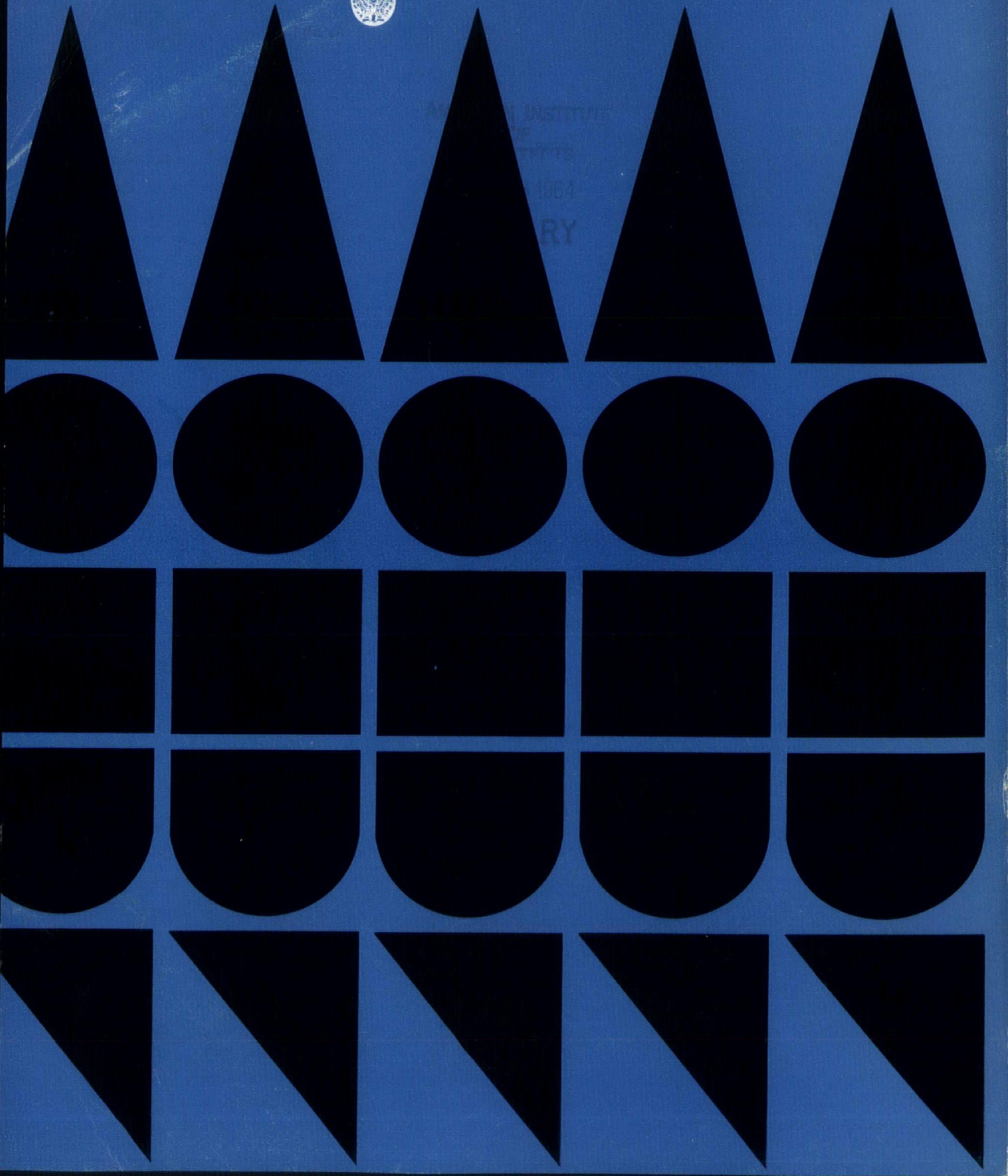
INDIANA ARCHITECT

AUGUST 1964



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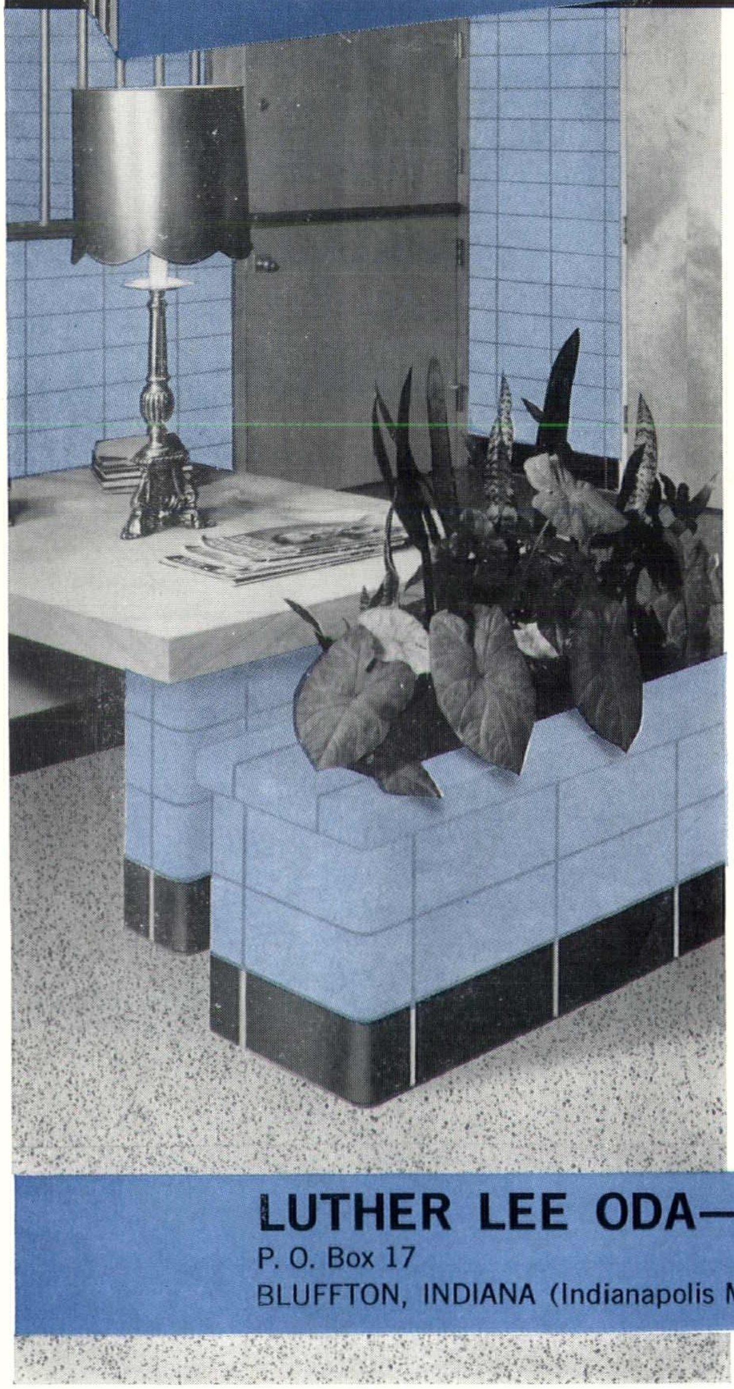

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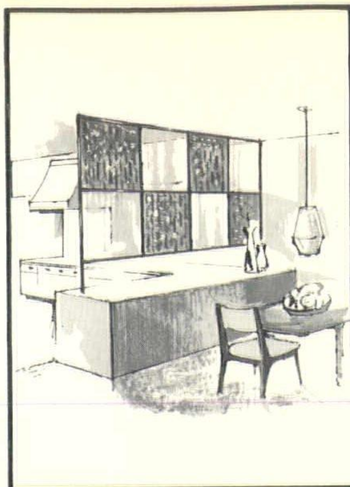
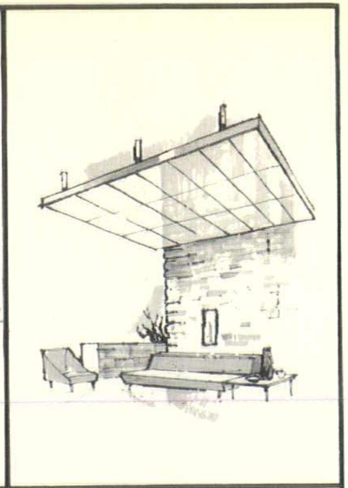
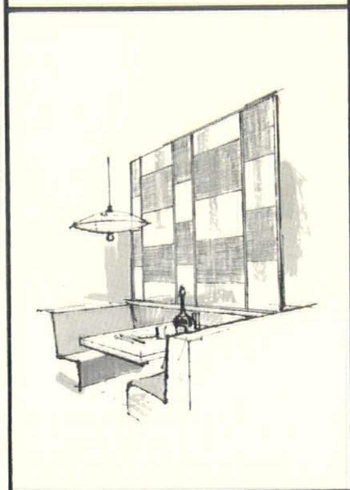
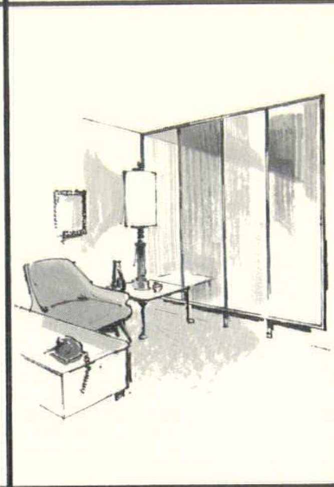
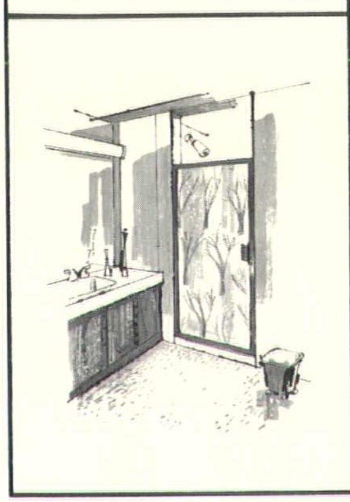
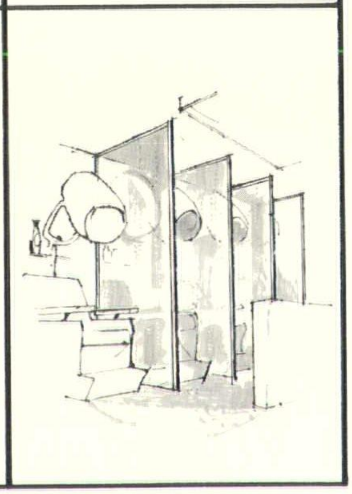

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Indiana Architect

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Plastics in Today's Buildings

By KEITH W. HARRISON,
Marketing Manager
Building Products Division,
American Cyanamid Company

Today, 22% of the total production of plastics of all types goes into construction and new uses for this versatile material are continually being developed.

