PRECAST POLYMER CONCRETE BUILDING PANELS: CASE STUDIES WITH LONGEVITY EXPERIENCE

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ABSTRACT

This paper presents several case studies from field applications and buildings constructed over the past 50 years demonstrating the rationale for the original development of precast polymer concrete building panels by dissecting each facet of their tested material qualities and then relating them to the longevity of numerous building exteriors. Each element, procedure, and function of the various types of polymer concrete panels here-with dissected have successfully performed and properly functioned over the past 50 years in a variety of environments from the frigid climes of the far north to the dank conditions of the south to hot dry desert areas. These successful products soon penetrated the international market and their applications extended from Europe to the Middle East. But with all of the strength, weathering and insulatory qualities that these precast polymer concrete panels possess—all had to undergo and pass extensive and sometimes exhaustive tests in officially registered city, state, federal and national laboratories. This was necessary in order that the actual physical properties, innate characteristics and manufacturing techniques of precast polymer concrete building panels would conform to the code requirements that are obligatory in every jurisdiction, each differing from the other as related to precast polymer concrete panels.

Keywords: Precast Polymer Concrete, Building Panels, Cladding, Polyesters, Resin types, Reinforcing, Diagrammatic anatomy

1. INTRODUCTION

To date very little has been published on the actual physical properties, innate characteristics and manufacturing techniques of precast polymer concrete building panels even though they have been a viable building material and product over the past 50 years. Apparently, companies that are, or have been involved in the manufacturing of precast building panels did not want to publish that type of proprietary information for fear of creating commercial competitors – an understandable rationale.

1.1. General information

In 1978, one of the first documents describing and analyzing these relatively little known processes and products was published [1] more than twenty years after their initial development. Only recently has some of the prime test data been published in an American Concrete Institute International (ACI) #548 symposium by the original developer and meticulously analyzed by an engineer, himself involved in polymer concrete products. [2]

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1.2. Technical Aspects
Although quite simple in concept, the matrix material is the key element to that product’s ability to perform as a viable entity. Polyesters were chosen over other polymers since they proved to have the best inherent qualities, including price and safety characteristics. Consultation with a prime resin manufacturer, who had significant testing capabilities, aided in determining the end formula along with further structural testing performed at several certified engineering testing facilities. Finally, two separate resin types were chosen. A two thirds to one third blend, an orthophthalic resin and an isophthalic resin performed the best. The former for its flexible yet resilient characteristics and the latter for its weathering qualities. Britteness was overcome as the flexible factor was built into this matrix so as to permit easier handling. Other formulas can possibly be created which might give similar or even better results, however, longevity wise, this matrix has proved itself over the last four decades.
The addition of ultra violet controls, a silane, a fire retardant and pigments completed the formula. The percentage (+/- 89%) and types of inert fillers (washed silica of 30 to 40 mesh grade) completed the desired mix. Now, because of the high physicals attained, mass was no longer necessary to create strength: a +/- ¾ inch thickness (2 cm) was now considered ideal for its use as a facing or cladding panel. In a thin facing (veneer, cladding) panel, (Fig. 1) the reinforcing mechanism is a centrally located fiberglass woven cloth of a seven-pound density.

![Isometric Sketch of ¾ inch Facing Panel](image1)

Fig. 1 Isometric Sketch of ¾ inch Facing Panel

The centralized location within the panel was determined to be the optimum configuration. Recessed attaching holes are cast into the panel and it is then screwed into a stud or masonry anchor. The recess is then covered with the same matrix used in the panel. If the installation is such that it is accessible from the back, a “T” shaped threaded grommet is cast-in and fastened either directly to a permanent position [3] or as illustrated (Fig. 2), the clip is then tack-welded to the stud. The latter installation permits movements caused either by thermal expansion or contraction, or some type of vibrating phenomena, such as earthquakes, without losing its anchoring position. Spacing of these inserts was determined by wind load testing and a permanent spacing ratio related to its dimensions was defined. To date, no known catastrophic failures have been recorded.

![Threaded Insert](image2)

Fig. 2 A “T” shaped threaded grommet
1.3 Field Applications
The Metro Media Studio multi-building complex (now Fox Studios) in Hollywood, California, is a typical installation where-in both attaching procedures were utilized. Over two hundred and fifty thousand square feet of cladding panels cover this edifice. Old buildings were blended in with the new to give a unified monolithic appearance (Fig. 3). To date, the wall panels that were completed in 1971 show no sign of aging. In fact, they have even sustained an earthquake and lasted unscathed because of their particular innate flexible features.

