ACI 551 R-92
(Reapproved 1997, 2003)

TILT-UP CONCRETE STRUCTURES

Reported by ACI Committee 551

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Tilt-up concrete construction is commonly used in low-rise building construction. This report discusses many of the items that should be considered in planning, designing, and constructing a quality tilt-up project. Major topics discussed include design, construction planning, construction, erection, and finishes.

Keywords: Analysis; box type system; composite construction; connections; cranes (hoists); diaphragms (concrete); earthquake resistant structures; erection;finishes; inserts; lifting hardware; load bearing walls; moments; parting **agents; panels;** rigging; roofing; **sandwich structures;** stability; strongback; structural design; tilt up **construction.**

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ACI 551R-92 became effective February 1992.

CHAPTER l-INTRODUCTION

l.l-Introduction

The technique of site-casting concrete wall panels on a horizontal surface and then lifting or "tilting" them into place is referred to as tilt-up construction. Tilt-up construction uses less forming material than cast-in-place concrete construction and minimizes heavy equipment usage, which results in savings in time, equipment, and manpower. This efficient and cost effective method of construction has been used in the United States since the early 1900's. Tilt-up has other countries around the world. The American Concrete Institute, recognizing the increasing interest in this type of construction, formed ACI Committee 551 in 1980. The Committee's mission is to "study and report on the design and construction of tilt-up structures."

This report is in conflict with ACI 318 in three areas. The first conflict is found in section 2.7.5 and deals with the distribution of concentrated loads. The second conflict is found in section 2.10.5, which discusses typical connection details between the panel, foundation, and slab-on-grade. The third conflict concerns the amount of shrinkage and temperature reinforcement required in a tilt-up panel and is found in section 2.15.5. At the time this report was prepared, these three conflicts were being discussed with Committee 318 in an effort to eliminate them.

1.2-Definition

The definition for precast concrete found in ACI 116R is "concrete cast elsewhere than its final position," and includes tilt-up concrete. A more specific definition of tilt-up construction is "a construction technique of casting concrete elements in a horizontal position at the jobsite and then tilting and lifting the panels to their final position in a structure."

1.3-History

In 1909, Aiken[1] described an innovative method of casting panels on tilting tables and then lifting them into place by means of specially designed mechanical jacks. This technique was used for constructing target abutments, barracks, ammunition and gun houses, a mess hall, factory buildings, and churches (see Figs. 1.1 - 1.4).

In the mid-1950s, Collins[2-4] wrote three volumes devoted to the entire process of tilt-up. These publications were ***Design of Tilt-Up Buildings,***[2] ***Manual of Tilt-Up Construction ,***[3] ***and Building with Tilt-Up.***[4] During this same time period, tilt-up concrete construction began to gain nationwide acceptance as techniques were refined. California led the way and Sun Belt states were quick to follow. Since that time, tilt-up buildings have been constructed in every state in the United States, and in other countries around the world.