The construction industry finds itself with more than two dozen major plastics challenging more traditional materials.

By definition, plastics are a large and varied group of materials, consisting wholly or in part of combinations of carbon with oxygen, hydrogen, and other elements. These arrangements are capable of being readily made into many forms through the application of heat and pressure.

What makes plastics so hard to define is that they start from so many different raw materials and end up in so many different end materials. But basically, there are two major divisions into which all plastics fall: thermoplastics and thermosets.

Thermoplastics are much like candles, in one respect. The synthetic resins when exposed to sufficient heat become soft, only to harden again when the reat is removed. This process continues no matter how many times it is repeated. It may require a high temperature.

Thermosets are analogous to the whites of eggs. Heat initially applied to the resins permits forming of the material. Additional heat applied at a later date will char the material and destroy it.

The big three of the plastics business — polyethylene, vinyls and styrene — are all thermoplastics. Epoxies, melamine, polyurethanes, set by chemical reaction, and polyesters, are typical thermosets.

The building industry hardly realizes the inroads made by plastics in the last decade in paints, laminated counter tops, flooring, brushes, handles, insulation, piping and tubing, roofing, fencing, daylighting, screening, paneling, glues, etc.

Decorative-utilitarian high-pressure laminates are standard now for counter tops, furniture and wall covering. Vinyl-chloride based flooring is also standard and has introduced a new level of quality and variety. Toplighting of acrylic, reinforced plastics and vinyl chloride is in common use and formed acrylic illuminated signs have swept that field. The same materials provide luminous ceilings and have transformed outdoor lighting. Polyester reinforced canopies are especially adaptable as pavilions for drive-ins, service stations, concession stands, parks and other outdoor shelter and "dress up" purposes. They admit daylight and reflect light at night.

Tough transparent plastic films protect the surfaces of a wide variety of building boards and acoustical tiles. Other films form vapor barriers and flexible sheets are made into easily-formed flashing. Plastic piping is forging ahead rapidly for both outdoor and indoor uses. In rising from an annual volume of $500,000 in 1948 to the $63 million level of today, the plastics pipe industry cracked a market long dominated by traditional materials.

Electrical components have long depended upon plastics and now plastics are firmly entrenched in hardware where toughness, silent operation and resistance to corrosion are important. Foams provide a new range of building insulation. Adhesives, coatings and sealants have been transformed by plastics-based materials.

The World's Fair makes extensive use of structural and semi-structural plastics.

American Cyanamid Company's World's Fair House is a showcase of the latest in plastics for light, glazing and new finishing materials. Over 20,000 square feet of melamine laminates and acrylics were built into this ranch style house.

Reinforced panels, sandwich panels, glazed plastic panels, acrylic sheet, solid vinyl siding — the plastics used to enclose space take every form at the Fair from siding barely detectable from the traditional materials to the ultra modern vacuum-formed butyrate sheet used as cladding on IBM's ovoid theatre.

At the Fair, also, three-dimensional acrylic grillwork is used for the enclosure screens and the carillon tower of the Coca-Cola Company Pavilion. The basic building blocks for this grillwork are 2-ft. x 2-ft. square units, injection molded of colorless transparent acrylic plastic.

Sheets cast from acrylic monomer are used in glazing on the second floor level of DuPont's World's Fair exhibit.

The exterior walls of the two connecting circular buildings that make up the Schaefer Center at the Fair are constructed of bubble-bearing acrylic sheet. For the walls, restaurant and exhibit areas, the architects wanted a transparent, sparkling effect to enclose the two circles, one 90-ft. in diameter to house the restaurant, the other 50-ft. wide. The decision was for specially designed bubble patterned rigid walls made of heat-formed ½" thick acrylic. In addition to providing a pattern that is reminiscent of a glass of good beer, the bubbles contribute to the rigidity and strength of the walls.

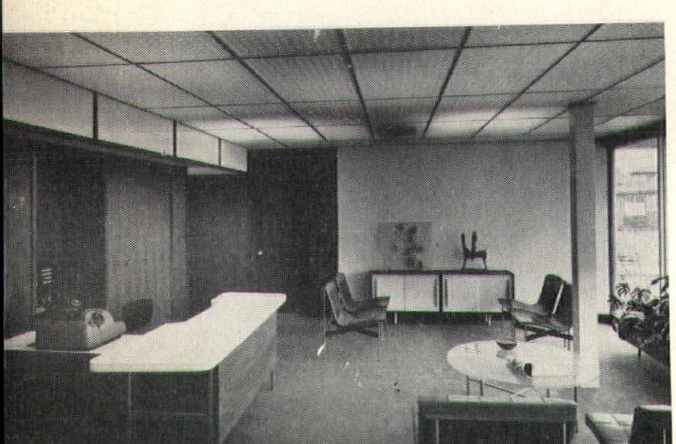
New York World's Fair structures serve as prototypes of innovations in architectural design and interior and exterior decoration that may be applied to industrial and residential building in the near future. The color versatility and economics of plastics are demonstrated in building after building. And the practical, original, imaginative ac complishments with these newest of man-made materials in virtually every style and type of structure in this vast show place emphatically demonstrate the huge potential for them in both commercial and residential building.

Throughout the plastics industry itself, many new build ing products departments like Cyanamid's Building Prod ucts Division, have sprung up in the largest chemical com panies. Smaller plastic processing organizations have ap plied the traditional ingenuity of their industry. On the other side of the picture, creative members of the building in dustry, architects, designers and dreamers bombard the plastics people with inquiries and demands in a hectic rush to be among the first to take advantage of the brave new world of plastic buildings.

Uses of acrylics for residential applications are myriad. Domed acrylic skylights provide natural lighting. Cast acrylic sheets with decorative embedments are ideal for dividers, cabinet doors. Translucent acrylics perform as weather-resistant window walls.

What are some prominent examples of plastics in build ing? Take for example, acrylics — often called the jewel of plastics because they are brilliant and virtually ageless Unlike other types of plastics, acrylics are not deteriorated by the ravages of weather and outdoor temperature ex tremes. Sunlight, which may cause other plastics to fade or discolor, has virtually no effect on acrylics. Acrylics are shatter resistant, easily formed, crystal-clear or colored Ideal for skylights, luminous ceilings or colorful dividers Acrylics are the versatile material for signs, spandre panels in colorful, curtainwall construction and building facades. Acrylic never yellows with age and vibration can' shatter it, making it ideal as a glazing material. Acrylics add luminous, non-fade color to building exteriors. Two o the prime suppliers of acrylics in the U.S. are America Cyanamid Company with their brand ACRYLITE and Rohm & Haas' PLEXIGLAS.

Other plastics are equally versatile. For instance . . . extruded vinyl handrails are now in use in enplaning and deplaning areas, around the apron and concourse, on the upper level and down to the quays: in virtually all public areas of the brand new Toronto International Airport. Variety of color is also available . . . black, gray and white.



Plastics in building are illustrated many-fold in this photo. Desk top is laminated plastic. Luminous Ceiling is dimple-patterned acrylic. Wall panels and cabinet doors are acrylic panels, also. Art slab on cabinet is cast from acrylic; has real pine bough embedded within. Round table top is inch thick acrylic also.

Keep an eye on rigid vinyl in building products. It ca be extruded, sheet formed or molded. The two largest woo window companies are now using rigid vinyl in production Latest major development is plastic coated siding bonded to plywood, hardboard or wood. Weldwood guarantees it colored siding against the need to paint for 15 years. B. F Goodrich is franchising rigid vinyl fabricators for combina tion storm windows and doors. Even molded styrene shutters are available for interior and exterior use.

In the near future, the large scale use of plastic hot and cold water pipes, gas pipes, electrical conduits, heating and ventilation ducts and windows in the home and in commer cial buildings should be observed. More "marriages" o plastics and other materials such as windows made up o extruded vinyl claddings fastened onto aluminum or stee cores, plastic envelopes enclosing decorative steel frame work shall be seen.

Greater use will be made of natural light in our home and commercial buildings. Special fully-insulated skylight in the principal living areas of the house will provide evenly filtered light to the entire room night and day. Translucen ceilings will become more practical and efficient. Translu cent sections of the wall or entire walls will be combined with translucent ceilings to obtain the desired effect.

The time will soon come when the curtain walls of larg buildings are made of plastics. Since these plastics can b readily formed, the architect will no longer be limited t flat or slightly shaped mullions between windows. His free dom of design will be greatly expanded and buildings shoul become much more beautiful.

wall in employee lounge of the Lilly Varnish Company is laid in stack bond of alternating shades of Cloud Blue and Silver Gray Colorshield wall units.

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halfstaff outside the house.

63 Bodies Taken From Rest Home

NORWALK, O. (UPI) — The last body of the 63 elderly patients who died in a fire at a rest home here has been removed from the ruins.

