Architecture more than any other branch of the arts is dependent on technical possibilities. Construction is the basis of all building and the right choice of materials and methods of construction is one of the requisites for the creation of good architecture. The development of architecture, therefore, is closely related to technical progress. New materials and new building methods give the architect the opportunity to employ new techniques which in many cases lead to a new conception of the esthetic basis of the art of building.

ACKNOWLEDGEMENT

I wish to acknowledge the kind permission granted by the editors of the Architectural Forum and by the Reinhold Publishing Corporation, publishers of Contemporary Structure in Architecture by Leonard Michaels (New York, 1950), to reproduce a number of photographs of buildings appearing in their publications.
Introduction...
Do the structures being erected today express the character of our civilization?

Historians, social economists, and philosophers remind us that architecture properly understood is civilization itself. The characteristic buildings of any given period remain memorials which are the cultural key to that particular period in the history of civilization. Once architecture was true construction. The forms of edifices were sculptured from native materials expressing the techniques and habits of the age. Why have architects changed their outlook? Instead of allowing their work to embody the new and changing techniques of the contemporary period, they are searching backwards for means of expressing modern culture. Instead of grasping for new methods and materials to "enlighten" architecture,* they are relying too much on the performance of the past. Le Corbusier

*In the following pages, the term "enlightened architecture" is used to mean the type of architecture using lightweight materials which are characteristic products of our industrial age.
writes "There is one occupation and one only, this is architecture, where reigns idleness of the mind, where we look backwards instead of forwards." Books and magazines should be forbidden architects after ten years of school and practice.

"It is the extent of the conception, the identification with all life, its symbolic presentation of a new philosophy of life, the power with which it is expressed—that is what gives assurance that we are on the threshold of a new period in the history of history."

This is not true today. Are architects expressing the atomic, or even the industrial age which we have just completed? No, they are afraid to use the materials that characterize our advancing civilization.

Why are we using bricks and mortar when we have lightweight metals and plastics

---

*Herbert Scheide, Introduction to Le Corbusier and P. Jeannerat (Zurich, 1945).
to substitute? Why are we using heavy stone work and timber construction when we have lightweight steel and aluminum and other metals to replace such antiquated methods? Indeed we are looking backwards for assistance.

The Egyptians spent years and years in building great pyramids and temples of solid stone. Manual labor was the prime requisite for them. The buildings were structurally sound, beautiful in character, the stone expressing the civilization of the age. This so-called backward people did not have a backlog of details and specifications and catalogues to which they referred. The structures were erected in the simplest manner possible, with the most commonly available material: stone.

This ingenuity in characterizing civilizations grew through the Greek cultural epoch and diminished somewhat in the period of Roman culture. The Greeks expressed post and lintel construction with stone and
wood in a manner representative of the materials and methods on hand. The Romans faltered somewhat in their attempts to copy some of the techniques of other cultures. However, with the rise of Christian civilization, the plastic flow of architecture which expresses the culture of the age through materials and construction, gave rise to Gothic architecture. In examples of Gothic architecture, we find stone, glass, and metals used in manners which brought forth beauty in construction and use of material. This was the last form of organic architecture to be developed. The buildings seem to grow out of their settings incorporating available materials to express the culture characteristic of the period.

The Cathedral of Notre Dame is an excellent example of such Gothic architecture. The architecture of this Cathedral is a combination of expressive construction and available material. Therefore, good architecture is a combination of expressive
With the appearance of the Renaissance period of architecture, there also was a revival of pretended architecture. And so it has been down through the ages. Not until recently have architects begun to reform these cliches. Along with this reformation of design should come a reformation of materials. We do not have to employ materials requiring hand labor and expressing an age which has past. Why should we build a wall with small hand-emplaced bricks, with costly labor when a panel of lightweight metal backed with a lightweight aggregate could replace about a hundred bricks, give a cleaner appearance, call for less maintenance, have less weight, have equal fire rating, and yet stamp this building as being an edifice which is precisely representative of the industrial and atomic age—not the stone age.

