$,

$n_r = 1.6:1$

FIG. 4.—SIMILITUDE RELATIONS.

in the model. A velocity of flow in nature of, say, 10 feet per second, would be 1 foot per second in the model. A day on the prototype would be 7.2 minutes on the model.

To be whimsical, for the moment, if we were Lilliputian residents in this model land conforming to its laws, we would be about ¾ in. tall, and because of the distorted scale, we would be as thin as tissue paper. Our eight hours sleep at night would last but 2.4 minutes, while our lunch hour would be only 18 seconds long.

The maximum discharge occurring in any one model stream will require about 2 cubic feet per second or about 1000 gallons per minute, this flow representing the project flood in the Lower Mississippi River.

An example of what these models can do is shown by comparison of flood hydrographs (Fig. 5) obtained from the Mississippi River Flood Control Model in Vicksburg and those for an actual flood which occurred in the river.

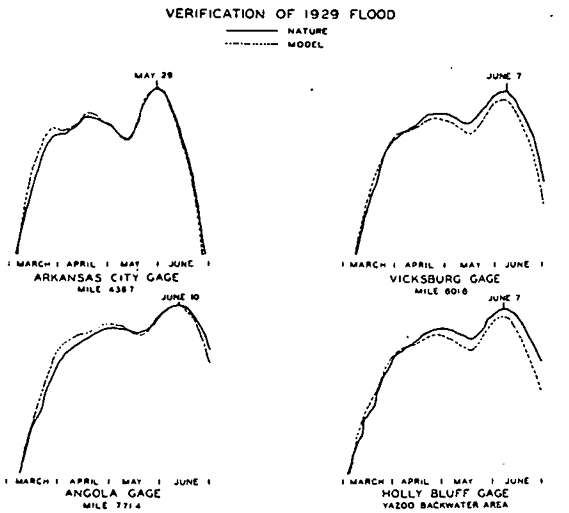



FIG. 5.—COMPARISON OF MODEL AND PROTOTYPE HYDROGRAPHS.

Let us consider now some of the construction features of our model. Since the model site of 200 acres will develop into a giant relief map of the drainage basin of the Mississippi River requiring in the model a maximum difference in elevation of 50 feet, the selection of a site which would require a minimum of grading presented a difficult problem. The site finally selected at Clinton, Mississippi, is located in gently rolling terrain 9 miles west of Jackson, and affords as close a resemblance to the finished topography as could be found anywhere near Vicksburg. Nevertheless, a total of 1,000,000 cubic yards of excavation and fill have been required to produce the required topography.

Work for preparation of the site was initiated in August 1943, utilizing German prisoner-of-war labor obtained from the Clinton Prisoner of War Camp established for that purpose immediately adjacent to the project area. Prisoners, of course, have now been released and all work is carried on by government hired labor.

Before actual construction work could begin it was necessary to establish a grid system on the ground for horizontal and vertical control. The selection of the type of projection used may be of interest. The range of latitude of the basin of the Mississippi River extends approximately from 29° to 49° North and the range of longi-

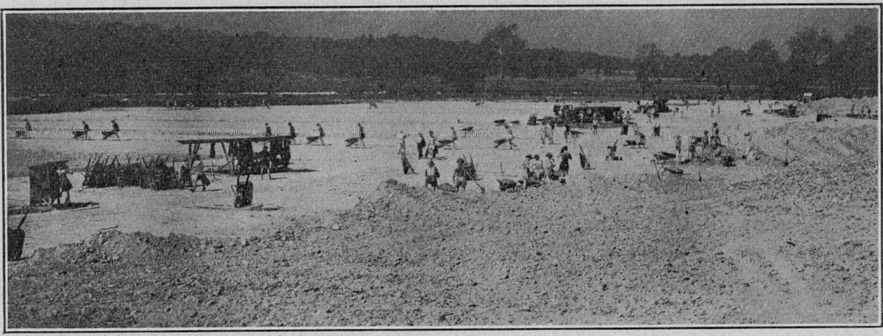


FIG. 6.—PRISONERS OF WAR ON WHEELBARROW HAUL.

tude from 78° to 114° West. No projection can give a true representation of such a large surface of the earth on a plane without introducing variation or distortion of scale, azimuth, or areas, particularly near the borders of the area under consideration.

The Bonne projection, which is the one selected for laying out the model on the ground, maintains a more nearly uniform scale relation over the area by combining the best features of the Polyconic

FIG. 7.—DRAGLINE AND TRUCKS ON TRUCK HAUL.