An investigation has been launched by Gov. James Rhodes into the cause of the tragedy. Authorities continue the grisly and difficult task of identifying the charred bodies.

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63 persons died in this tragic fire which destroyed a rest home near Norwalk, Ohio on November 23, 1963. Such a catastrophe is unnecessary because buildings can be constructed of fire safe materials that cannot burn. Particular attention must be given to roof and ceiling materials and architects who specify fire safe floor and roof systems or precast concrete columns and beams can be assured that such a tragedy will never strike.

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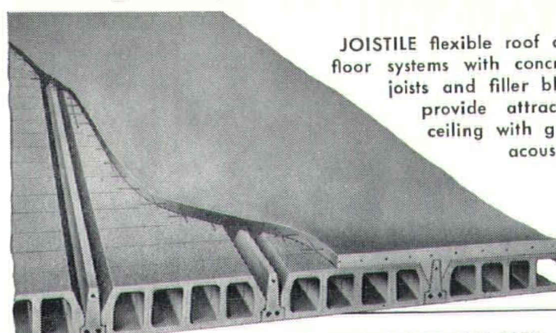
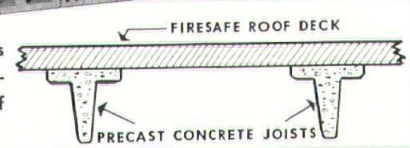
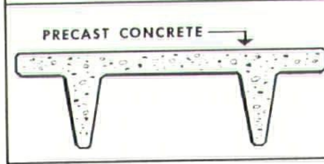


JOISTILE flexible roof and floor systems with concrete joists and filler block provide attractive ceiling with good acoustics.

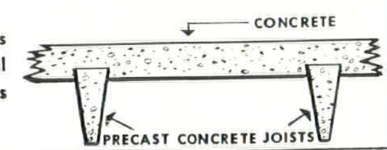
SINGLE-TEE joists span to 50' to support fire safe roof deck material.





DOUBLE-TEE slabs provide framing, deck and ceiling in one unit.

KEYSTONE joists provide economical support for spans to 36'.



Why plastics in building? First, above all other materials of construction, plastics offer true ease of maintenance. When properly used, plastic building products are truly maintenance free over the span of their useful life. The second reason for existance of plastic building products lies in the flexibility of building techniques they make possible. Many plastic products can be manufactured to closer dimensional tolerances than is possible with wood fiber or masonry. A third basis for the use of plastics in building is the lightness of weight. Only with plastics can building components or whole buldings be designed with the strength to do the job and a lightness of weight which cuts loads on soil, foundation and supports. The use of plastic foams for their structural properties as well as their insulation is still in its infancy but lightweight buildings are surely a coming development.

If plastics can provide these three basic advantages — freedom from maintenance, unlimited design flexibility and lightness of weight, what then are the obstacles to their overwhelming success in the major building markets?

First, there is cost. By and large, plastic building products are far more expensive than the established competitive materials. Plastic siding sells for 25% more than aluminum, double the price of the cheap coated-fiber boards. In residential building, a second obstacle is the consumer himself. There is something different about a building that causes the adventurous individual to suddenly become extremely cautious. This caution is manifested in two ways: a resistance to the aesthetic properties of plastic products and a demand for performance far in excess of the performance expected from more familiar materials. However, researchers in the plastics industry believe tomorrow's house may well be "shot in place." A balloon structure could be inflated on the site, sprayed with foamed plastic and then the balloon removed. Still others predict huge cast structures that will be transported by helicopter and "dropped in place." Some firms even predict that the day will come when houses are poured from barrels of on-the-spot molding chemicals.

Probably the most persistently asked question respecting plastics in building is how long they will last and what is the proof. For many plastics there are no long-time histories of use in building or of exposure to either indoor or outdoor conditions. For these, principal reliance must be placed upon an estimate of their probable performance based upon their chemical-physical nature. There are no completely reliable accelerated laboratory tests that predict accurately the long-time behaviors of materials, especially under outdoor conditions. This constitutes a major challenge to the plastics and building industries.

Another obstacle to the acceptance of plastics in buildings lies in the myriad of regulatory agencies in the U.S. The regulatory systems of the U.S. are indeed a problem for plastics but they are also a problem for any new materials or products in the building industry. Plastics need not feel discriminated against, nor need they feel discouraged. Codes and restrictions may retard their acceptance but if the product is right, the acceptance will come.

* * *

(Many articles have been written about Plastics in Building by such authorities as R. P. Conger of Congoleum-Nairn Company, Albert Dietz of M.I.T., D. S. Plumb, of Monsanto Chemical Company. Some of their thoughts have been included in this summary-type article. The author acknowledges their assistance).

Thermoplastic acrylic panels may be formed with heat and retain the shape when cool, making it possible to create custom effects such as the domed translucent wall illustrated. Decorative acrylic panels enhance cabinets and work areas.

Twin polyester canopies on elevated platforms at this new service station catch the motorists' eye. At night, concealed base lights make the translucent surfaces glow brightly.

Spiral Generation

by DR. JOHN E. JOHNSON
Plastics Development and Service
The Dow Chemical Company

In nature's affininty for spheres, man has found a continuing engineering challenge. The sphere is strong; it uses material effeciently — as in a skull, or the shell of a turtle or an egg. Architects have long noted this and profited as they designed for applications from pressure storage to deep sea research vessels.

Our forebears fashioned spheres of ice or thatch or adobe. And even with today's prevailing rectangular construction, curved shapes have provided points of departure and interest. Some examples: Frank Lloyd Wright's Round house; Buckminster Fuller's geodesic structures; Pier Luigi Nervi's many dome designs.

RESEARCH ON CURVES

Dow in its research has recognized these principles:

1. There is a need, as yet unsatisfied, for lower cost enclosures.

2. The most efficient use of materials must heed and take advantage of trends toward automation, toward prefabrication and toward ever-growing requirements for more insulation (for humans, for livestock, for food storage), against either hot or cold.

In these considerations, curved architectural shapes assume an important role.

Many architects and engineers are familiar with the company's applications research on Styrofoam extruded polystyrene foam as a form liner for thin shell construction. Forming and thermal insulation are accomplished in a single step, with resulting efficiencies.

SPIRAL GENERATION

This report concerns a new approach to structural use of foam as a free-standing form. Dow calls it "Spiral Generation"—an ingenious system which can form singly or doubly curved structures of plastic foam. The inventor is Donald R. Wright, an engineer in the company's long Range Plastic Applications Research Laboratory. Early findings of a continuing research and development program indicate significant reductions in construction time and building costs. A dome of Styrofoam 45 feet in diameter with walls four inches thick has been erected in approximately 20 man hours, exclusive of foundation work.

The Spiral Generation method involves use of a specially designed machine which bends, places and fastens pieces of plastic foam together into a pre-determined shape. A variety of shapes can be produced by modifying and "programming" the machine. In forming a dome, the machine head is mounted on a boom, which swings around a pivot like the hand of a clock, laying and sealing layer upon layer of foam board in a rising spiral.

USE OF STYROFOAM

Much of the work to date has involved use of Styrofoam extruded polystyrene foam as the structural material. This is so because Styrofoam has an unusual combination of characteristics that contribute to an automated method of enclosing space: Styrofoam is stiff, but capable of controlled deformation; it can be bonded to itself through application of heat (and other methods); it is extremely light weight; it has good structural rigidity; it has high and permanent insulating efficiency; it is easy to work; and it forms an excellent base on which to apply a variety of surface finishes. Dow is also working with other materials, including polyurethane foams.

For more than five years, Dow has directed research to the application of foam to curved shapes. Sections of hemispheres have been built by Spiral Generation varying in

diameter from only a few feet to more than 50 feet—from a fraction of an inch in thickness of foam to four inches. Most recent efforts have involved domes 80 feet in diameter with eight-inch foam wall thickness.

SHAPES AND STRUCTURES

Formation of an unlimited number of variations of spherical sections is possible, although the hemisphere is most common and most easily achieved. The joining of sections of different shapes to enclose rectangular areas is a part of the continuing research.

Developmental structures at The Dow Chemical Company's Midland, Michigan, headquarters have included industrial shelters, warehouses, offices, tank covers, and municipal waste disposal pond covers. A 45-foot diameter dome has been constructed near Ann Arbor, Michigan, as a golf course starter house.

Types of structures under research consideration include agricultural shelters, low temperature warehouses, vacation housing, athletic enclosures and disaster housing.

DOME FORMATION

The majority of reasearch structures generated by this method have been hemispherical domes, made from strips of Styrofoam FR.

Construction begins on a leveled site. A foundation necessary to support and anchor a base ring for the dome is completed prior to the generation of the dome. Specific foundation design depends upon architectural and engineering considerations.

After preparation of site and foundation, a base ring, made of angle iron preformed to the diameter of the sphere, is assembled, located on the foundation and anchored. A starter strip of Styrofoam is then attached to the base ring.

The forming machine boom is pivoted from a centrally located point of support. The structural formation begins with timed feeding of Styrofoam strips to the electrically driven forming head. The generation process is continued as successive strips of Styrofoam are thermally welded together by the traveling head to form the hemispherical dome. After the structure has been completed, the desired cut outs for windows, ducts and doors are made using templates where necessary.

The dome interior and exterior surfaces are then coated to produce the desired surface characteristics. Latex paints, epoxy resin system, or cementitous coatings can be used.

