IN-LB	Inch-Pound Units
SI	International System of Units

Construction of Concrete Shells Using Inflatable Forms—Report

Reported by Joint ACI-ASCE Committee 334

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This report provides information on the construction of structural concrete shells using an inflated form. Major facets of the construction process are covered, including foundations, inflation, monitoring, and backup systems. Other aspects, such as the geometric variations of inflated forms, thickness of polyurethane foam, and mixture proportions for shotcrete, are also considered.

Keywords: dome; fabric; inflation; polyurethane foam; reinforcement; shotcrete; thin shell.

CONTENTS

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CHAPTER 1—GENERAL

1.1—Introduction

For centuries, concrete shells (predominantly arched and dome-shaped structures) have efficiently enclosed large clear-span volumes. The strength of compound-curved surfaces allowed early builders to construct self-supporting thin-shell buildings from a variety of materials, especially concrete. In the past, it took a tremendous amount of time and effort to create the desired shapes; construction of these thin-shell structures sometimes spanned several decades.

Knowledge of design and construction approaches for thin-shell concrete structures has greatly increased over the past 100 years, both from research and practical experience. The use of inflated forms has allowed shells to be constructed more economically (South 1990). Inflated forms (or air-supported forms) use air pressure to expand and hold a prefabricated flexible membrane in a predesigned shape. This type of process has become a primary mode for constructing thin-shell concrete structures in recent decades and presents unique challenges and concerns. This report contains lessons learned in the construction of thin-shell concrete dome structures using inflated forms. One example of a thin-shell concrete structure constructed using an air-inflated form is Faith Chapel Christian Center, shown in Fig. 1.1.

Fig. 1.1—Faith Chapel Christian Center, Birmingham, AL: 280 ft (85.4 m) diameter and 72 ft (22 m) tall, which includes a 3200-seat sanctuary, classrooms, and an administration building.

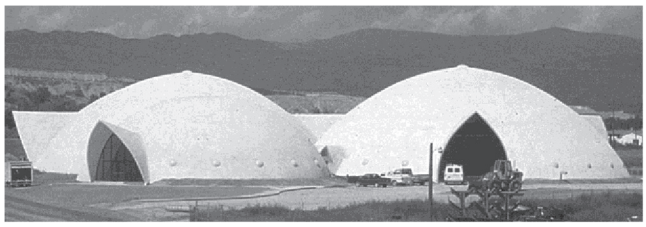

Fig. 1.2—Price City Works Complex, Price, UT. Four domes: 130 x 43 ft (40 x 13.1 m) fire station; 130 x 43 ft (40 x 13.1 m) storage facility; 130 x 43 ft (40 x 13.1 m) maintenance shop; and 90 x 40 ft (27 x 12.2 m) office and administration building.

1.2—Scope

As inflatable forms continue to gain popularity, additional research is needed to increase understanding of the behavior of this type of concrete shell construction process. Included in this report are construction procedures, tolerances, and design checks to ensure that the finished structure meets adequate safety and serviceability levels. This report focuses primarily on inflated forms for concrete thin-shell domes (and structures of similar geometry), which also incorporate a spray polyurethane foam (SPF) layer as part of the construction process. The addition of SPF layers to a flexible inflated form aids in the safe construction of concrete thin shells and contributes to the overall thermal efficiency and longevity of the concrete shell. While a large percentage of concrete shells are designed and constructed with an SPF layer, many structures are built using fabric forms where the concrete is applied directly to the form, either from the outside or the inside. The guidelines in this report apply generally to all methods of concrete shell construction with inflated forms. One example of a dome using SPF as part