Ohio

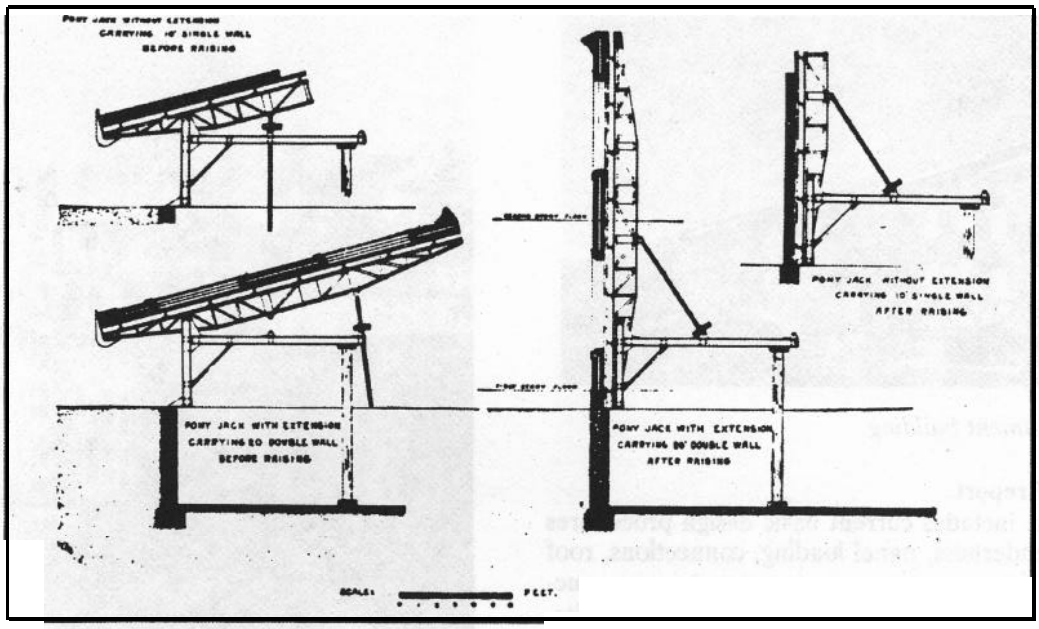


Fig. 1.2-Wall raising jack

1.4-Advantages

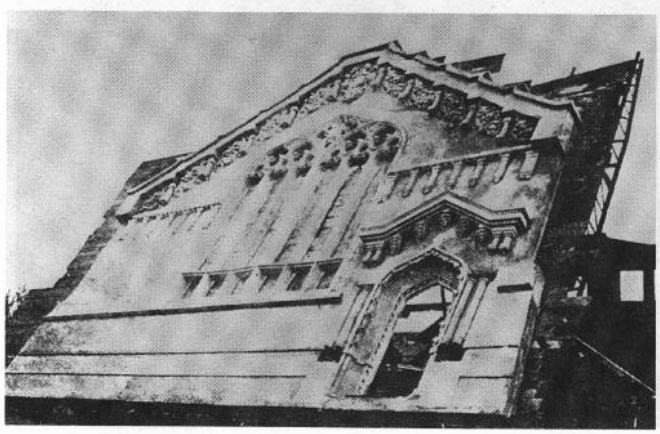
There are many advantages in tilt-up construction for low and even mid-rise buildings, including industrial plants, warehouses, office buildings, residential buildings, and commercial shopping centers. Examples of these types of buildings are shown in Figures 1.5 to 1.11. Some of these advantages are:

1) Elimination of expensive formwork and scaffolding
2) Fast, economical construction cycle time — from initial grading to move-in
3) Lower insurance rates that are typical for non-combustible construction
4) Wide variety of exterior finishes such as colored concrete, exposed aggregate, graphic painting and form liner finishes
5) Easily modified structures for building expansion
6) Durable, long-life and low maintenance building

Perhaps the greatest advantage of tilt-up is the ease and speed of construction. Panels can be tilted with high capacity mobile cranes and braced in less than ten minutes. It is possible to construct the complete building shell, from foundation through the roof, for a 100,000 ft^2 warehouse with office space in 30 days or less.

1.5-Disadvantages

1) Certain architectural treatment may become costly because of the construction techniques
2) Lack of availability of qualified personnel and contractors
3) Weight of the panels on certain soils
4) Available space to cast panels
5) Temporary bracing during construction
6) Availability of lifting equipment
7) Structural integrity requires careful consideration



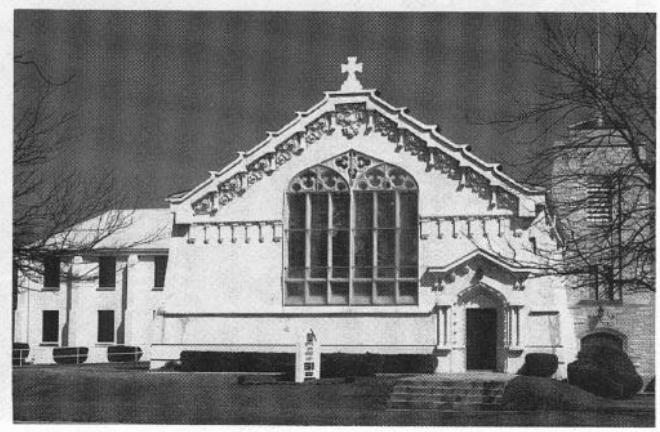


Fig. 1.3-Tilting front wall o *I987*

Fig. 1.5-Apartment building

Fig. 1.6-Condominium

1.6-Scope of report

This report includes current basic design procedures relating to slenderness, panel loading, connections, roof diaphragms, lifting analysis, temporary bracing, construction planning, construction procedures at the jobsite, erection, and safety procedures, along with a discussion of concrete mixture proportions and methods and types of finishes. Because of the concern for energy conservation a section devoted to the construction of insulated sandwich wall panels is also included.