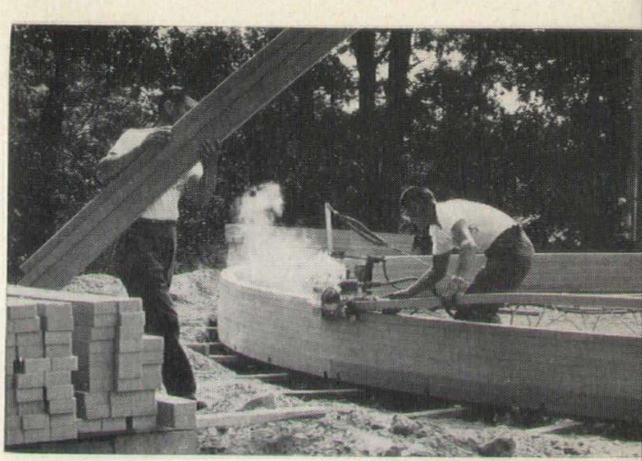
CONTINUING RESEARCH

The continuing reasearch and development program includes work in such areas as weatherproofing, fireproofing, structural reinforcement, acoustical treatment, economics and building code requirements. For example, a current project involves use of Styrofoam as the spirally generated form on which to place reinforced portland cement concrete on the outside and plaster on the inside. A variety of coatings are under study, ranging from these materials of cementitious nature to intumescent paint.

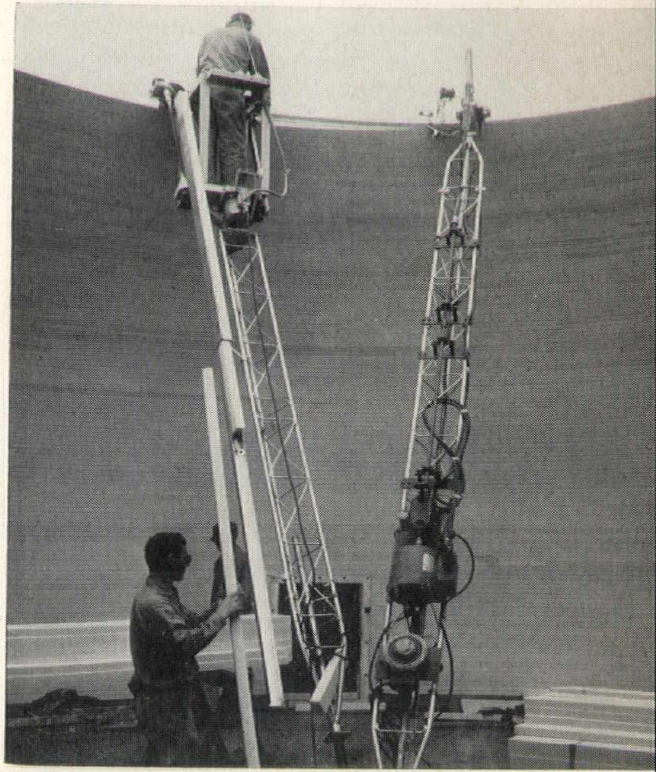
Among mechanical procedures under study are optimum methods of fenestration, entry and exit, utility mounting and protection against mechanical damage.

A factual economic analysis that may enable accurate prediction of finished building costs is a key to ultimate utility.

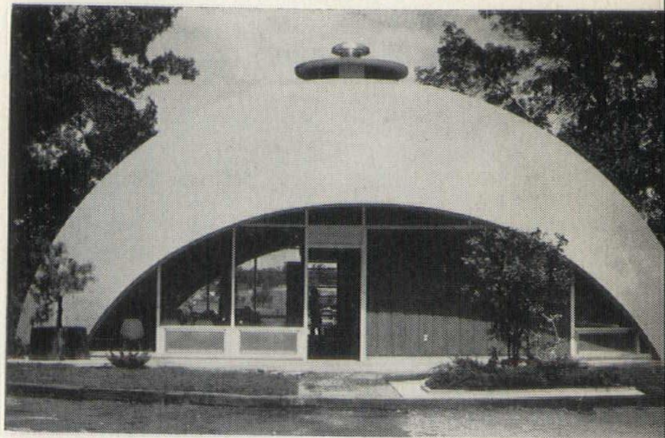
Until the discovery and its directions are more fully deveolped, Dow is pursuing a carefully controlled applications program.



Foam boards are heat sealed as a dome begins under spiral generation process under research by Dow Chemical.



As foam wall rises, boards are fed to the machine head by operator riding a second boom.



Completed 45-foot diameter dome near Ann Arbor is in use as golf starter house. Two men erected the dome, with walls four inches thick, in twelve hours.

DON E. GIBSON
Executive Director
Indiana Society of
Architects

An ISA Editorial

For many years, the great majority of practicing architects in Indiana have proclaimed the dire need for a state-supported school of architecture and planning here in the Hoosier state. The profession has maintained, and rightly so, that the absence of such a professional educational facility is one of our State's greatest cultural deficiencies and economic weaknesses.

Almost one year ago, a united profession asked that a special legislative study committee, composed of legislators, educators and practicing architects, be created to determine if such a school were feasible. The Legislative Advisory Commission of the Indiana General Assembly granted that request, and a blue ribbon committee assembled for its first meeting in December. No group could have performed its assigned task with greater skill and understanding, nor with such devotion and dedication.

Each member of this Study Committee deserves the warmest praise and staunchest support from the entire architectural profession. It is with deep pride that we salute the members of this committee:

- Representative M. Maurice Goodnight of Lafayette, the chairman
- Senator V. Dewey Annakin of Terre Haute, vice-chairman
- Robert J. Schultz, AIA, South Bend architect, secretary
- Senator Keith McCormick, Lebanon
- Senator Wilfrid J. Ullrich, Aurora
- Representative George L. Fisher, Leesburg
- Representative William T. Sebree, Anderson
- Dr. Frederick L. Hovde, president, Purdue University, Lafayette
- Dr. Raleigh W. Holmstedt, president, Indiana State College, Terre Haute
- Dr. Elvis J. Stahr, jr., president, Indiana University, Bloomington
- Dr. John R. Emens, president, Ball State College, Muncie
- Dr. George E. Danforth, AIA, director, School of Architecture, Illinois Institute of Technology, Chicago
- Dr. Frank Montana, FAIA, dean, School of Architecture, Notre Dame University, South Bend
- C. Eugene Hamilton, AIA, Muncie architect
- Raymond S. Kastendieck, FAIA, Gary architect and former treasurer of The American Institute of Architects
- James L. Walker, Jr., AIA, New Albany architect

Equally deserving of the profession's thanks are the administration and faculty of each of the four state schools, and the many civic leaders throughout the State who support this cause.

Also warranting the profession's appreciation is the announcement by Walter Scholer, Jr., that his firm, for many years the campus architects for both Purdue and Ball State, was withdrawing from consideration as architects for the new school proposed for Ball State, to eliminate any possible conflict within the profession, and suggesting that the design of the facility rightly should be the responsibility of the selected dean of the school.

The first major steps towards establishing a state College of Architecture and Planning have been taken; but they are only the first. An almost overwhelming task remains: Convincing the people of Indiana and their elected representatives in the next General Assembly that such a College is essential.

This task will require the whole-hearted support of every architect in Indiana, and even then, the chances of passage in the first attempt are only marginal.

Conceivably the findings of the study committee might not agree with the opinions of every registered architect, but these findings were made only after the most careful consideration of all relevant facts. They were not based upon personal opinions, emotion, or ignorance.

As a profession, we must honor those findings; we must support those recommendations; and we must do so with every resource at our command.

To do less than this is to put to rest forever our long-cherished dream. It's up to us.

Ball State Selected for School of Architecture

After nine months labor, the special School of Architecture Study Committee created by the Indiana Legislative Advisory Commission, late last month completed the last formal phase of its study with the announcement that Ball State Teachers' College at Muncie, Indiana, had been selected as the site for the proposed College of Architecture and Planning.

The decision as to location actually was made by a six man special sub-committee on site, appointed by the main Study Committee and specifically charged by the Committee to study carefully the facilities at each of the four state-supported centers of higher education (Indiana State Teachers' College, Indiana University, Purdue University and Ball State)) and in the City of Indianapolis, and to report back to the main Committee with one selection.

Since the presidents of each of the four state colleges and universities are members of the main Study Committee, along with three Representatives and three Senators of the Indiana General Assembly, four architects and two architectural educators, it was decided that the important question of location should be made on the most impartial basis possible. The sub-committee created was composed of the two architectural educators, Mr. George Danforth, Director of the School of Architecture, Illinois Institute of Technology, Chicago, and Dean Frank Montana, FAIA, Dean of the School of Architecture, Notre Dame University, South Bend; two practicing architects, Mr. Robert Schultz of South Bend and Mr. C. Eugene Hamilton of Muncie; and two legislators, Senator Wilfred J. Ullrich, and Aurora pharmacist, and Representative M. Maurice Goodnight, a Lafayette pharmacist and chairman of the main Study Committee.

Prior to the sub-committee's investigation, the main Study Committee voted to accept and endorse the findings of the site sub-committee. This position was endorsed also by the Indiana Society of Architects and the Northern Indiana Chapter, AIA, representing the state's architectural profession.

Actual site visitations were made to each of the five localities seeking the architectural school, and all members of the sub-committee were present at each visitation. One full day was spent at each site, during the month of June and the first day of July.

Presentations were made by each facility visited, following the same pattern: A formal presentation by the administration and faculty of the college or university, followed by a tour of the existing campus, and concluded by a question and answer period. In Indianapolis, the presentation was made by local area architects working with Indianapolis Chamber of Commerce and civic leaders.

A twenty-point rating sheet was used in comparing the five possible sites. This grading sheet, prepared by the professional members of the sub-committee with the advice and assistance of the Indiana Society and the American Institute of Architects, covered such items as existing augmenting courses (in engineering, the sciences and humanities and fine arts), the quality and potential of the existing facility, the attractiveness of the site to future architectural students and staff, area cultural opportunities, freedom of educational philosophy available, existing library facilities, administrative interest, size and orientation of actual physical site for the architectural school itself, the character of the campus, civic relationships, and the other important consideration which must go into such a decision.