Why then do we not follow the example of Gothic structure? The greatest period
of architectural development was brought forth during the Gothic era. As in the Gothic period and other admired periods of architecture, the design arises essentially and obviously out of the methods and materials of construction. I wonder what type of structure the Gothic architect would have had erected if he had such materials as steel framing, lightweight structural members, lightweight steel panels, large sheets of glass, lightweight aggregates, and plastics at his command? Would he have built his cathedral out of heavy stone? This is a question to which we will never know the answer. However, we do know this, seven hundred years later architects are still attempting to erect buildings with the same materials, gathering similar effects and yet incorporating a few new erection methods. How illogical! New erection methods to place heavy wood masonry and brick materials! Why are we not using new materials in connection with the use of new erection methods?
Building Code...
Unit-Weight-Cost comparison between a conventional masonry and a metal clad panel wall.
Windows can be located at any point.

METAL CLAD WALL PANEL
(4"-4" square)

UNITS: 1
WEIGHT: 225 lbs.
COST: $23.49

CONVENTIONAL MASONRY
(4"-4" square)

UNITS: 115
WEIGHT: 1500 to 2700 lbs.
COST: $40.49
What is it that is hampering building construction from progressing as rapidly as other modern industry? One would think that since the construction industry is one of the oldest of trades all over the world it should be foremost in advancing toward a progressive attitude. It definitely is not. Look about us in our own cities. You can count the number of buildings on one hand in each average city in which the architect involved has taken the initiative to make use of the new materials and construction techniques that would be indicative of our modern civilization. We can put the blame on many factors such as traditionalist architects, old-fashioned clients, material shortages and costs, and shortage of skilled labor. Yes, these are factors but there is another reason overshadowing these others, and that reason is the unrevised building codes of the United States. There is little use in stating the benefits of building codes. We all understand the necessity of their presence to
maintain a quality of construction and safety that is beneficial to the general welfare of the community. We need building codes. But should they act as a 'checkrein' which tends to retard every step forward in the direction of cost economizing and the minimizing of the labor and materials of construction? No, the building code should be a flexible set of standards for construction allowing interpretations best suited to particular cases, showing respect for the acquired knowledge of past experience and inspiring architects to benefit building with newly acquired technical knowledge.

If the building code has failed to meet such a standard, the architects themselves are somewhat to blame. It would certainly take an architect of stronger character to point out the benefits which could be derived from technical progress than one who simply succumbs to rules because they have proved adequate in the past. Why do they not organize for strength with engineers and manufacturers to urge code committees to recog-
nize and respect the validity of technical advancements in building? In the meanwhile, the building code tends to hamper the architect's progressive attitude toward building by its strict reliance upon ancient regulations.

It would appear that in such a progressive country as the United States where industries such as the automotive and aircraft have progressed so rapidly through the use of industrialized materials, that the building industry should also progress in a comparable manner. It seems that the code laws will recognize new materials but in many cases procrastination of law making has hindered progress. A good example of this fallacy is the curtain wall construction system. It has been known for many years that certain curtain walls could be erected to replace heavy masonry construction. However, legislation delayed the recognition of the safety of this system. It has only been since the end of World War II that thin curtain walls could be constructed in any
area which is considered a heavily populated commercial fire-zone.

It is easy to see that code laws preserve the old laws instead of searching for new advancing techniques. Unconsciously the code laws seem to make it more profitable for the construction industry to adhere to the more expensive and less economical methods. It is difficult for one to see where they have encouraged the development within the standard of safety. A sentence from an article on the building code in the Architectural Record for March, 1946, was written so aptly: "Building codes preserve the 'status quo' in construction." The building code committees could easily change their attitude toward legislation. They should reconsider the codes from a point of view of today's standards and of the contributions which the construction industry could make to the community if it were not hampered by unintelligent reactions. When the building industry would be encouraged to embark towards new directions, there
would result a new spirit of initiative that would benefit all who were connected with the industry. The public would benefit from a scientific rather than a political approach to construction. The public would also become accustomed to allowing initiative in building developments. It also would result in speedier and more economical types of construction.

Under such conditions, the architect would have less of his energy consumed by trying to determine just what is permitted by the building code. Also the architect would find himself with a greater freedom of design and an increased volume of construction. The manufacturers would find a more normal marketing procedure, a larger potential volume, and the ability to estimate more readily the value of new developments.

Building regulations as now formulated tend to hamper production and increase construction costs principally by specifying
requirements higher than necessary for safety and health, thereby requiring the use of more material, more expensive materials, and costlier methods.

Architects, engineers, and manufacturers have realized the fallacy in many of the code laws and did something about it in November, 1949. The Building Officials of America Conference in Washington adopted a policy to publish a new basic building code. This code was to be the climax of four years of research in the field. It was to include not only specifications but also the performance of many materials.