Following the recommendations contained in this report will reduce the need for experimenting at the jobsite. The five steps of design, planning, construction, erection, and creating finishes are crucial to a successful tilt-up project. With ample preplanning between the owner, contractor, concrete subcontractor, erection subcontractor, accessory suppliers, and architect/engineer, and close adherence to the ideas and suggestions in this report, tilt-up concrete construction can provide a quick, economical, and versatile method of constructing low and mid-rise buildings.

CHAPTER 2-DESIGN

2.1—General

2.1.1 ***Slenderness*** **—** Tilt-up buildings are typically low-rise structures of four stories or less in height, with the majority being one and two stories. Wall panels for these buildings are generally designed as load-bearing beam-columns spanning vertically between the ground floor and the roof, or intermediate floors. Typically, these panels support vertical gravity loads in combination with lateral loads such as wind, seismic, or earth pressures. Often the panels are very slender; slenderness ratios of

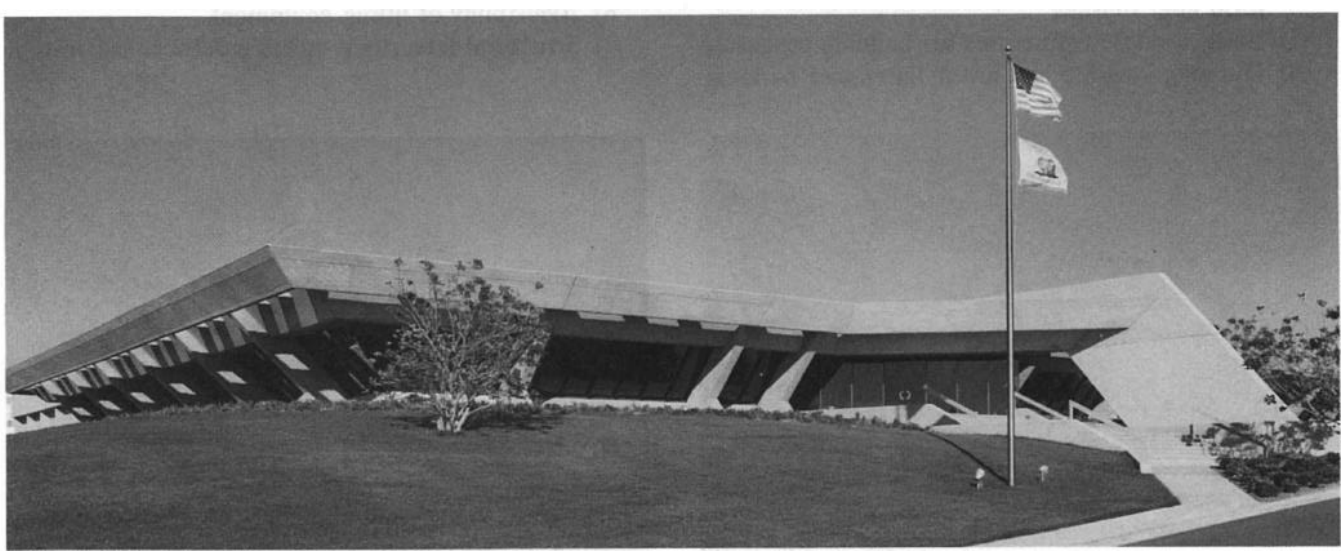


Fig. 1.7-Industrial building

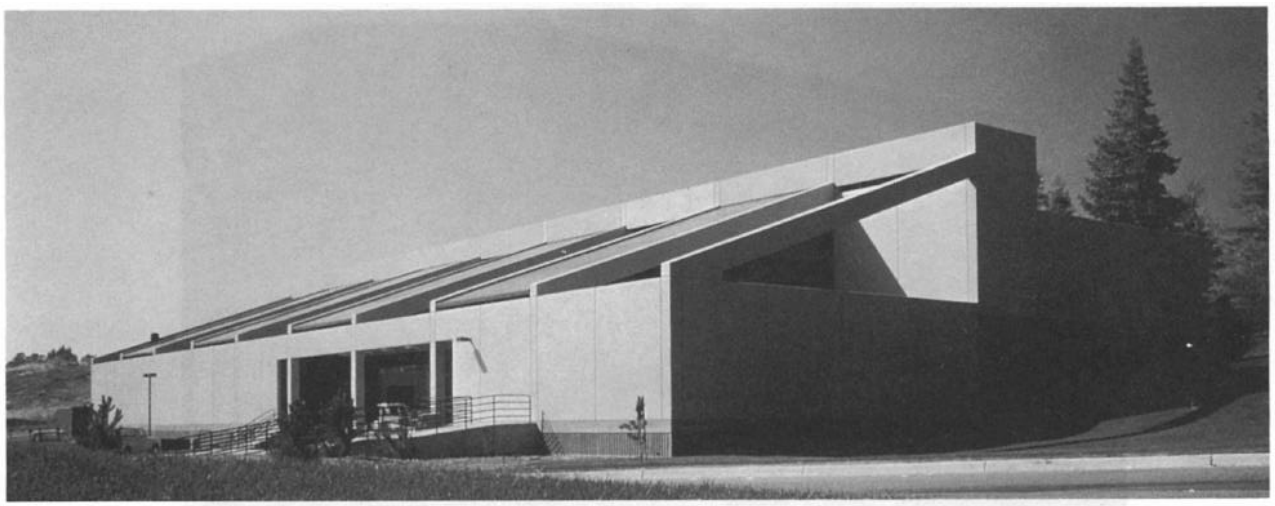


Fig. 1.8-Service building

Fig. 1.9-Warehouse

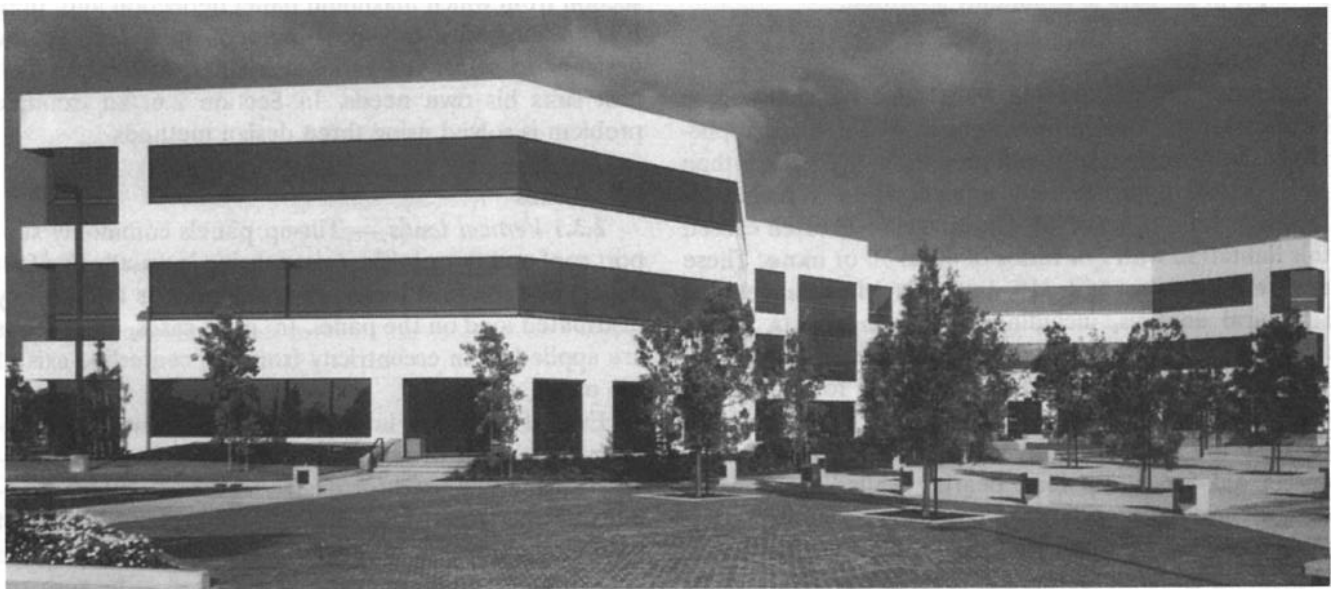


Fig. 1.10-Office building