Each member of the sub-committee individually graded each of the five facilities, and on the evening of July 16th, the four professional members of the sub-committee met to make the final determination.

Following the addition of each individual's scores, the four committee members then went through the grading sheet, agreeing on a score on each point for each of the facilities. In this manner, unanimous agreement was achieved on the exact rating to be given each facility on each point.

On the basis of this evaluation, also, Ball State received the highest vote, and accordingly was selected as the proper site by all the professional members of the sub-committee.

The following morning, July 17th, the four professional members of the committee met with the two legislative members, who had declined to vote except in the case of a tie, since they believed that the location was a matter to be determined solely by those active in the profession.

Other decisions reached by the Study Committee inclued:

1. A state-supported School of Architecture and Planning in Indiana is needed and the establishment of such a school is feasible.

2. The school should provide for a total enrollment in the five-year curriculum of approximately 200 students, maintaining a student-to-faculty ratio of approximately 15 to 1.

3. A new physical plant would have to be created for the school, containing approximately 40,000 square feet and costing approximately $1,000,000.00 to construct and an additional $100,000.00 to furnish and equip.

4. A new architectural library would have to be collected, at an initial cost of approximately $25,000.00.

5. The annual operating budget of the school, once it is in complete operation, would be $300,000.00.

6. The school would be established in stages. In the first year, the dean of the school and one secretary would be selected and employed, requiring a budget of $30,000.00. This first year would be spent in creating the curriculum of the school and planning the program. The second year, two additional faculty members would be recruited, increasing the budget to $40,000, and the first approach would be made to prospective students and faculty. During this year, the physical plant itself would be constructed.

The first students would be enrolled in the third year of operation, at which time the physical plant and library should be ready. Each year therafter a new class would be added until all five class years were in operation and the faculty complete, at which time maximum budget requirements would be realized.

7. Accreditation of the school could not be obtained until the full five-year curriculum were in operation.

It is anticipated the Ball State officials will petition the next Indiana General Assembly for university status, and that the name of the facility will be changed to Ball State University.

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Architecture in the News

In a special membership meeting held August 7th, the members of the Indiana Society of Architects approved new bylaws and new name for the present I.S.A. Chapter, and new bylaws and name for a new state association.

The present I.S.A. Chapter will become, on January 1, 1965, the Central-Southern Indiana Chapter of The American Institute of Architects, and will be one of two Chapters (with the Northern Indiana Chapter of the American Institute of Architects) in a new state association to be known as the Indiana Society of Architects.

The new structure will permit stronger representation of the profession on those matters affecting the practice of architecture in Indiana—particularly in the fields of legislative and governmental representation, public relations, relations with the construction industry, and education and registration. These duties will be the main responsibility of the state association, while other professional matters will be handled by the individual chapters.

Officers and directors of the new association will be elected at the first annual meeting scheduled for October 23, 24 and 25 at French Lick, in conjunction with the present I.S.A. Chapter convention.

The program of the convention will concentrate on the proposed state-supported College of Architecture and Planning at Ball State, and the technical portion of the convention will feature a Specification Workshop, put on by members of the Indianapolis Chapter, Construction Specification Institute.

Also at the August 7th meeting, Walter Scholer, Jr., of Lafayette, immediate past president of the Indiana Society

WEBER SCHOLER PORTEOUS

and newly-installed Regional AIA Director from the East Central Region, was honored by the I.S.A. Board of Directors for his services during his term as president. Former President Wayne M. Weber and current President Alfred J. Porteous presented Director Scholer with a plaque expressing the board's appreciation of his services.

* * *

The Fourth Governor's Conference on Aging will be held at Purdue University beginning at 8 P.M. Sunday, September 27th and closing with a luncheon, September 29th. A number of nationally known speakers as well as state leaders in the field of aging will appear on the program. Rather than deal with some one concern, practically all of the major concerns of the Commission will be touched on by the speakers. The Program Committee has chosen as a Conference theme, NEW HORIZONS IN THE FIELD OF AGING, and the speakers have been selected with a view to acquainting our conference guests with new programs in the field of aging and the development of new concepts concerning aging.

Registrations will be in the Memorial Center, Purdue University, beginning at 5:30 P.M. September 27th and at 8 A.M., September 29th.

INDIANA ARCHITECT consulting artist Bob Willis, of Design Associates, Indianapolis, gathered four of nineteen awards in the recent Sixth Annual Exhibition of Advertising and Editorial Art and Design, sponsored by the Art Directors Club of Indiana. Some 350 entries were submitted in the annual competition.

Two of his awards, both Merit Awards, were for covers of the INDIANA ARCHITECT, the April "Prayer Rug" presentation and the March interpretation of the "Dynamic Clear Span", the aluminum dome concept which won the Reynolds Student Award for Notre Dame architectural student John Torti.

Ninety-four entries were chosen for exhibition at the John Herron Art Museum during the month of June; judging was by a jury of well-known American art directors. The awards are given to recognize outstanding graphic design and to promote better advertising art in Indiana.

In the photo above, artist Willis (left) receives one of the Merit Awards from the Art Directors Club president at the Awards Banquet held in June.

This month's cover presentation is an artistic salute to plastics in construction, specially created by artist Willis.

* * *

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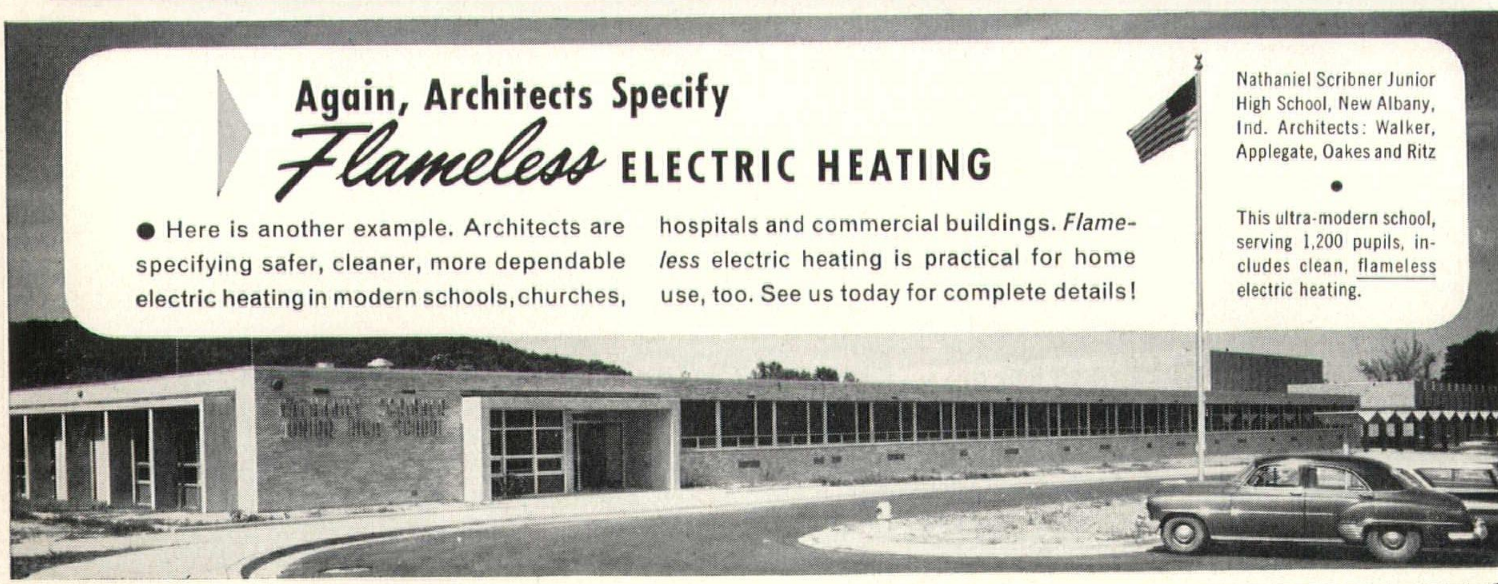

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Plastics as a Material of Construction

by R. E. GACKENBACK
American Cyanimid Company

As a material of construction, plastics are assuming greater importance in the process industries. Plastics are resistant to a large variety of chemicals and, thus, play an important role in reducing construction, maintenance and corrosion costs. Plastics are fabricated by many methods into many useful shapes and forms, and this industry has grown in volume and in variety of materials. Each generic class of plastic has certain superior characteristics which make it ideal for many applications. The main criteria for selection of a plastic is chemical resistance to the proposed environment, suitable mechanical properties for the vessel or structure, and low economic cost. Light weight, ease of repairs, and minimum maintenance are also important. By the same token, it must be recognized that plastics have some shortcomings which must be taken into consideration. They have poor resistance to solvents and heat, a high coefficient of thermal expansion, and low tensile strengths. Exposure to sunlight and weathering has a tendency to age certain of these materials.

PHENOLIC PLASTICS

The first synthetic polymeric materials were introduced to industry in 1901 when Dr. L. H. Baekeland discovered that useful resins could be produced by reacting phenol and formaldehyde at elevated temperatures in the presence of an alkali. Phenolformaldehyde resins are cured with an acid catalyst which converts the liquid resin to an infusible and highly cross-linked thermosetting plastic. The basic properties can be improved by the addition of reinforcing agents and fillers such as asbestos, carbon, graphite, wood flour, cellulose, mica, paper, silica, cotton cloth, and glass fiber. The phenolics are naturally dark brown in color and darken further on aging; they have limited colorability. These materials come in a variety of forms and can be specifically compounded for casting, molding, or laminating.