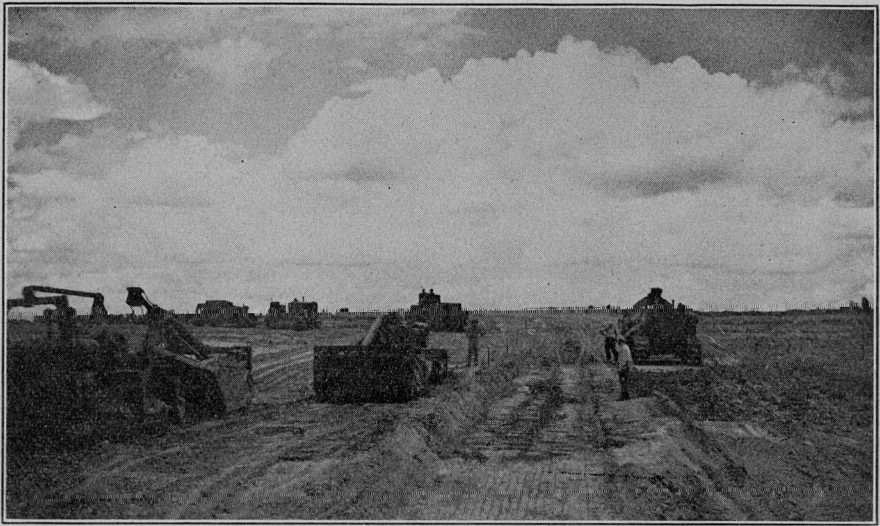


FIG. 8.—SCRAPERS ON SHORT HAUL.


FIG. 9.—ROUGH GRADING FOR ALLEGHENY RIVER.

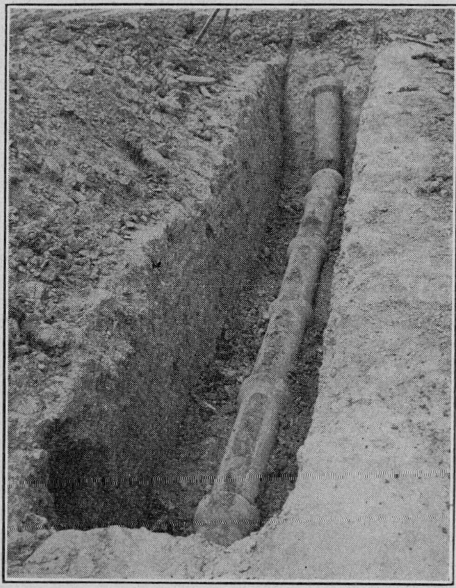


FIG. 10.—VIEW OF 8-INCH INLET AND RISER.

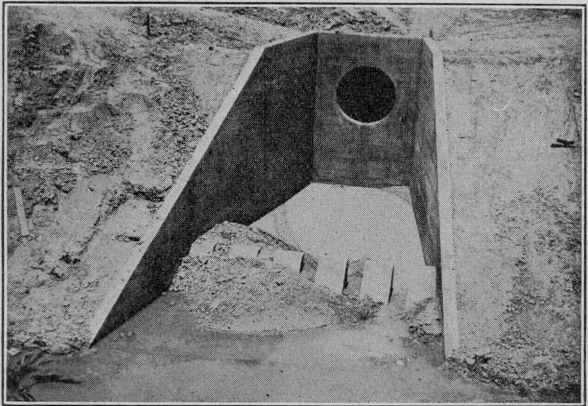


FIG. 11.—42-INCH OUTFALL SEWER OUTLET WORKS.

and Lambert projections. This projection maintains close agreement in scale along the meridians and parallels introducing only small errors at the corners of the area to be mapped.

To simplify the field work of laying out the actual projection on the ground and maintaining it during the construction period, a rectangular grid of 100-foot squares was superimposed on the Bonne projection.

In preparing the original grading plans, cut and fill was balanced for a haul not to exceed 500 feet in as many areas as possible. Limiting most of the haul to 500 feet was necessary because of the desire to use prisoner-of-war labor in moving dirt with wheelbarrows and shovels, thereby reducing to a minimum the amount of critical heavy equipment required.

Fortunately, these ancient methods of moving dirt did not last many months. The gradual acquisition of real earth-moving equipment was responsible for completing the rough grading this fall.

In grading the site, great care has been taken in compacting the fill. Obviously any settlement would be disastrous to the model. The fill was made in accordance with the standard procedures checked by the Soils Division; placing the earth in 8-inch lifts, obtaining the proper moisture content, and then rolling with sheepsfoot rollers to obtain the desired density.

Placing the fill in layers, incidentally, simplified the shaping of the topography. Contour maps were prepared to show the extent of each lift, or of several lifts, so that the proper shape of a ridge or a valley could be obtained.

