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VOLUME VII

Special Structures
and Critical Facilities

Urban Design,
Socioeconomic Issues
and Public Policy

Lifelines: Utility
and Transportation Systems

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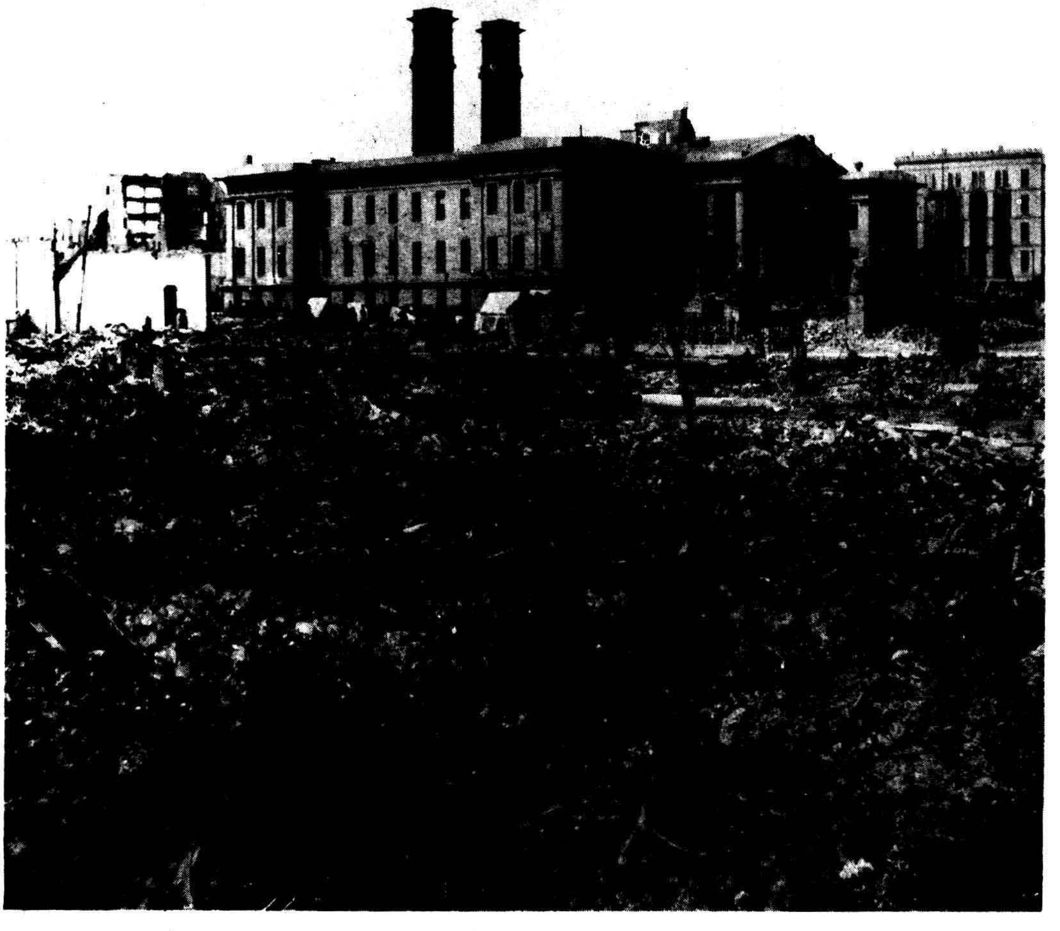
10. SPECIAL STRUCTURES AND CRITICAL FACILITIES



San Francisco Mint, essentially undamaged, surrounded by ruins following the 1906 earthquake and fire. The building is still used today. This building of massive construction occupies an entire block with comparatively wide streets around it. The facades consist of granite for the basement story and limestone above. The structure rests on a pile foundation. The window openings throughout the structure were protected by inside steel shutters. With the aid of the building's independent water system, employees and a large number of troops successfully kept fire from the building while the surrounding area burned. Fire entered the building briefly on the southwest side but was extinguished before it caused significant damage. Heat from adjacent burning buildings, however, spalled the limestone on the second and third stories on the north side. (Keystone-Mast Collection, University of California—Riverside)

10.1 Special Structures

EARTHQUAKE RESISTANCE OF DRYDOCKS

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SUMMARY

This paper investigates the earthquake resistance of a typical drydock to earthquake motions. Psuedo-static earthquake forces and finite element methods are used to investigate the problem. Stress distribution on the cold joints is investigated. The normal stress distribution across a horizontal section is not linear. The computer results show that the overall stress levels in concrete are below 500 psi in compression and about 180 psi in tension. The analysis from this paper shows that the drydock appears to be safer from the predicted pseudo static earthquake force than results from the simplified conventional stress analysis.

INTRODUCTION

Graving drydocks are massive concrete structures used for the repair of ships and are of critical importance to the commercial and defense needs of the country. Many of these drydocks exist on the West Coast of the USA and other parts of the world where earthquake occurrence is highly probable. The conventional design practice of these drydocks is based on simple beam theory which assumes that the strain distribution is linear across the section and also neglects the tension in the concrete. The bottom slab of the drydock is designed on the basis of "Beams on Elastic Foundations." The walls of the drydock are lightly reinforced. The drydock selected for analysis was originally designed in 1937 with little attention paid to earthquake forces. The present paper describes a pseudo-static earthquake analysis using refined finite element analysis and current field data on material properties. Effects due to weakness across horizontal construction joints are also discussed.

DESCRIPTION OF GRAVING DRYDOCK DD3

The graving drydock DD3 used in this study was designed in 1937 by the U.S. Naval Facilities Engineering Command (NAVFACENGCOM) (formerly the Navy Bureau of Yards and Docks) and constructed in 1940. It is 693 feet long. The drydock floor and walls are supported by many rows of wooden piles driven into stiff clay. Each row consists of 39 piles and are spaced longitudinally at 2.5-foot centers. In the middle section, the piles are spaced at 4-foot centers, while beneath the drydock walls, the spacing is 2.75-foot centers. The middle five piles of each row have special keys (notches) in the top of the piles and are embedded in the concrete to resist uplift. During the latter part of 1981, the thickness of the drydock floor was increased by 1.5 to 2 feet. The original design was based on equivalent fluid pressure of 85 psi acting on the side walls. The minimum specified strength of concrete is given by f'_c = 2,500 psi.

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