For the process industries, the basic resin, filler, and catalyst are carefully mixed, molded into shape, and cured under heat and pressure or by heat alone. Items used in quantity are produced by the compression and transfer molding techniques, while most process vessels are produced in one piece through the use of light weight and inexpensive open molds. Large and complicated vessels are readily molded in sections that are later joined either by flanging and bolting or by cementing to make a complete unit. On the largest pieces of equipment, external reinforcement is required for structural strength.

The physical and mechanical properties of the phenolic plastics are little affected by the type and amount of filler or reinforcing agent. In the chemical industry most phenolic plastics are reinforced with asbestos or glass. A typical specific gravity for an asbestos-reinforced phenolic, for example, is 1.7 which is between that of wood and aluminum. This plastic shrinks 0.5% during curing, dimensional stability is excellent, and thermal expansion is low. The phenolics are non-conductors of heat and electric current. An outstanding property is their resistance to heat. In chemical applications, maximum service temperature is 300°F for continuous operation and 350°F for intermittent operation; around 375°F, the chemical grades begin to decompose but do not support combustion.

Phenolics are strong and light; the tensile strength ranges from 5,000 to 7,000 lb./sq. in. and the compressive strength from 11,000 to 13,000 lb./sq. in. The hardness, Rockwell R 110, is among the highest found in any plastic. The material is known for its rigidity and toughness; it resists blows and shocks reasonably well. It is unaffected by thermal shock and suffers no damage from rapid temperautre changes. The abrasion resistance is good; wear will occur only at high velocities or in the presence of slurries.

The range of chemical resistance of this plastic is broad. Fresh and sea water have no harmful effects and the rate of water absorption is low. Outdoor exposure in all kinds of atmospheric environments does not alter the inherent chemical resistance; weathering, sunlight and ultra-violet rays have no apparent effect. The non-oxidizing mineral acids and their salts are easily contained and handled. The resistance to hot concentrated hydrochloric acid and to 60 to 90% sulfuric acid at moderate temperatures is outstanding. The resistance to strong oxidizers is poor; however, dilute nitric acid and wet chlorine gas can be processed. Mild alkalies and alkaline salts have no harmful effects, but strong sodium and potassium hydroxide cause rapid deterioration. The resistance to organic chemicals is good. Reinforced phenolics are satisfactory for chlorinated aliphatic hydrocarbons and for most chlorinated aromatic hydrocarbons. The strong aromatic solvents have a solvation effect, whereas the common aliphatics, alcohols, oils, and greases have no effect. Most organic acids and detergents have little or no effect.

Relative low cost, excellent chemical resistance, good balance of mechanical properties, and ease of fabrication make the phenolics a useful plastic for the process industries. Available equipment includes ducts, stacks, tanks, towers, jets, condensers, heat exchangers, agitators, pumps, valves, piping and fittings. When properly designed, fabricated, and used in accordance with manufacturers' directions, reinforced phenolic plastics have performed excellently for over 20 years with a minimum of maintenance.

FURANE PLASTICS

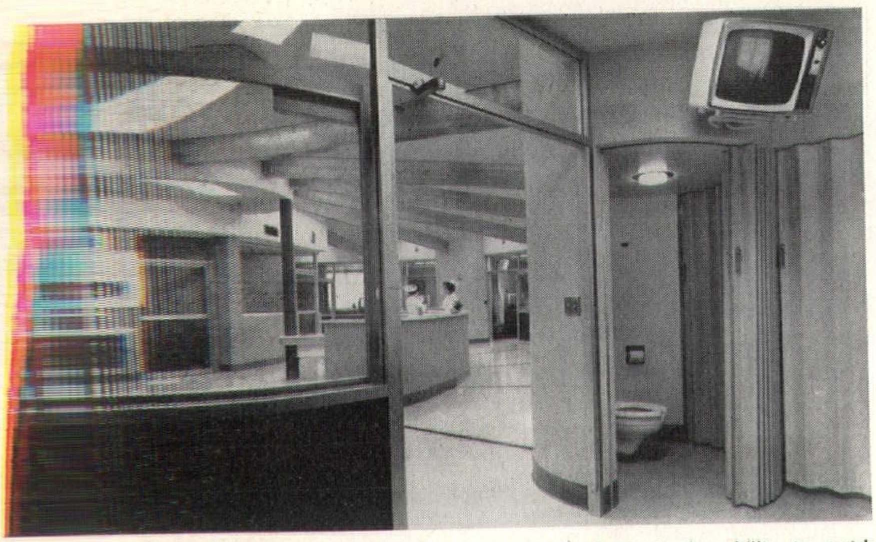
Although the phenolic plastics have been widely accepted in the chemical process field, they are somewhat limited in their applications because of poor alkali resistance. Fortunately, the furane plastics possess good alkali resistance and can be used in these environments. For improved properties, this plastic is generally reinforced with asbestos, carbon, wood flour, mica, paper, silica, cotton cloth or glass fiber. The furanes are black to dark brown in color and possess limited colorability. The furanes can be fabricated by the same techniques used for the phenolics. The furane plastics can be laminated, cast, or molded into a variety of structures for employment in chemical processing.

The specific growth of asbestos-reinforced furane plastics is about 1.7 which is 1/5 that of steel. The rate of thermal expansion is low and the dimensional stability is excellent. The thermal and electrical conductivity values are low and the furanes are excellent thermal and electrical insulators. The upper temperature limit of this self-extinguishing plastic in continuous operation is 250°F.; in intermittent service, the limit is 300°F.

The cured plastic has good rigidity and strength; tensile values vary from 4,000 to 6,000 lb./sq. in. and compressive strength from 11,000 to 13,000 lb./sq. in. The hardness is Rockwell R 110, which is relatively high for plastics. The impact strength is low, but the reinforced material is tough and resists moderate blows and shocks; for added strength, external reinforcement may be used. The resistance to abrasion is good.

The chemical resistance of the furanes is equal to that of the phenolics in outdoor serviceability, water exposure and acid media but is superior to that of the phenolics in alkaline media and solvents.

Furane plastics are very versatile; however, they are more expensive than the phenolic materials. Therefore, the



A unique property of plastic is the ability to match perfectly the surfaces of different structural materials. Here, in a view of a hospital pediatric pavilion (looking from a patient room), Moderncote wallcoverings and Modernfold folding doors (New Castle Products, Inc., New Castle), a continuity is achieved that enhances the plush, finished effect desired. Another unusual installation of Moderncote: background for Michelangelo's famed "Pieta", on exhibit in the Vatican Pavilion of the New York World's Fair.

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furanes find service only in those applications where their greater resistance to alkalies and solvents is required. The process industries utilize valves, pumps, piping, fittings, ducts, agitators, tanks and towers made from this material.

POLYESTER PLASTICS

The term polyester represents a large family of resins which are cured with selected catalysts to form a hard, brittle, thermosetting plastic. When the polyester resin is compounded with suitable reinforcing materials, a tough plastic is produced. Glass fibers in the form of mat, cloth, rovings, and rope are the most generally used reinforcing agents; for special application, organic fibers and asbestos find occasional service.

Polyester plastic structures for the process industries are made by hand laminating, either over mandrels or in molds. Multiple layers of glass fiber are impregnated with mixed polyester resin, laminated to shape, and cured at room or elevated temperatures with little or no external pressure. A proper laminate is of uniform thickness, dense, and free of voids, cracks, crazing, and dry spots; delamination seldom occurs. The surfaces in contact with the corrosive media are smooth and have no exposed glass; the other surfaces are reasonably smooth and free of exposed glass. The structure under fabrication can be made in one piece or in sections. The sections can be field or shop joined by flanging or by cementing with polyester resin and glass mat.

Polyester glass laminates are characterized by their light weight which is ⅓ to ¼ that of carbon steel. The specific gravity ranges from 1.3 to 2.1 and depends on the amount and form of the reinforcement. Dimensional stability is good; cold flow is non-existent. The thermal conductivity is very low and the dielectric characteristics are good. Most polyesters are combustible; the rate of burning is directly proportional to the styrene content. Certain grades can be made self-extinguishing and some fire retardant grades are available.

Reinforced polyester laminates are stronger than wood and approach the strength of soft carbon steel. For a plastic, the tensile strength is high and ranges between 13,000 to 15,000 lb./sq. in.; this makes the weight to strength ratio very high. The flexural strength is around 26,000 lb./sq. in. Upon immersion in water or chemical media, the glass-plastic laminate shows some loss of tensile and flexural strength in a relatively short time. After the initial drop, the strengths remain quite constant on continued exposure. The material is tough and possesses high impact resistance; it withstands mechanical shocks and blows exceedingly well. It is unaffected by thermal shock or sustained temperatures up to 225°F and intermittent temperatures up to 275°F. The rate of water absorption is low and resistance to vapor transmission is excellent.

Polyesters possess good aging and weathering characteristics; continuous outdoor exposure for over 10 years does not have any adverse effects. Fresh, brackish, and sea water also have no effect. The resistance to concentrated and dilute non-oxidizing mineral acids is excellent at room temperature. At elevated temperatures, the resistance falls off and only moderate and dilute concentrations can be handled. The resin is unaffected by hydrofluoric acid and fluorine compounds, but the glass reinforcing is rapidly attacked by these media; therefore, organic fibers are substituted for the glass in these environments. The polyesters are more resistant to dilute chromic acid, dilute nitric acid, sodium hypochlorite, and other oxidizing media than either the phenolics or furanes. Concentrated sulfuric acid, concentrated nitric acid, chlorine, and hydrogen peroxide cause degradation, especially at elevated temperatures. Salt solutions containing carbonates, chlorides, cyanates, nitrates, phosphates, and sulfates have no harmful effects. The alkaline resistance is fair, and only dilute solutions can be tolerated. This plastic is suitable for use with many organic chemicals; those with a strong solvent tendency cause some degradation. The performance in aliphatic solvents, straight chain paraffins, alcohols, formaldehyde, and refinery crudes is good. Certain aromatics are safely handled at room temperature, but at elevated conditions, the solvent action is excessive. Chlorinated hydrocarbons cause softening and degradation.