The valleys of some rivers, on the other hand, particularly where the rivers are close together, as in the Upper Ohio basin, have been filled and will subsequently be excavated to form the river valleys just prior to the concrete paving of the model channels.

Since the model streams themselves will not be able to carry off the rainfall occurring over the model area, a storm-water drainage system had to be provided; the annual rainfall at Clinton is approximately 55 inches. I would like to make it clear in this regard that the operation of the model itself has nothing to do with the rainfall over the model area, since the actual discharge of the model streams is provided for by a separate water-supply system with the water being introduced in accordance with the discharge scale of the model as mentioned a few moments ago.

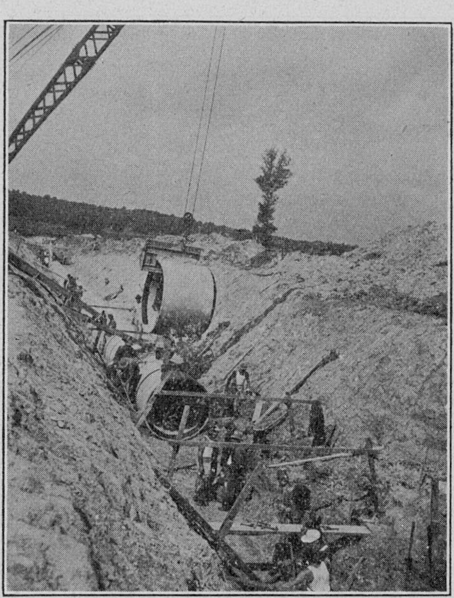


FIG. 12.—LOWERING 60-INCH CONCRETE PIPE INTO TRENCH.

To provide for surface drainage, each little river valley is furnished with inlets rising to the surface to intercept water running in small V-shaped ditches on each side of the model streams. This water, in turn, is carried underground through laterals to outfall sewers discharging into a drainage canal surrounding the model. The total footage of pipe required amounts to approximately 85,000 feet varying in size from 8 inches to 60 inches.

The magnitude of the undertaking calls for considerable effort to be made during the design and construction to improve on current practices as much as possible. At present a design and inspection force of about 35 are engaged in compiling, cataloging, and analyzing the prototype data. Reduction of this mass of information to construction drawings and specifications and the detailing of templets will require a staff twice this size. Such an organization is now being developed.

It is estimated that the construction of the model proper will require from two to five years to complete, but it is planned to operate portions of the model as soon as they are finished. The major factor

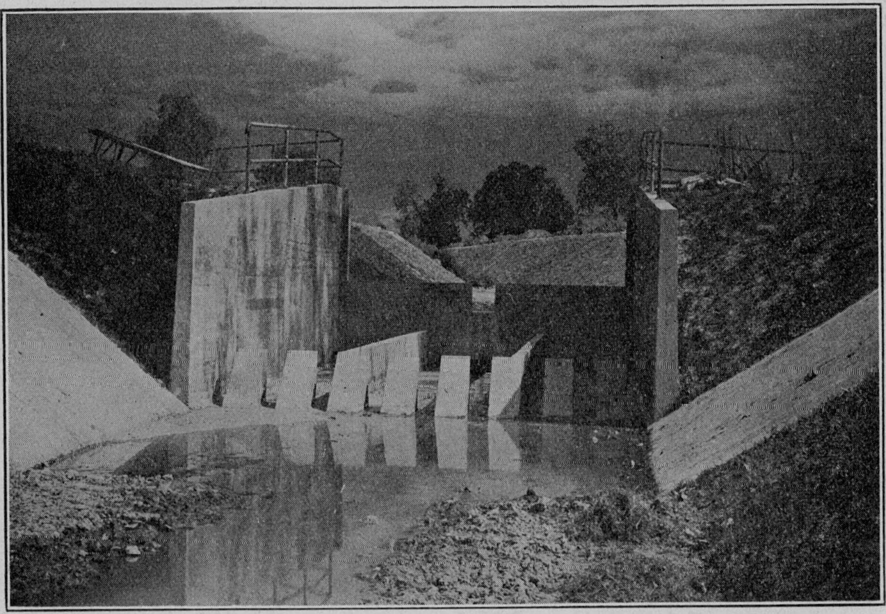


FIG. 13.—DROP STRUCTURE IN DRAINAGE CANAL.

FIG. 14.—900 CFS AT DROP STRUCTURE.

delaying the completion of the model in its entirety within a shorter period is the lack of data in the form of hydrographic and topographic surveys on many of the tributary streams in the basin. Some streams have never been surveyed in modern times, while other surveys may be too far out of date. For rivers which change their channels frequently, such as the Lower Mississippi River, the model will have to be rebuilt from time to time.