The significance of the code is that it would not bind any communities to its use, but it would set an approved standard to which they could adhere. An indication of its use nationally was the attendance of representatives of 80% of the nation’s population.

If the cities and towns all over the country would adopt this one code, then we
would have a more uniform standard of construction through the elimination of the now 2,500 separate codes throughout the country. Since the code would include performance of new materials, it would allow architects to include contemporary methods of construction. If this policy is adopted and meetings are held perhaps two a year to acknowledge the performance of new materials, then this could be marked as a significant step in keeping our building industry in step with modern developments.
"Enlightening" Materials...
STEPS IN WALL PANEL ERECTION

FIRST STAGE
ERECTION OF CURTAIN WALL
BEAM SPAN IS DEPENDENT ON
TOP ENDS OF BAT TP BEAMS.
ANCHOR BEAMS WHERE THE
BEAMS ATTACH IS KEPT
ADJUSTABLE SHOES

SECOND STAGE
VERTICAL STEEL CHANNEL
STUDS ARE INSERTED
INTO HOLE IN STUDS.
ALIGNMENT OF STUDS
IS PRACTICAL AND REGULAR.
INSIDE AREA IS MADE
HOSTILE BY REINFORCEMENT

THIRD STAGE
ANELS ARE BOLTED TO STUD

SILL MEMBERS

PREPARED STUCCO OR
STUCCO

FOURTH STAGE
INCREASED BEAMS ARE
ATTACHED

FIFTH STAGE
WITH CONTINUOUS HorizontAL
APPOCALIPSE STRESS CONCRETE
INSTALLATION OF WINDOW
STUDS PROVIDE AREA
ALLOW THIS SPACE OPEN OR
CLOSED.
America is now in the midst of a building boom such as has never been equalled before. Would it not seem reasonable that construction costs should be lowered as the result of such an increase in construction? But this is not true. The cost of construction has risen to such an extent since World War II that it is no longer feasible to use what are now antiquated construction methods and materials. It does seem ridiculous that in the case of an industry such as the construction industry—which is presumably progressive—a reliance on the labor-devouring methods of an earlier period has continued in vogue and has been responsible, to a considerable extent, for the rapid rise of construction costs. This should not be and would not be if architects would attempt to eliminate labor consuming methods of construction.

There are various reasons why materials expressing the industrialized age should be used in architecture. These materials can be used in manners which are quicker and cheaper to provide shelter against the destructive forces of nature and of mankind which are weather, fire, and
intruders. Materials should be used to provide for cleanliness, sanitation, and healthful living. Materials should be used that can reduce labor and maintenance to a minimum. Materials when properly emplaced can give a man a feeling of beauty, they can enrich his soul with the charm of sincere architecture much like melodious harmony can lift a man from the depths of a darkened moment. These materials can be selected by their performance per pound. Industry has produced such materials. Let us then use them to their fullest advantage and forego the costly labor consuming materials of the past. With the industrialization of architecture, more homes, commercial and industrial, educational, and recreational buildings will be erected by those who cannot meet today's outrageous costs. Our civilization can well benefit if we acknowledge and use the materials produced by our advanced industries. Such materials
as sheet aluminum, sheet steel, sheet copper, plastic, glass, cemento board, corrugated asbestos, and lightweight cements should be utilized.

One of the finest methods of "enlightening" functional building is through the medium of the exterior wall. For century after century buildings had to be erected board by board and ultimately brick by brick. This procedure was fine a hundred years ago when skilled craftsmen could be had for a few pennies. Besides this, there was no other means of construction available.

Today we have hundreds of construction shortcuts developed through the industrialized age. Let's make use of them. Perhaps one of the more recent industrialized construction systems is that of the light curtain wall. Various architects and industrial-wise manufacturers of metals have
TYPICAL WALL PANEL SPACING FROM WINDOW SILL TO WINDOW HEAD BELOW

TYPICAL WALL PANEL SPACING FROM SPANDREL TO SPANDREL

TYPICAL WALL PANEL SPACING FROM COLUMN TO COLUMN

WALL PANEL SPACING METHODS
been experimenting with lightweight metal wallbuilding extensively since the time of World War II. H. H. Robertson Corporation, Detroit Steel Products Company, and the Aluminum Company of America are some of the manufacturers who have been leaders in this investigation for a number of years. Restrictive trade and labor practices and the restrictive building codes have been a large hindrance to the development of this curtain wall. Architect William Lescaze and Robert Davison (building researcher) were instrumental in developing a metal clad insulating wall that was applicable to many types of buildings. The metal clad siding panel would have to be applicable to many various openings and ceiling heights, yet standard enough to build in a prefabricated manner which would be convenient for manufacturing.