The most widely accepted use of reinforced polyesters is in the form of ducts, hoods, and duct systems for handling corrosive vapors, and for this purpose, polyester fans and blowers are available. Piping, fittings, and troughs are readily available. Circular tanks having a diameter of 15 ft. and a height of 20 ft. are in common usage, and rectangular tanks can be built in almost any size. The method of fabrication is quite versatile and the variety of shapes is almost limitless. The smooth surfaces can be readily cleaned and do not cause contamination of the product. Unpigmented resin is translucent; therefore, liquid levels can be determined with the aid of minimum lighting, and sight glasses and liquid level gauges are not required.

EPOXY PLASTICS

Epoxy plastics are the newest thermosetting plastic to be used by the process industries. Epoxy resins are cured with the aid of selected catalysts. Usually glass fiber reinforcement is used to strengthen the plastic and to provide flexibility.

In most respects, the fabricating techniques used for polyester plastics are also applicable for the epoxy plastics. Hand laminating is commonly employed for making chemical processing equipment whereas machine laminating is used to produce sheet and piping.

Glass-reinforced laminates possess light weight; they are ⅓ to ¼ as heavy as steel. The specific gravity depends on the reinforcement and ranges from 1.3 to 2.1. Dimensional stability is excellent and cold flow is absent. The coefficient of thermal expansion and specific heat are low and the resistance to thermal shock is excellent. Epoxies have excellent electrical insulating characteristics and can be used to eliminate stray currents. The service temperature is 250°F for continuous usage and 300°F for intermittent applications. Some special resins are available for service in the 300 to 400°F temperature range.

The reinforced thermosetting epoxies possess the highest tensile strength of any reinforced plastic. Laminates with a tensile value of 17,000 lb./sq. in., a compressive strength of 28,000 lb./sq. in. and a Rockwell M hardness of 95 are quite common. The excellent chemical resistance of these materials assures adequate retention of these properties when in contact with corrosive media; with increases in temperature, there is some loss of strength. Because of the reinforcing materials, the laminate combines toughness, high impact resistance and excellent mechanical shock. The plastic is durable and abrasion resistant.

Epoxies possess outstanding chemical resistance. They are equal to the polyesters in acid resistance, slightly inferior in solvent and organic chemical resistance and superior in alkaline resistance.

Reinforced epoxies are supplied to industry as tanks, towers, hoods, ducts, stacks, and piping. Casting resins are used for potting and encapsulating electrical and electronic equipment. Filled resins are formulated for patching and repairing metal and plastic equipment. This thermosetting plastic is more expensive than the polyesters, and its high cost puts a definite limit on its uses.

ABS PLASTICS

The ABS plastics are compounds or blends containing acrylonitrile, butadiene, and styrene in varying amounts. The ABS plastics combine the rigidity of plastics with the toughness of elastomers. They are available as compounds for molding, extruding, and calendering.

An outstanding property of this plastic is its lightness which is roughly 1/7 that of steel; its specific gravity is 1.07. Dimensional stability is excellent and thermal expansion is low. This plastic is considered a non-conductor of heat and electricity. The upper temperature limit for continuous service is 160°F, although intermittent service at 180°F is feasible for short periods of time. This material is odorless, tasteless, and non-toxic; it is classed as a combustible plastic.

These blends are strong, rigid, and tough; the tensile strength is 4,000 to 6,000 lb./sq. in., the compressive strength is 6,000 to 7,000 lb./sq. in., the elongation is 26 to 30%, and the Rockwell R hardness is 90 to 100. The strength, hardness and rigidity decrease as the operating temperature increases. The notched impact strength at room temperature is 4 to 6 ft.-lb./in. and most of this is retained at low temperatures. The resistance to abrasion is good.

Acrylonitrile - butadiene - styrene blends resemble hard rubber in chemical resistance. Ozone, sunlight, and outdoor exposures induce some degradation; thus, the material has limited outdoor durability. Rain, moisture, and water have no harmful effect, and the rate of water absorption is very low. Non-oxidizing mineral acids, alkalies, and their salts are readily handled. Oxidizing media cause degradation and deterioration; only the mild dilute solutions of these media can be considered harmless. The greatest weakness of this plastic is its poor resistance to organic chemicals and solvents; common solvents like gasoline, turpentine, and cleaning fluids cause swelling and softening.

Most ABS plastic is extruded into pipe or molded into fittings which are joined by solvent welding or threading. Sheet stock can be fabricated into many different shapes. The sheets are readily formed by heating above the softening point and shaping over suitable molds. The sections are joined by solvent welding or cementing; heat welding is not applicable. The process industries utilize tanks, fume hoods, ducts, covers, bins, troughs, and other equipment made from this plastic.

POLYETHYLENE

Polyethylene was introduced in 1942. Many types are available and for convenience the ASTM has classified them into three groups based on density: Type I or low density, Type II or medium density, and Type III or high density. All types have a characteristic wax feel. This surface phenomena enhances the cleanability and provides a low coefficient of friction.

The usual fabricating methods such as injection molding, compression molding, extruding, and drawing are applicable. Thin films may be joined by cementing, or by heat sealing. With the development of hot gas welding, hot air is used to fuse a polyethylene filler rod to the parent material; penetration is very limited, but the joint efficiency is about 90%. This plastic can be easily sawed, drilled, tapped, threaded and machined by simple woodworking techniques.

The polyethylenes are among the lightest of all commercial plastics. With a specific gravity of 0.92 to 0.96, the material is about ⅛ as heavy as steel; it will float on water. The rates of water absorption and moisture permeability are low. Thermal expansion is high and thermal conductivity is low. The temperature limitation of low density polyethylene is 130°F for continuous service and 170°F for intermittent usage. Increasing the density of the base plastic will increase the tolerance to heat and decrease the permeability to gases and vapors; thus, high density material may be continuously used at 220°F and intermittently at 250°F. Polyethylene is a nonconductor of electricity and has excellent dielectric properties. The material is odorless, tasteless, non-toxic, and resistant to bacterial growth. It has a tendency to burn slowly.

The tensile strength of the high density grade is about 4000 lb./sq. in. and compression strength is poor. The plastic lacks rigidity and deforms very easily; it is susceptible to creep or growth. It is very tough and flexible over a wide temperature range; flexibility decreases as the thickness of section increases. Polyethylene has excellent impact strength and is very resistant to breakage. The surface is sufficiently hard, Rockwell R 45, to withstand normal handling, but it has poor resistance to abrasion and cutting. Regular polyethylene has a tendency to fail in service from stress cracking which is caused by a combination of excessive stresses and an active chemical media; however, this phenomena is completely eliminated in the high density type.

All types of polyethylene have about the same degree of weatherability and chemical resistance. They are well-known for their zero moisture absorption; thus, they can be extensively used to handle and transport all types of process water and sea water. Because of the susceptibiliity to embrittlement by untraviolet light, all types must be compounded with carbon black for outdoor exposures. Hot and cold non-oxidizing mineral acids and alkalies do not damage the inherent inertness of these plastics. Cold nitric acid in dilute concentrations has no visible effect, but hot concentrated acid does impair the tensile strength and elongation. Chromic acid and sodium hypochlorite, which are damaging to most other plastics, are not harmful to the polyethylenes. Carbonate, chloride, dichromate, fluoride, nitrate, phosphate, sulfate, and sulfide solutions are easily handled and processed. Compared to other thermoplastics this group of materials has unusual insolubility and inertness to solvents and other organic chemicals. Acetic acid, when cold and dilute, is safely contained, but at elevated temperatures, the plastic becomes permeable to this chemical. Most organic acids and their salts are harmless. The only common solvents that have any effect at room temperatures are the chlorinated hydrocarbons, the ketones, the aromatics, and some aliphatics. These solvents tend to soften but do not dissolve the plastic at ambient temperatures; dissolution may occur at elevated temperatures.

Polyethylene is a familiar material of construction. The largest quantity of polyethylene is extruded into pipe and tubing; tubing is available in long coil lengths and requires few fittings. The joints are made quickly and easily with insert fittings and clamps. When buried, its flexibility allows snaking and following of the trench contours; above ground, it needs almost continuous support. This pipe has been widely employed to convey potable water, process water, mine waters, chemical sewage, and corrosive solutions. As a film, this plastic is used as drum liners, bags, and moisture seals. The rigid plastic can be fabricated into containers, duct systems, liners, fans, valves and assorted shapes. Some small storage vessels and tanks have been built and placed in chemical service.

POLYVINYL CHLORIDE PLASTICS

Rigid polyvinyl chloride can be extruded, calendered, laminated, compression molded, and injection molded. This rigid thermoplastic can be machined, sawed, drilled, tapped, threaded, and milled on conventional metal and woodworking equipment. It can be joined by bolting, screwing, cementing, and hot gas welding. There are two types of rigid polyvinyl chloide (PVC): Type I has normal impact resistance and higher chemical resistance; Type II has high impact resistance and somewhat lower chemical resistance. Type I is also known as unplasticized polyvinyl chloride or UPVC. For identification purposes, Type I is dark gray in color and Type II is light gray.

This thermoplastic has a specific gravity of 1.4 which is roughly 1/5 that of carbon steel. The rate of thermal expansion is high while the rate of thermal conductivity is low. A serious disadvantage of PVC is its low temperature limit. In continuous service, it can be used up to 150°F; for intermittent service, the limit is 170°F. A new member of this family, polyvinyl dichloride (PVDC) has a continous service temperature limit of 180°F. Because of chlorine in the molecule, the plastic is self-extinguishing. The dielectric properties are excellent and rigid PVC is a non-conductor of elecricity. The rate of water absorption is low and permeability to gases is nil. Dimensional stability is good. This material is odorless, tasteless and non-toxic; it does not impart color to or contaminate the solutions being handled or processed. It is unaffected by bacterial growth.