In concluding this discussion on the Mississippi Basin Model, we have seen how the Corps of Engineers proposes to bring to the laboratory one of the largest drainage basins in the world. It is believed that this model will show how to correlate the release of flood waters from reservoirs so as to obtain the maximum benefits not only in the tributary streams, but also in the main streams themselves. We can operate any assumed conditions of flow in this vast network of rivers to determine the results—good or bad. Finally, we can show what additional flood control works will be needed or what improvements might be desirable in the existing works to take care of floods greater than experienced heretofore.

# SEWAGE TREATMENT IN NEW YORK CITY

By Richard H. Gould*

(Presented at a joint meeting of the Boston Society of Civil Engineers and Sanitary Section, B.S.C.E., held on December 18, 1946.)

In trying to tell the story of sewage disposal in New York City, there is always the problem of where to begin and where to stop. As to when to stop, that is quite easy, and you can be assured that I will try not to exceed the time allotted to me.

The disposal problem is fascinating and might even be called romantic in the sense of it being a major struggle against the evils that beset the City and the well-being of the people. Some 1,100 million gallons of clean water is collected from various distant watersheds, then polluted by the wastes from about 7.5 million people and eventually discharged to the waterways surrounding the City.

All this started many years ago when New York was small and with the advent of an adequate public water supply and the adoption of the water carriage system of sewerage. The general practice was to build sewers to the nearest waterway as directly and cheaply as possible and that was all there was to the disposal problem, New York has broad and magnificent waterways fed by the large fresh water flows from the Hudson, Passaic and Hackensack Rivers, and also by large tidal flows from the ocean and Long Island Sound. These waterways have a large capacity to dilute and assimilate sewage, and it is for these reasons that the unrivaled and sometimes thoughtless growth of the City has been able to advance for so many years without paying a great deal of attention to the problem of sewage disposal.

Conditions of local nuisance were developed well over 50 years ago, principally in slips and in waterways such as Newtown Creek and Gowanus Canal where discharges were heavy and tidal circulation inadequate. It is true that five small treatment plants were built near Coney Island and along Jamaica Bay in the period from 1894 to 1903 but consideration of the general problem was first made by the New York Bay Pollution Commission in 1903. This was followed

---

*Director, Division of Engineering and Architecture, Department of Public Works, New York, N. Y.

by the work of the Metropolitan Sewerage Commission, formed in 1906 and dissolved on the submission of their final report in 1914.

Upon the consolidation and creation of the present City of New York in 1898 the jurisdiction of the disposal of sewage was placed with the Presidents of the five Boroughs comprising the City. Late in 1929 sewage disposal was recognized as a city-wide function and transferred to the Department of Sanitation. In 1938 a charter revision placed this function in the Department of Public Works where it now rests.

An urgent requirement for city-wide attack on the treatment problem was the preparation of a comprehensive plan. For this, of course, we had a great deal of information compiled by others over the years and also certain fixed conditions that must be met. There were 13 sewage plants in existence. The better of these provided for no more than fine screening, some were quite ineffective; all were inadequate for future requirements. In many places active nuisances were present. Dissolved oxygen in the waters was depleted over large areas, in some waterways to a critical point, and the trend was ever downward. Bathing was not permitted by the Health Department anywhere except in Little Neck and Eastchester Bays and at the ocean beaches, and even at Coney Island the conditions were doubtful. Areas near the waterfront were congested so that few isolated tracts were available for treatment works. Any works that were constructed, therefore, would have to be non-offensive in character. Of 17 locations finally selected for treatment plants only four are distant as much as 1,000 feet from residences. Another very cogent condition is that funds for sewage disposal are not exempt from the debt limit as are those for water supply, but must compete in the tax levy and capital budgets with other projects, many of which may impress the politically minded as having a greater popular appeal. Very large single projects, therefore, are difficult to get under way.

The objectives toward which we are working are to remove all visible evidences and obnoxious conditions resulting from sewage and to restore the dissolved oxygen in the inner harbor to a reasonable and safe balance. In the outer waterways, that are suitable for recreation and bathing, the dissolved oxygen is to be raised to encourage fish life and the waters freed of bacterial pollution that might endanger bathers or others coming in contact with the waters.

The tidal prisms of the harbor and connecting waterways result in large tidal flows and far reaching currents. A surface float in a single tidal run of about six hours can be carried from the Brooklyn Bridge in downtown New York, to the Whitestone Bridge over the Upper East River connecting Queens and The Bronx. One set out in the Harlem River at 145th Street has been carried around the northern end of Manhattan and down the Hudson River to 138th Street. Similarly, a float set out near the Battery at the southern end of Manhattan has been carried in a single run through the Narrows and not far from the westerly end of Coney Island. It will thus be seen that sewage discharged at any point in the harbor can be distributed over very large areas.