These metal panels encircle a building two to a floor. The lower pane is attached to a spandrel beam (either steel or concrete).
The upper strip can be used either as a solid panel or a window. This is most practical since the system is now independent of columns.

The designers felt that this horizontal metal clad skin was much more practical in application than a vertical skin.

Let's look at the practical aspect of this wall as compared with a wall built of brick backed with masonry. The panel would be 4' 4" square, hence we would have one unit which would replace 115 masonry units (the number of masonry units usually required to enclose such an area). The completed sandwich panel made of either sheets of stainless steel, aluminum or copper and insulated with either glass, asbestos-cement or a material such as vermiculate concrete, would weigh approximately 225 pounds. This is a large saving in weight over the 2700 pounds which a solid brick wall this size would weigh. The new panel is 3 1/2" thick and the old solid brick walls would
be 17". The building owner would find himself with about 9 1/2" more of rental space around the whole perimeter of the building. The "k" Factor of this wall would be .12 which is twice as favorable as the old style brick and furred plaster system. The transverse and wind load restraint are much higher than the restraint of any masonry wall. At the time of this design, the use of such a panel would save approximately 92 cents per square foot. These figures are undoubtedly variable.

Let's look at other features. The insulating material could be designed so as to give a four hour fire rating. In erection no exterior scaffolding would be necessary. The time of erection is much faster. The maintenance of exterior walls would be negligible since no pointing or painting would be necessary. If an area is damaged, it could be easily replaced.

This system of lightweight exterior panel construction could prove to be some
thing revolutionary in the construction industry. Undoubtedly there are many bugs in this system which would have to be ironed out. It can be done with proper industrialization by the architect and builder.*

Many technical problems have arisen especially with metal panels because of their imperious quality. One of the foremost problems is the forming of condensation on the interior walls. This problem is relatively simple in porous walls of brick for example. The problems of expansion and contraction, of moisture penetration, and of methods of erection are among the most important problems arising in connection with this type of construction.

Engineers have discovered that condensation can be impeded in the winter by a vapor impervious barrier which would be placed nearest the low pressure area on the

---

Crucible Steel Co. of America has designed a sandwich panel consisting of cellular glass insulation which is placed between two layers of concrete with connecting reinforcing. The outside surface is stainless steel sheet facing. This is designed to meet a 3-HR fire rating.
inside. With the increased amounts of air conditioning present in buildings today, the problem then arises as to what should be done about summer cooling when the warm side of the wall becomes the cold side. Various panel fabricators have attempted to solve this problem by placing a vapor impervious barrier in the center of the panel and placing layers of insulation on either side. In this solution the outer layer of insulation is assumed to function with full efficiency in the winter while the inner layer is relied on to slow down the rate of heat transfer in the summer. Another solution is to place the insulation material in the center which is surrounded on either side by a vapor impervious barrier. However, a puncture of either of the vapor barriers would cause condensation to be trapped between the barriers. Perhaps a solution to this problem is to have a wall that actually breathes. That is, the panels would be so joined as to allow air
The Aluminum Co. of America has designed a wall panel which is faced with ribbed cast aluminum and bolted to vertical angle stiffeners. It is backed with 4 in. of precast diatomaceous concrete. Aluminum foil cemented to back-up with bituminous cement provides the vapor barrier.
to pass without any barrier thereby blocking any condensation.

Another problem which must be considered in panel construction is moisture penetration. Of course, with an impervious panel such as metal we find little need for concern. If we use a panel which is made of a porous substance such as a cement base or plywood then we should concern ourselves with this problem. Recently engineers have devised the theory that moisture penetration is due to a replacement of air. When the wind blows against an exterior wall on the high pressure side, some pressure is bound to seep into the porous wall and seek a natural outlet on the low pressure side or interior wall. This air which is drawn through the wall has to be replaced by air to equalize the pressure in the center of the wall. During rain storms this wind carries rain water into the wall which then causes leaks.