![Fig. 3 Metro Media Studios, where over a quarter of a million sq ft of facing panels were used to cover old buildings as well as new ones.](image)

Another most prominently visible installation was the use of the facing panels over metal studs where-in over 800 new and existing K-Mart stores throughout the United States were clad with this type of facing panels (Fig. 4).

![Fig. 4 K-Mart stores](image)

To illustrate how the utilization of all of these physicals solved a problem of failing cementitious materials, the wall errant claddings were removed and replaced with polymer concrete facing panels (Figs. 5, 6) on this massive structure. The entire recladding was accomplished without interrupting the normal course of that company’s business activities.

![Fig. 5 Workmen Placing Furring Channels and Polymer Concrete Panels](image)

![Fig. 6 Placement of ¾ in. Facing Panel](image)
2. FURTHER DEVELOPMENT

2.1. Creating Additional Features

Once the innate qualities of the matrix proved that a polymer concrete facing or insulated wall panel installations could weather the test of time, more exotic challenges were undertaken. After an extensive testing program, the GSA (U.S. General Services Administration) determined that polymer concrete tile surfaced panels must be applied on a dormitory addition to replace the “Smalti” (1/2 inch) tiles that were applied on the original walls of the US Air force Academy. The “Smalti” tiles proved to be too unstable, expansion coefficient – wise for that climate as they were literally “popping” off the walls due to the sudden and extreme changes in temperature. To date, those polymer concrete tile surfaced facing panels (installed in the late 1960’s) have not experienced any major delaminations (Fig. 7).

![Tile cast into facing panels as utilized on U.S. Air Force Academy dormitories. Architect: Hinningson, Durham, Richardson, and Leo A. Daly](image)

A similar situation wherein a matching complex configuration of an existing tile installation at the Medical College of Virginia was required. Cast-in insulated polymer concrete panels with a wall board for the inside face was specified since the conventional method of tile setting proved to be too costly to field apply otherwise. The curtain wall sections were trans-shipped and cast directly into the spandrel section at the factory, thus eliminating on site labor and insured a weather-tight mounting (Figs. 8, 9).

![Medical College of Virginia, Richmond, VA Architect: Lee, King and Poole](image)

![Close-up view of tile panels](image)

2.2. Special Techniques

Special techniques were developed, such as bush hammering (Fig. 10), ceiling coffers (Fig. 11) which were installed to aesthetically coordinate an exposed exterior and interior soffit situation, and even Roman columns were cast (Fig. 12) to construct 24 ft. long (7.3 meters) quarter sections totally impractical to be cast and installed from cementitious materials (Fig. 13).
The diagrammatic anatomy of an insulated panel (Fig. 14) indicates how encapsulating polyurethane foam (board) forms a core which produces an insulated panel. Depending on the thickness, almost any practical desired “U” factor can be attained simply by increasing the thickness of the core; i.e. both faces of the panel remain the same +/- ¾ inch (2 cm) thickness. Rib areas are formed at the perimeters which contain the anchoring devices.

As noted previously, the flexibility factor which was purposely incorporated into the matrix formulation had to be overcome so as to cast longer panels. By the use of truss-like steel re-bars, greater clear-span lengths, up to 20 feet, could now be attained. Thus, wind load requirements are met. The variance in clear span [4] determined by extensive load testing may best be illustrated in this (Fig. 15) example: Wherein only 2+ inch insulated panels were placed to span 10 feet, a thickness of four inches was required to accommodate a span of over fifteen feet.

Further, an additional feature of the innate qualities of polymer concrete was incorporated into this installation. Being a laboratory for testing monkeys for original outer space experiments, extreme cleanliness necessitated that the interior of the panels (which were exposed) be not only impervious to water absorption, but also should be extremely smooth so that it could be washed daily for sanitary purposes. The panels, cast exterior face up, were poured onto a polished surface thus producing the required inside sanitarily smooth texture.
3. CONCLUSIONS

Each element, procedure, and function of the various types of polymer concrete panels here-with dissected have successfully performed and properly functioned over the past 50 years in the frigid climes of the far north to the dank conditions of the south to hot dry desert areas. These successful products soon penetrated the international market (Figs. 14, 15) and their applications extended from Europe to the Middle East.

But with all of the strength, weathering and insulatory qualities that these precast polymer concrete panels possess – all had to undergo extensive and sometimes exhaustive tests in officially registered city, state, federal and national laboratories [5-11]. This was necessary in order to conform to the code requirements that are obligatory in every jurisdiction, each differing from the other; besides that, the foreign regulatory entities typically refuse to accept an international code of reciprocity [12] as related to precast polymer concrete panels.

REFERENCES