Strangely enough, in spite of the long reach of tidal currents, the actual exchange of new sea water is surprisingly small. Much of the water flowing on the ebb current returns on the flood, and it has been computed that around five days on the average is required for most of the water at the lower end of Manhattan to work its way out through the Narrows. In the Upper East River, not so greatly under the influence of the Hudson River, the displacement times are much longer.

There are at least two significant deductions that can be made from these conditions that may be applied to sewage disposal. In the first place it is apparent that a very high percentage of the oxygen demand of sewage discharged into the harbor is exerted within the harbor limits and this must be reflected in the degree of treatment required to maintain oxygen balances. If, however, this balance is maintained, the long contact time of the sewage in the harbor assures us that by the time this material works its way out to the recreational areas, it has undergone a large degree of purification through natural agencies in accordance with well established principles. In other words, viewed from the standpoint of the ocean beaches, the harbor itself is a large and effective treatment works.

The plan for sewage treatment now adopted and under which we are working calls for plants at 17 locations with an ultimate installed capacity of 1619 m.g.d. Generally speaking, plants located on the Upper East River and Jamaica Bay where the circulation is limited, will provide complete treatment by the activated sludge process. Those on the Lower East River and Upper Bay will give an intermediate treatment of activated sludge type modified by principles developed from our experimental work and practice. In the so-called Class A waters where safety of bathers is involved, the effluents will be chlorinated. All plants will be provided with sludge digestion tanks with utilization of the digestor gases and most of the excess sludge will be shipped to sea.

The City now operates 13 sewage treatment works. Six of these are the older plants, five having fine screens and one a septic tank. Three of these are provided with chlorinators. Seven more modern plants have been built at a cost of about $58,000,000. Six of these are in full operation, and the seventh is unfinished but operating on a partial treatment basis. During 1945 the average flow treated was 414 m.g.d. or about 40% of the estimated gross sewage flow of the City. Most of the excess sludge is shipped to sea in three 1,500 ton vessels and disposed of something over 10 miles from shore. Some digested sludge is recovered for park fertilization from sand beds in Marine Park and some is going to beds on the Idlewild Airport. Screenings go mostly to City refuse incinerators. The last figure on average operating cost for all plants was a little over $10 per m.g.

During the war years practically all new construction has been stopped. We have, however, been busy on a substantial design program to be ready for postwar construction. At 1939 prices this program was listed at about $107,000,000 and involved five new plants with extensions and additions at nine other locations. The construction under this program will result in meeting about 94% of the City's immediate objective in the disposal of sewage. The plans under this program are about 55% complete and we have as many projects now ready for contract as can be built in the next several years under the existing price and financial situation. Future advances in New York hinge very much on the question of finance.

With this general overall picture of past accomplishments and future programs one may well inquire as to the necessities and urgencies that lead New York City to embark on a program of sewage treatment that will add many millions of dollars to the annual operating budget. The answer lies in the very practical matter of self-preservation. It includes the preservation and restoration of real property values, the preservation and restoration of recreational facilities, the preservation of health, and, by no means unimportant, the preservation of decent environmental conditions. Fortunately, it is possible to demonstrate the value of sewage treatment from the results of works now operating.

Prior to the construction of the Wards Island Project the Harlem River was a filthy stream, unsightly and odorous. Bordering areas were blighted. After the project was finished the East River Drive was built and is to be extended north along the Harlem. Housing developments and a high school have been built on its banks and a general face lifting and reclamation of values is taking place. Thus the Wards Island Project is paying dividends in a very tangible form locally and its influence is of equal importance elsewhere throughout the harbor in the general reduction of the pollutional load. In a similar way the Coney Island Project has corrected conditions of active nuisance in Coney Island Creek, Shellbank Creek, and Paerdegat Basin with consequent benefit to the value of local areas and the improvement of the nearby water areas for recreational use. Like stories can be told of the Flushing River, Flushing Bay, and Bowery Bay, near the La Guardia Airport, as a result of the operation of the Tallmans Island and Bowery Bay plants. A marked improvement of the boating and recreational center around City Island has resulted because of sewage treatment there. Thus it is that while costly, sewage treatment pays its own way and is essential and indispensable. Had New York City not taken energetic action in this matter, property values and environmental conditions would have grown progressively worse and many other important improvements would have lost much of their value.

# OF GENERAL INTEREST

## PROCEEDINGS OF THE SOCIETY

### MINUTES OF MEETINGS

### Boston Society of Civil Engineers

NOVEMBER 20, 1946.—A regular meeting of the Boston Society of Civil Engineers was held this evening at Chipman Hall, Tremont Temple, Boston, Mass., and was called to order by President, George A. Sampson, at 7:00 P.M. This was a joint meeting with the Designers Section, B.S.C.E. Two hundred and ten members and guests were present and one hundred thirty-seven persons attended the dinner.