A simple means of counteracting this problem of leaks is to provide sufficient
EXTERIOR FACING DESIGNED BY H. H. ROBERTSON
CO HAS 24 IN. WIDE PLUNED STEEL OR
ALUMINUM PANEL BACKED WITH FLANGED STEEL
PLATE ENCLOSED 1/2 IN. RIGID GLASS FIBER
INSULATION THIS SPECIFIC PANEL IS NOT DESIGNED
TO MEET FIRE TEST.
space behind the exterior surface to allow for equalizing the pressure. If the pressure in the center of the wall is nearly equal to that of the exterior pressure, then there should be no moisture penetration. However, it is necessary to allow for ample coping on top of the wall or at the window sills to prevent excess water from entering the wall. Seep holes should be placed at the bottom of the wall to allow all excess water to gravitate out the bottom in case the theory of suction for ventilation does not work.

In the building industry, non-ferrous metals are the youngest. The use of non-ferrous metals for the external facing of buildings is relatively new. Aluminum, the most common of non-ferrous metals, has been produced for approximately one hundred years. It was not until the early part of
A thin curtain wall designed by the Republic Steel Corporation has a stainless steel face backed with rib-reinforced panels of carbon steel with two piece flanges to isolate front and back surfaces and containing two inches of fire insulation.
the twentieth century that aluminum could be produced with the strength necessary for building needs. The need for a lightweight material of high tensile value such as aluminum has been developed chiefly for the airplane industry. Consequently the building industry has taken advantage of this material to put it to practical use as an exterior facing. Aluminum can be produced to reach a tensile strength of forty tons per square foot. The low module of elasticity of aluminum allows the metal to bend very easily. On the other hand, this low module of elasticity is a definite advantage for the withstanding of impact loads. There are certain other qualities of which the architect should be aware. The thermal expansion of aluminum varies from .0000114 to 0.0000128 inches per degree Fahrenheit which is approximately twice the expansion of steel. Thermal expansion must be considered in its relation to the behavior of large structures.
The basic advantages of aluminum to be used as an exterior wall facing are the following:

1. Aluminum weighs approximately one-third as much as most other commonly used metals (composing equal volume).

2. Aluminum withstands the weather and the attack of many gases present in industrial areas making it most valuable for exterior construction. No corrosion whatever.

3. Aluminum alloys can be developed to high strength.

4. Aluminum can be fabricated to most any shape and assembled by ordinary metal working methods.

5. Attractive finishes can be given aluminum which will provide the architect with many unusual and beautiful effects.

6. Where explosive dust or gases are present, the property of aluminum is of special importance. There is no sparking of aluminum to contribute to explosion hazards.

7. Suitably treated, aluminum reflects as much as 85% of the visible light rays falling on it.

8. The maintenance of aluminum today is negligible.

In order to meet the requirements of building codes it is essential for aluminum

* Taken from Alcoa Aluminum in Architecture (Pittsburgh, Pa., n.d.), p. 2.
The R.C. Mahon Company has designed a panel which has fiber glass insulation sandwiched between panels of either steel or aluminum sheathing. The design will not meet fire tests.
wall facing to be backed with a material with insulating characteristics.

Manufacturers such as H. H. Robertson Company and Detroit Steel Products Company have developed such a wall facing. The "Q" panels developed by the H. H. Robertson Company consist of flat and fluted aluminum plates enclosing 1 1/2" (or more) of insulation. These panels are manufactured in standard 2' 0" widths with interlocking side lips that form a tight joint.

The erection of such panels has added much needed speed and simplification in building construction. Panelled materials of this nature are characteristic of the beauty and practicality which can be derived from the usage of industrialized products in contemporary architecture.

The use of glass as a lightweight building material has increased greatly in
The Aluminum Steel Corp. has designed a wall panel of stainless steel backed with 2 inches of factory-poured calcium hydroxide insulation. Inside finish is composed of furring lath and plaster or foil-backed plaster board and plaster to maintain stiffness of return edges of panel flanges and to meet fire tests from inside. This wall is expected to meet a 2-hour fire test.
recent years. Buildings such as the United Nations Secretariat; the Ellucki's Equitable Life Insurance Building; Skidmore, Owens, and Merrill's Lever House; and the Lake Shore Apartments by Mies van der Rohe, have become inspirations to architects who are now advocating a thin glass facade.

