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Stay-In-Place (SIP) Formwork

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Civil - Construction Equipment & Methods

STAY-IN-PLACE (SIP) FORMWORK

THE NEED

The use of aggregate materials, which are strengthened by a bonding medium or cement, has lasted with the beginning of construction. For many years, the use of various disposable or reusable wood forms for almost all types of concrete forming has been a general forming way. However, wood forming, the most common and previously cost effective option, has been challenged by a result of world wide restrictions on harvesting and the need to utilize a diminishing resource in a highest cost and best use fashion. Also, costs have increased significantly for plywood and dimensional lumber. Recently, reusable wood or metal frames have become popular for concrete construction. Even though these forms are useful in many applications and less wasteful, these forms still provide construction engineers with unsolved problems. That is, these must still be assembled, disassembled, cleaned and removed from the job site and stored. This is a time consuming and costly process made less practical by the inflexible nature of the large panel design. The resulting concrete structure is unfinished both inside and out. Thus, various alternatives to wood have been tested and advanced as viable replacements so far. These include steel, concrete blocks and various vinyl composites, which are removed or remain in place. Among these systems is the conventional Stay-In-Place (SIP) forming system.

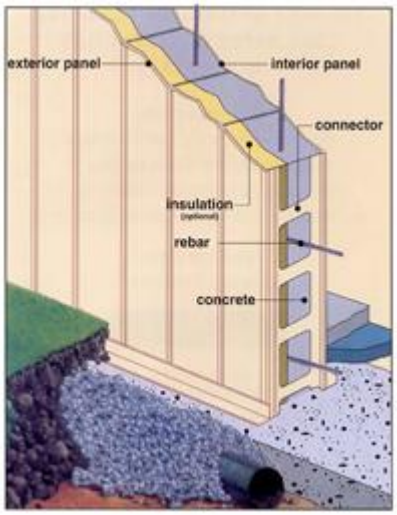

FIGURE 1 OCTAFORM: CONCEPT OF OCTAFORM (COURTESY OF OCTAFORM SYSTEM INC.)

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THE TECHNOLOGY

Early versions of SIP forming systems did not satisfy designer's expectation due to inflexibility of design and the fact that many raw materials lacked the necessary composition to offer long term cladding of the basic concrete structure as an option. In addition, early SIP products had some barriers from design deficiencies that replaced traditional methodologies with an alternative set of construction challenges. With the recent development of composite materials, SIP system are offering architects and engineers numerous advantages over competitive systems such as maximum flexibility, cost saving, and efficient time control in the various construction field; residential, commercial, industrial building and bridge as well. SIP systems have been applied to various type of project providing various panels composed of synthetic materials such as polyvinyl chloride (PVC), galvanized coiled sheet steel, fabricated steel, carbon/epoxy thin shell and so on for the specific requirement of each project. The Octaform Wall System™ for building construction, AMICO Stay-form for multi-pose construction, and Carbon Shell System (CSS) in University of San Diego for bridge construction are introduced.

The Octaform Wall System™

The Octaform Wall System™ consists of various PVC panels, connectors and strengtheners that connect together to form a water and fire-resistant vinyl protective shell that encapsulates the concrete, reinforcing steel and insulation. The design of the Octaform Wall System offers the flexibility to configure in straight lines, curves or circles quickly and easily. The forms stay permanently in place, eliminating the need to install additional cladding on the outside or inside of the building.

AMICO Stay-form

AMICO Stay-form is fabricated from hotdipped galvanized coiled sheet steel of 26 ga. thickness for standard grade material at 27" x 97" finished sheet size and of 25 ga. sheet for heavy grade material at 27" x 97 " finished sheet size allowing the subsequent formation of solid sheet V-Ribs of 3/4" depth running parallel to the length of sheet and spaced 3-7/8" apart. Construction joints are easily made with Stay-form. Either side of Stay-form provides a substantial key for bonding abutting pour faces-especially so when the mix is of sufficient viscosity to cause small protrusions of the pour to project through the mesh to the opposite side causing such surface irregularities as to provide a made-to-order key for the pour interface. Consequently, no chipping or other joint preparation is necessary. To erect a partition of Stay-form, side adjoining sheets should be lapped and wire-tied at approximately 6" O.C (On Center). with 16 ga. soft galvanized tie wire. End adjoining sheets should be lapped 2" and lap should occur over a support. If an end lap should occur between supports, such lap should be of 4 inches length. End laps, of course should be secured with wire-tying just as side laps. Due to the relatively light-gage material of which Stay-form is fabricated, sheets may be readily cut lengthwise with hand shears and cross-wise by initially snipping the ribs along the path of the cut and bending the sheet at the cut to open up the ribs. Then the grid web

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between the cut-ribs can be readily cut with hand shears. Openings to accommodate conduit and rods may be made with an "X" cut at the center of conduit entry. The ribs of Stay-form may be placed in either a vertical or horizontal position dependent on the orientation of the supporting structure but in any event, best results are obtained when the ribs are placed so that they project in the direction towards the first pour.