President Sampson announced the death of the following members:

Christopher J. Carven who was elected a member October 21, 1885, and who died October 9, 1946.

Gordon S. Rutherford who was elected a member December 18, 1940, and who died August 25, 1945.

President Sampson announced that the December meeting would be held at Chipman Hall, Tremont Temple. The speaker will be Mr. R. H. Gould, Director, Division of Engineering and Architecture, New York City.

President Sampson called upon Prof. Dean Peabody, Jr., Chairman, Designers Section, to conduct any necessary business for that section.

President Sampson introduced the speakers of the evening:

Mr. Chester N. Godfrey, Executive Partner, Cram and Ferguson, Architect Engineers;

Prof. Arthur Casagrande, Graduate School of Engineering, Harvard University;

Mr. H. M. Parsons, Project Manager, Turner Construction Company, who gave a most interesting illustrated talk on "The Foundations for the New John Hancock Building in Boston."

The talks were illustrated with lantern slides and motion pictures of pile driving activities.

A rising vote of thanks was given the speakers.

Adjourned at 9:50 p.m.

EVERETT N. HUTCHINS, *Secretary*

DECEMBER 18, 1946.—A regular meeting of the Boston Society of Civil Engineers was held this evening at Chipman Hall, Tremont Temple, Boston, Mass., and was called to order by President, George A. Sampson, at 7:00 P.M. This was a joint meeting with the Sanitary Section, B.S.C.E. One hundred ten members and guests were present and eighty-five persons attended the dinner.

President Sampson announced that the January meeting would be a joint meeting with the Hydraulics Section, to be held at Chipman Hall, Tremont Temple. Speaker to be Mr. Nathan B. Jacobs, President of Morris Knowles Inc., Pittsburg, Pa. Subject: "The Water Supply of Philadelphia".

President Sampson called upon Mr.

Walter E. Merrill, Chairman of Sanitary Section, to conduct any necessary business for that section.

President Sampson then introduced the speaker of the evening, Mr. Richard H. Gould, Director, Division of Engineering and Architecture, Department of Public Works, New York City, who gave a most interesting talk on "Sewage Treatment in New York City". The talk was illustrated with slides. Those taking part in the discussion included Messrs. Frank A. Marston, Karl R. Kennison, Thomas R. Camp, E. Sherman Chase, Edwin B. Cobb, Frank L. Flood and Herman G. Dresser.

A rising vote of thanks was given the speaker.

Adjourned at 8:30 P.M.

EVERETT N. HUTCHINS, *Secretary*

## SANITARY SECTION

OCTOBER 2, 1946.—A meeting of the Sanitary Section was held today at the Society Rooms at 7:00 P.M. following an informal dinner gathering at the Ambassador Restaurant. Twenty-nine persons attended the meeting, with twenty-one at the dinner.

It was voted that the Chairman appoint a committee to advise the Library Committee as to books and periodicals which should be available in the Society's library. Accordingly, Chairman Merrill appointed the following Committee: W. E. Stanley, Chairman, C. O. Baird, Jr., and J. E. McKee.

The speakers of the evening were: George F. Brousseau, Superintendent of Sewers, Braintree; C. Frederick Joy, Jr., Superintendent of Sewers, Milton, and Norman Winch, Superintendent of Sewers, Needham. They spoke on "Assessment and Connection Practices in Three Greater Boston Sewerage Systems". There followed considerable discussion on this subject.

It was then voted that the Chairman appoint a committee of five to advise the appropriate committee of the Federation of Sewage Works Associations on a manual of model ordinances for sewers. Chairman Merrill thereupon appointed the following Committee: F. L. Flood, Chairman, G. F. Brousseau, R. W. Moir, R. M. Soule and Norman Winch.

The three speakers were then given a rising vote of thanks and the meeting adjourned about 9:20 P.M.

GEORGE C. HOUSER, *Clerk*

(Joint Meeting with Main Society)

DECEMBER 18, 1946.—A joint meeting of the Sanitary Section and the Boston Society of Civil Engineers was held in Chipman Hall, Tremont Temple, at 7:00 P.M., on the above date, with 110 persons present.

With Chairman W. E. Merrill presiding, upon motion duly made and seconded, it was voted that the Chairman should appoint a Nominating Committee to recommend candidates for officers of the section and members of the Executive Committee for the year beginning March 5, 1947. Chairman Merrill thereupon appointed a Nominating Committee as follows: Charles O. Baird, Chairman, William L. Hyland and Frederick S. Gibbs.

