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# Current research projects.

Fritz Lab

# CURRENT RESEARCH PROJECTS

Fritz Engineering Laboratory

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INTRODUCTION: Since its founding in 1909 Fritz Engineering Laboratory has advanced knowledge and techniques in the field of Civil Engineering through its various research and industrial testing programs. We wish to take this opportunity to present to you a brief description of the work in progress in a few of approximately thirty research programs in which the staff are currently engaged. Examples of the testing phase of the following projects may be found on the main floor of the laboratory at the station indicated.

## STATION A

### PROJECT 293: WAVE REFLECTION AND TRANSMISSION FOR CYLINDRICAL PILE ARRAYS

In Oceanographical Engineering the reflection of waves from solid sea walls of different types is an important occurrence. If the sea wall is permeable, the transmission of waves through the structure, as well as those reflected from it, combine to describe a part of the "wave characteristics" of the structure. A group of piles in a specific geometrical pattern might be generalized as a porous sea wall. Therefore, both wave reflection and transmission play an important part in the "wave characteristics" of pile groups.

The purpose of this investigation is to investigate the relationship between wave reflection and transmission, and several pile-group configurations. A total of 16 circular piles were used in different rectangular arrangements and one staggered pattern. In the rectangular arrangements both the spacings transverse to the oncoming wave and the spacings longitudinal to the oncoming wave were investigated. The experimental studies were performed in a two-dimensional wave channel.

## STATION B

### PROJECT 280: SPUR DIKES FOR BRIDGE ABUTMENTS

Sponsor: Modjeski and Masters, Consulting Engineers

A sound highway bridge design also involves hydraulic considerations for the safety of the bridge foundation. Severe scouring around bridge abutments in times of flood result from the increased flow velocity in the constricted area between abutments and eddy currents and separation around the abutments and piers. In recent years the interest of engineers has been focused on the usefulness of spur dikes in minimizing scour at the abutments by streamlining the flow and establishing uniform velocity distribution through the opening. A spur dike has been defined as a projection extending upstream from the bridge abutment.

Preliminary investigation indicates that a properly designed spur dike can produce a fairly uniform velocity distribution between abutments. The purpose of the experimental investigation is to determine in a fixed bed model the desired lengths and shapes of spur dikes to provide a uniform velocity distribution in the waterway between bridge abutments.

## STATION C

PROJECT 310: PHASE C MODEL STUDY OF GAS REMOVAL SYSTEMS

Sponsor: United States Army Engineers

In dredging operations, the pump may encounter mixtures consisting of widely varying amounts of solids, liquids and gases. When material containing a considerable amount of entrained gas is encountered, some of this gas is liberated in the suction pipe of the dredge and may accumulate in such quantities that the volume of solids discharged by the pump is reduced or completely stopped.

A model study will be conducted to determine the best and most efficient way of removing gas before it reaches the pump. Such parameters as gas content, pump speed and suction pipe geometry will be studied. The relative merits of such evacuators as vacuum pumps and water ejectors will be evaluated.

## STATION D

PROJECT 313: MODELS FOR THREE-DIMENSIONAL STRUCTURES

Sponsor: Lehigh University Institute of Research

Architects and structural engineers when designing complex structures such as sports arenas, exhibition halls, and large auditoriums, often strive to support the roof with a minimum number of columns impeding on main floor areas. This has given rise to new structural frames with unusual appearance (mostly shell type structures). Such frames are often complex in nature and become very difficult or impossible to analyze for the internal stresses resulting from dead and live loads. A useful tool which can be effectively used in analyzing these structures is structural models.

The work involved in this project consists of the following phases: 1) A study of the properties of various available materials which can be used to make the models, 2) Development of practical methods of fabricating shell models of constant and variable thickness, 3) Investigation of the reliability of various methods of loading structural models, and 4) Development of methods for interpreting results obtained from models and extrapolating them to prototype structures.

STATION E

PROJECT 273: MULTI-STORY FRAMES

Sponsors: American Institute of Steel Construction
American Iron and Steel Institute
Column Research Council (Advisory)
United States Navy Department
Welding Research Council

In order to apply plastic theory to the design of multi-story building frames the assumptions implied in the existing plastic theories must be studied in detail. The effect of axial forces and secondary moments due to deflections can not be neglected as in the analysis and design of single-story frames. The instability of restrained columns and of entire frames becomes the overriding concern.

The general purpose of this project is to develop methods for 1) Predicting the ultimate strength of multi-story frames subjected to various combinations of loads and 2) Designing such frames based on their ultimate strength. Both braced and unbraced frames are being studied. To verify the developed theories, experiments involving full scale frames will be conducted.

STATION F

PROJECT 316: SHEAR CONNECTOR DESIGN FOR HIGHWAY BRIDGES

Sponsor: American Iron and Steel Institute

The design of shear connectors in steel and concrete composite bridges has been based on a design procedure which evolved from static tests of various types of shear connectors. In reality repeated loading occurs on all shear connectors in a bridge and this should be considered in the design of the connectors.

The purpose of the current investigation is to obtain sufficient information concerning the fatigue strength of the most commonly used connectors so that a design procedure based on fatigue strength can be developed. This new design procedure may make it possible to simplify the spacing of connectors and reduce the number required.

STATION G

PROJECT 223: PRESTRESSED CONCRETE BRIDGE MEMBERS

Sponsors: Pennsylvania Department of Highways
Bureau of Public Roads
Reinforced Concrete Research Council

This project was established to develop fundamental information for evaluating the behavior of prestressed concrete beams. Work has consisted of studies in the following three areas:

1. Bond characteristics of steel strand.
2. Fatigue resistance of strand and concrete.
3. Ultimate strength under moment and shear.

The study of bond characteristics resulted in the establishment of design criteria for insuring adequate safety against a bond failure. The study of fatigue resistance resulted in development of procedures for determining the flexural fatigue life of prestressed beams. The study of ultimate strength resulted in the development of criteria for design of web reinforcement. Currently repeated load tests are being conducted to determine if a prestressed beam with sufficient web reinforcement to develop its static flexural capacity will have a satisfactory fatigue life.

STATION H

PROJECT 304: LONGITUDINALLY STIFFENED PLATE GIRDERS

Sponsors: Pennsylvania Department of Highways
Bureau of Public Roads
Welding Research Council
American Iron and Steel Institute

The objective of this project is to investigate the possible contribution of longitudinal stiffeners to the static load-carrying capacity of plate girders and to make recommendations that would be useful in translating the results into design rules. Both analytical and experimental research are in progress to determine both the bending and the shear strength of longitudinally stiffened girders.

STATION I

PROJECT 288: LARGE BOLTED CONNECTIONS OF HIGH STRENGTH STEELS

Sponsors: Pennsylvania Department of Highways
Bureau of Public Roads
Research Council on Riveted and Bolted Structural Joints
American Institute of Steel Construction

With the increased use of high strength steels in construction during recent years, the necessity to investigate their behavior when used in joints connected with high strength bolts became apparent. Consequently the work at Lehigh is now concerned with the behavior of A440 and T-1 steel joints fastened with A325 or A490 high strength bolts. The results from the tests are being used to verify a theoretical method of predicting the strength and performance of any joint.