Carbon Shell System (CSS) in University of California, San Diego

The CSS technology is licensed to Composite Solutions, Inc. (CSI) for use in designing and constructing innovative building and bridge structures that are seismically resistant and affordable. The carbon shells perform like conventional steel reinforced beams but contain no steel rebar. They are made of lightweight carbon fiber-reinforced polymers (CFRPs) that are assembled and filled with concrete at the construction site. The shells, which are long, hollow tubes, act as SIP forms designed to replace rebar and conventional temporary formwork for constructing concrete girders and columns. The modular bridge system utilizes carbon and e-glass Fiber-Reinforced Polymer matrix (FRP) composite components in conjunction with conventional construction materials. The bridge consists of a two span continuous system with a beam-and-deck superstructure. The development of the new bridge system is based on the carbon shell system technology in which carbon/epoxy tubes filled with lightweight concrete serve as structural elements. The girders consist of carbon reinforced concrete in which the carbon tube serves as external reinforcement and formwork for the infill concrete. The structural slab is composed of modular E-glass deck panels weighing about one-fourth of a conventional reinforced concrete deck. The beam-and-slab bridge superstructure is thus composed of longitudinal carbon shell girders connected across their tops with a fiberglass composite deck.

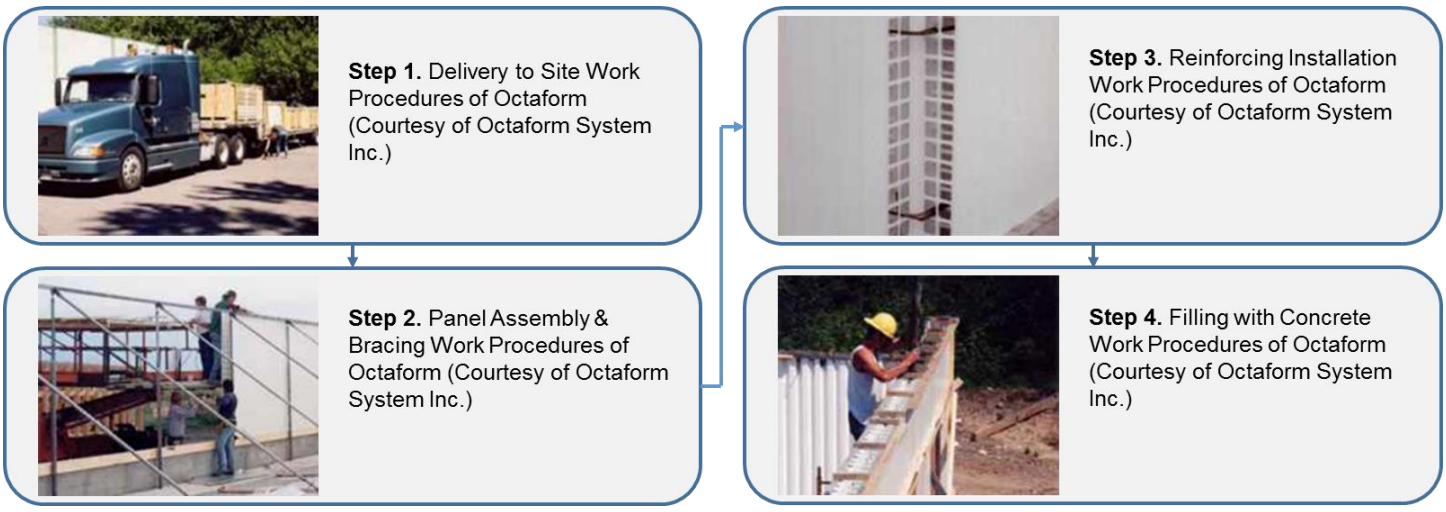

FIGURE 2 INSTALLATION PROCESS (OCTAFORM)

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The Benefits

The product is easily added to ready-mix concrete or to the surface of existing concrete. Dramatically delays the initiation of corrosion and greatly reduces the overall corrosion activity (65% reduction). Provides corrosion inhibition in the presence of varying chloride concentrations, even high concentration of deicing or marine salts. The time of penetration is very fast, penetrating concrete to a depth of at least 3 inches in 28 days. Causes no harm to the environment. It extends the service life of concrete structures and reduces maintenance costs. If it is used in concrete restoration its application does not require concrete removal. It can be applied to concrete that already exhibits corrosion. All the concrete properties and appearance remains unchanged (It does not affect the plastic properties of concrete). No changes in mix design or placement operations are required. The product does not affect the properties of hardened concrete, such as compressive strengths, permeability, etc.

Status

ASTM tests show that FerroGard reduces corrosion currents by as much as 65%. It has been implemented in several DOT projects and was also selected for use in an extensive Federal Highway Administration research project. FerroGard comes in two types; FerroGard 901 which is used as an admixture in the placement of new concrete or FerroGard 903 that is topically applied to existing structures.

Barriers

The product is able to reduce corrosion but not to stop it. A combination of this product with other protective systems is required if the level of durability of the concrete structure needs to more than double.

Points of Contact

Sika Corporation, Gemite Products, Inc.

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REVIEWERS

Peer reviewed as an emerging construction technology

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