GEORGE C. HOUSER, *Clerk*

## DESIGNERS' SECTION

OCTOBER 9, 1946.—Following the usual dinner at the Ambassador Restaurant, Chairman Dean Peabody called the meeting to order at 7:00 P.M., in the Society Rooms at 715 Tremont Temple.

The Clerk's report of the previous meeting on May 8, 1946, was read and approved.

Professor Peabody then introduced Mr. Francis R. MacLeay, Chief Engineer of the Corbetta Construction Co., of New York, as the speaker of the evening. Mr. MacLeay's topic, "The Solution of the Housing Problem" included a discussion of a novel construction method of building a reinforced concrete storage warehouse for the U. S.

Navy at Mechanicsburg, Pennsylvania, by using pre-cast units. This discussion was highlighted by the showing of a sound-color film explaining in detail the complete construction sequence.

Following this film, Mr. MacLeay explained by means of blackboard sketches how this pre-cast method of construction could be applied to building housing units, either single or multistory units. A lively discussion period followed the talk.

The meeting was adjourned at 9:30 P.M.

Attendance, 70 members and guests.

ERNEST L. SPENCER, *Clerk*

(Joint Meeting with Main Society)

NOVEMBER 20, 1946.—The Designers Section and the Main Society held a joint meeting at Chipman Hall, Tremont Temple. President George A. Sampson called the meeting to order at 7:30 P.M., after dinner had been served. There was no business for either group to conduct so the meeting was directed to the subject for discussion, "The Foundations for the New John Hancock Building in Boston."

Mr. Sampson introduced Mr. Chester N. Godfrey, Executive Partner, Cram and Ferguson, Architect-Engineers, as the first speaker of the evening. Mr. Godfrey discussed the general features of the entire building such as exterior architecture, floor plans and mechanical equipment (air conditioning, escalators, elevators, and lighting).

Professor Arthur Casagrande, Harvard Graduate School of Engineering, was the second speaker. Dr. Casagrande described the foundations of three old existing buildings in the Back Bay area and showed their settlement curves. The design, construction and settlement rates of the Liberty Mutual and New England Mutual Insurance Company Buildings were reviewed. The speaker then proceeded to discuss the various possible foundations for the new John Hancock Building considering cost, sub-surface soil conditions, construction method, and stability. The type finally selected was that of some 1600 steel H-Piles about 120′ long.

The pile tests that were made on piles of this type were described.

Mr. H. M. Parsons, Project Manager, Turner Construction Company was the third speaker. Mr. Parsons described the special method of building the foundation. This method consists of a sectional procedure in order to insure no damage to the adjoining buildings.

Each speaker illustrated his remarks by slides and a short color movie was shown at the conclusion showing the actual handling and driving of the piles.

A lengthy discussion period in which all speakers participated followed the presentation of the talks.

Meeting adjourned at 9:15 P.M.

One hundred thirty-seven present at dinner and two hundred ten at meeting.

ERNEST L. SPENCER, *Clerk*

(Joint Meeting with Highway Section)

DECEMBER 11, 1946.—At 7:00 P.M., after a dinner served at the Ambassador Restaurant, Chairman Peabody of the Designers Section called the meeting to order in the Society Rooms at 715 Tremont Temple. This was a joint meeting with the Highway Section. MacAvoy, Chairman of the Highway Section, had no business to bring before the Transportation group. The clerk's report of the two previous meetings of the Designers Section were read and approved.

Professor Peabody introduced the speaker of the evening, Mr. Henry L. Kennedy, Manager of the Cement Division of the Dewey and Almy Chemical Company of Cambridge, Massachusetts. Mr. Kennedy began his talk entitled, "Application of Entrained Air in the Production of Better, More Durable Concrete," by giving a brief resume of the various types and uses of admixtures in concrete mixtures such as plasticizing agents, accelerators, air entraining agents, expansion controlling agents, and retarders. He reviewed the early work by Professor Scholer in 1927 on air entraining concrete.

The function of entrained air with respect to the neat cement and the fine aggregate were discussed and it was demonstrated that the agent acts on the fine aggregate and not on the cement. Air entrainment in rich and lean mixes as well as the necessity for the redesign of concrete mixes to maintain a given strength when using an air entraining agent were discussed.

Some of the various means of measuring the entrained air were explained. The effect of excess air in concrete was illustrated and it was shown that about 3-6 per cent air was sufficient for good resistance to scaling and abrasion.

The two methods of entraining air in concrete, namely, by using an Air-Entraining Cement, or by an admixture to the gage water, were evaluated.

A discussion period followed Mr. Kennedy's talk.

Meeting adjourned at 8:45 P.M.