Type I plastic is tough with high inherent strength. The tensile strength of this material is around 8,000 lb./sq. in; the compressive strength is 10,000 lb./sq. in., and the flexural strength is 16,000 lb./sq. in. These properties decrease with an increase in temperature. Under continuous loads, the plastic undergoes considerable creep; fabricated structures and pipe require external support. The impact resistance is rather low and severe blows and mechanical abuse may cause failure. The addition of modifying agents to pure resin results in Type II PVC. The resistance to impact is greatly increased; however, it is accompanied by an increase in the coefficient of thermal expansion and a decrease in strength. Both types have excellent resistance to wear and abrasion.

Type I, UPVC, has the best resistance to ultraviolet rays and atmospheric conditions; the weathering characteristics are excellent. Equipment and piping exposed to climatic conditions for over 10 years have not shown any signs of degradation. When buried, the plastic is unaffected by corrosive soils. Fresh, brackish, or sea water has no effect. This plastic has outstanding resistance to acids including nitric, chromic, phosphoric, hydrocloric, and hydrofluoric. Most UPVC is resistant to 70% sulfuric acid but the product of only a few fabricators or converters is resistant to 93% sulfuric acid. Oleum is definitely deleterious and results in rapid deterioration of the plastic. The resistance to chlorine gas and oxidizing agents such as sodium hypochlorite and hydrogen peroxide is good. Rigid vinyl is resistant to inorganic alkalies in all concentrations. It is unaffected by all common salts; complex salts including organic compounds may have a minor effect on the plastic. Mineral oils, vegetable oils, animal oils, and greases are harmless at room and elevated temperatures. Cold fatty acids have little effect; hot fatty acids promote softening. The organic acids cause some degradation and loss of properties; this thermoplastic is not recommended for handling glacial acetic acid. The aliphatic hydrocarbons and alcohols do not affect the plastics; however, the aromatics, ketones, esters, ethers, and chlorinated hydrocarbons cause softening, swelling and dissolution. The chemical resistance of Type II polyvinyl chloride is inferior to that of Type I and closely resembles that of the ABS plastics.

The greatest use of PVC has been in pipe, fittings, and valves. Sheets have been formed into ductwork, fume hoods, stacks, vents, and fans. Small unsupported tanks can be fabricated from sheet while larger tanks are made of steel and lined with rigid sheet. Since UPVC is easily shaped and joined, it is quite practical to make field installations and to alter and modify existing installations.

POLYVINYLIDENE CHLORIDE PLASTIC

Polyvinylidene chloride or Saran, since its introduction in 1938, has become a widely accepted and well-known plastic. It is a thermoplastic which closely resembles UPVC in its properties and methods of fabrication.

Saran's excellent chemical resistance is well-known and is comparable to that of PVC. This copolymer has been extensively used in the maufacture of pipe and tubing. Its many applications led to the development of Saran-lined steel pipe and fittings where the chemical resistance of the plastic is combined with the strength of steel. This combination permits the use of this plastic at temperatures up to 200 °F and pressures 350 lb./sq. in. Field fabrication is easily and quickly accomplished with the aid of conventional pipe equipment. Saran pipe by itself is weak and needs either many points of support or continuous support whereas Saran-lined steel requires the same number of hangers as does steel pipe of the same loading.

FLUOROCARBON PLASTICS

Fluorocarbon plastic are basically composed of carbon and fluorine. Several types are available: polytetrafluoroethylene, or TFE, polychlorotrifluoroethylene, or CFE, and vinylidene fluoride. They are colorless-to-light-colored materials which possess a waxy feel. CFE and vinylidene fluoride powders are readily molded on standard compression, injection, transfer, and extrusion equipment. TFE powders are molded and extruded by techniques similar to those used in powder metallurgy. All are easily machined, drilled, tapped, threaded, punched, and stamped. None of these materials can be heat welded and bonding of these materials to themselves is only done with great difficulty. The bonding of fluorocarbons to other materials is accomplished by mechanical means and by the use of catalyzed phenolic and epoxy adhesives. The techniques are difficult to master and specialized applicators are normally required.

These types of fluorocarbons are similar in many respects. The specific gravities average 2.1 which is roughly ¼ that of carbon steel and ¾ that of aluminum. All are nonconductors of electricity and heat. The rates of thermal expansion are similar to those of polyvinyl chloride but less than that of polyethylene. The rate of water absorption is nearly zero and the permeability to gases and liquids is very low. The coefficients of friction are very low and these plastics are known for their anti-stick and non-wetting properties. The fluorocarbons are non-flammable and heat stable. CFE and vinylidene fluoride can be used over a wide temperature range, extending from below —300°F to above 300°F, without decomposition, while TFE can be used at temperatures as low as—450°F and as high as 450°F in continuous service and 500°F in intermittent service. The fluorocarbons are oderless, tasteless, non-toxic, and do not cause contamination.

TFE has a tensile strenght of 1,000 to 3,000 lb./sq. in., a compressive strength of 600 lb./sq. in. and does not break during flexural testing. CFE has a tensile strenght of 5,000 to 6,000 lb./sq. in., a compressive strenght of 2,000 to 3,000 lb./sq. in., and flexural strength of 8,000 lb./sq. in. Vinylidene fluoride has a tensile strength of 7,000 lb./sq. in., and compressive strength of 10,000 lb./sq. in. The impact strengths are nearly identical. All these fluorocarbons are relatively flexible, elastic, and tough; the resistance to shock, wear, and abrasion is excellent.

Of all plastics, the fluorocarbons possess the greatest degree of inertness. They are unaffected by ozone, ultraviolent light, and weathering. The oxidizing and nonoxidizing acids and their salts have no effect; these plastics are even inert to aqua regia and strong sulfuric and nitric acids. The resistance to alkalies, including fused caustic, is outstanding; however, the molten alkali metals do attack these materials at elevated temperatures. Organic chemicals and solvents produce no lasting deleterious effects. Some of


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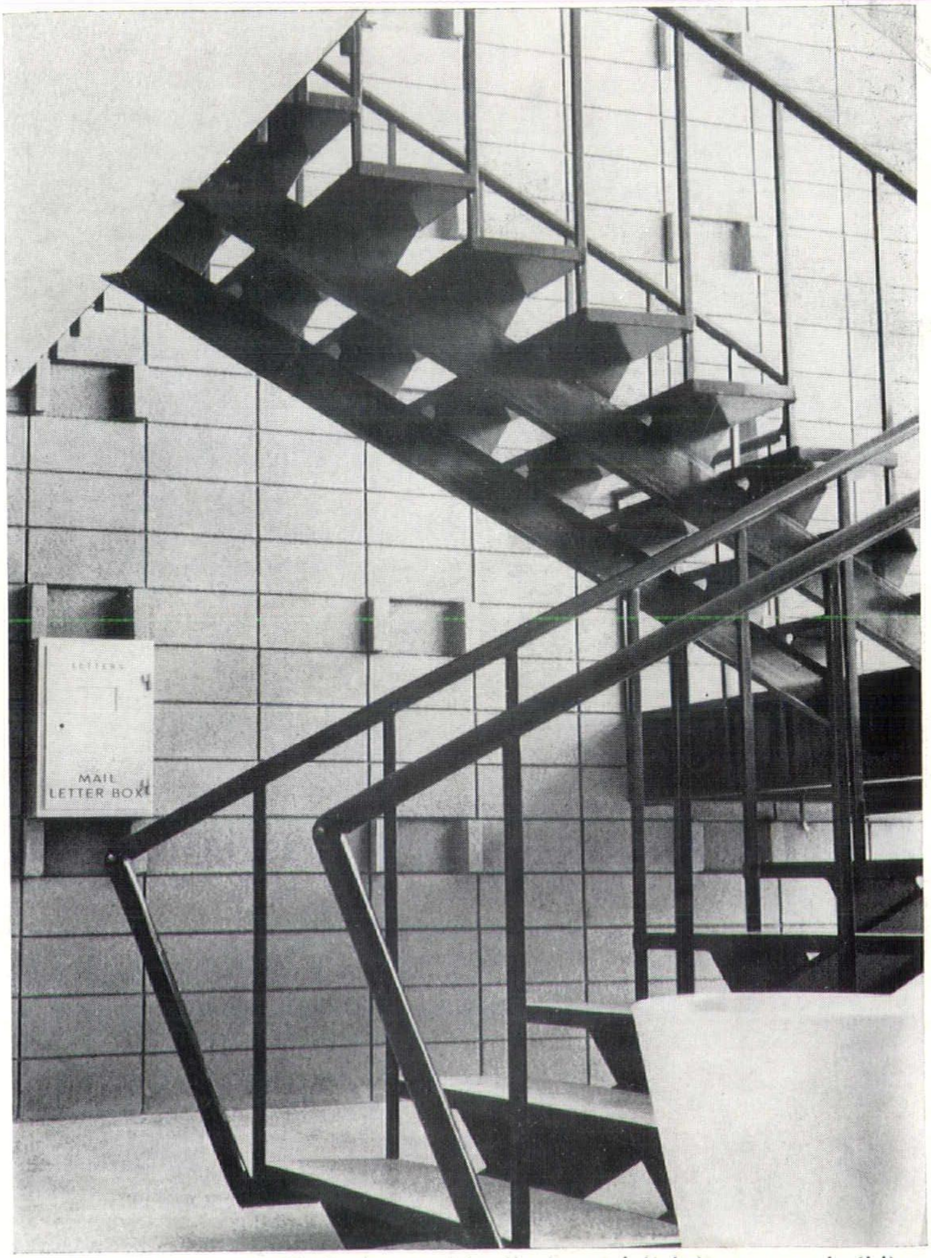

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