Seventy-five members and guests present.

ERNEST L. SPENCER, *Clerk*

## HYDRAULICS SECTION

NOVEMBER 6, 1946.—A meeting of the Hydraulics Section was held this evening at the Society Rooms, 715 Tremont Temple, Boston, following an informal dinner at the Ambassador Restaurant.

The meeting was called to order at 7:20 P.M. by Chairman, Harold A. Thomas, Jr. After a short business meeting, during which the Chairman was empowered to appoint a Nominating Committee, Chairman Thomas introduced the speaker of the evening, Mr. Richard H. Ellis of the Inspection Bureau, Associated Factory Mutual Fire Insurance Co., who gave a talk on "Water Supplies for Industrial Fire Protection".

The talk was followed by an open discussion period with thirty-eight members and guests present.

The meeting adjourned at 8:50 P.M.

J. G. W. THOMAS, *Clerk*

## ADDITIONS

*Members*

John S. Bethel, Jr., 130 Vernon Street, Wakefield, Mass.

Paul S. Crandall, 100 Hancock Street, Lexington, Mass.

Otis D. Fellows, 1002 Beacon Street, Newton Centre, Mass.

George B. Garrett, Jr., 16 Westland Avenue, Boston, Mass.

William C. Moberger, 26 Bolster Street, Everett 49, Mass.

Charles T. Main, 2nd, 52 Salisbury Street, Winchester, Mass.

*Juniors*

Arthur Hebert, Highland Road, Tiverton, R. I.

Gordon H. Searles, 74 Waite Street, Malden 48, Mass.

*Students*

Paul A. Dunkerley, 372 Metropolitan Avenue, Roslindale 31, Mass.

Joseph F. Quinn, Jr., 156 Wilder Street, Lowell, Mass.

## DEATHS

GORDON S. RUTHERFORD, August 25, 1945

FRANK S. BAILEY, January 21, 1947

# ADVERTISEMENTS

*The advertising pages of the JOURNAL aim to acquaint readers with Professional and Contracting Services and Sources of Various Supplies and Materials. You would find it of advantage to be represented here.*

Vol. XXXIV JANUARY, 1947 No. 1

# BOSTON SOCIETY OF CIVIL ENGINEERS

FOUNDED 1848

## INDEX TO ADVERTISERS

# COMMITTEES

**1946-1947**

## NOMINATING COMMITTEE

**Past Presidents (Members of the Committee)**

Arthur L. Shaw
Albert Haertlein
Athole B. Edwards

Alexander J. Bone
James F. Brittain
Lawrence G. Ropes
(Term expires March, 1947)

Charles O. Baird, Jr.
Allen J. Burdoin
Frank L. Lincoln
(Term expires March, 1948)

## SPECIAL COMMITTEES

**Program**

George A. Sampson, *Chairman, ex officio*

Thomas R. Camp
Stanley M. Dore
Frank M. Gunby
Everett N. Hutchins
William L. Hyland
Dean Peabody, Jr.
Walter E. Merrill
Harold A. Thomas, Jr.
Francis T. McAvoy

**Publication**

Everett N. Hutchins, *Chairman*

John B. Babcock
J. Stuart Crandall
Gordon M. Fair

**Library**

Athole B. Edwards, *Chairman*

Edwin B. Cobb
Thomas C. Coleman
Eugene Mirabelli
Ralph M. Soule

**Hospitality Committee**

John H. Harding, *Chairman*

Edward S. Averell
Frederick S. Gibbs
Joseph D. Guertin

**Relations of Sections to Main Society**

Dean Peabody, Jr., *Chairman*

Walter E. Merrill
Francis T. McAvoy
Harold A. Thomas, Jr.
Francis Mastropieri

**Welfare**

Ralph W. Horne, *Chairman*

**John R. Freeman Fund Committee**

Howard M. Turner, *Chairman*

Charles M. Allen
William F. Uhl

**Desmond FitzGerald Award**

Charles O. Baird, *Chairman*

George G. Bogren
Albert G. H. Dietz

**Sanitary and Hydraulics Section Award**

George G. Bogren, *Chairman*

Scott Keith
Herman G. Dresser

**Designers Section Award**

Albert G. H. Dietz, *Chairman*

John R. Nichols
George W. Lewis

**Transportation Section Award**

Charles O. Baird, *Chairman*

Arthur B. Appleton
R. Newton Mayall

**Subsoils of Boston**

Donald W. Taylor, *Chairman*

Miles N. Clair
Irving B. Crosby
Lawrence G. Ropes
Stanley M. Dore

**Investment Committee**

Chester J. Ginder, *Chairman*

George A. Sampson
Harvey B. Kinnison