This trend has also been devised to circumvent the code law requirements of many cities. Many codes still require the use of 8-12" of masonry backing material to be used for every outside wall in multi-storied constructions. However, they allow as much window space as can possibly be incorporated in the design. This 1/4 or 1/2 inch of glass is much cheaper in installation and initial cost than the old type of thick masonry construction.

Glass is also being used as a lightweight insulation material. It is commonly called foam glass by the building industry. Foam glass is made in blocks 12" x 10" x 6"
WALL PANEL DESIGNED BY ARMCO STEEL CORPORATION HAS VERTICAL OR HORIZONTAL SELF-FRAMING STAINLESS STEEL PANELS. PRINCIPAL FEATURE IS SIMPLE JOINT AND CONNECTOR SYSTEM. THE FACING IS BACKED WITH ANY SUITABLE FIRE INSULATION AND IS EXPECTED TO MEET A 2-4 HR. FIRE RATING.
and can be used on walls, floors and ceilings as a heat insulating, lightweight material. Foam glass is especially applicable to roof insulation and thin wall insulation because of its light characteristic and its high thermal insulation efficiency. Its use is particularly advantageous where precision control of temperature or humidity is an essential factor. At the present time the price is at a point which is relatively high in comparison with other insulating materials. However, if foam glass is used in large quantities, it could be made economically attractive to the building industry.

Data on foam glass.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>10.5 lbs per cubic foot</td>
</tr>
<tr>
<td>Conductivity at 70°F</td>
<td>0.45 BTU/hr/sq.ft./°F/in.</td>
</tr>
<tr>
<td>Conductivity at 300°F</td>
<td>0.70 BTU/hr/sq.ft./°F/in.</td>
</tr>
<tr>
<td>Coefficient of expansion</td>
<td>(°C) x 3.3 x 10^{-6} (°F) x 10^{-5}</td>
</tr>
<tr>
<td>Specific heat</td>
<td>(°F) 0.16 to 0.19</td>
</tr>
<tr>
<td>Crushing strength</td>
<td>150#/sq.inch</td>
</tr>
</tbody>
</table>
This glass can be used as an insulation material in mat form. Usually these mats are about one-inch thick and 10-15 yards long and 3-4 feet in width. They can be applied in a similar manner as other wall insulation. This type of an insulation is commonly known as fiber glass. It has a lighter weight than foam glass (3 pounds per cubic foot), but does not have the strength of the blocked forms of the foam glass.

Another use of glass in lightweight construction is the use of thermolux glass. This consists of thin glass fibers which are emplaced between two ordinary sheets of glass. The sheets are pressed together and the ends are sealed by an adhesive bonding. This intermediate layer of fiber glass forms a diffusing medium. It also provides for thermal insulation thereby eliminating

WALL FACING DESIGNED BY THE AMERICAN BRASS CO. HAS RIBBED COPPER PANELS TRIMMED WITH EXTRUDED BRONZE, ATTACHED TO TUBULAR COPPER ALLOY FRAME. THE FACING IS BACKED WITH 3 IN. OF GYPSUM BLOCK, AND THEREFORE EXPECTED TO MEET A 2 HR. FIRE TEST.
heat and sunlight in the summer and reducing heat losses in the winter.

This glass is not transparent but it is translucent enough to allow ample illumination. Therefore it is particularly applicable to usage in areas where privacy is appreciated and yet ample amount of light is also needed.

The use of thermolux glass is quite appropriate for constructing buildings with lightweightness in mind. A designer with initiative could use this material intelligently as a translucent roofing and siding and at the same time achieve effects that would be expressive of our industrialized civilization.

Whenever plate glass is used for vertical or horizontal exterior enclosure material, three vital problems always confront the architect. In the first place, the architect should consider the amount of heat which will be lost through a thin sheeting of glass. In the second place,
the thinness of plate glass will allow excessive amounts of noise to penetrate. In the third place, excessive amounts of condensation will form on the windows due to temperature variances between the outside and the inside.

It is commonly known that the tendency in design today is to allow for larger glazed areas. Glass companies realized this and of course were pleased with the frequent amounts of glass which were being incorporated in contemporary construction. However, with these three problems of heat loss, excessive noise, and condensation, the question then arose as to how to use glass and yet minimize its deficiencies. It seems that the most feasible solution would be one which is similar to that of panel construction. A dead air space should be incorporated to keep the exterior and interior temperature differences from causing condensation, to reduce noise, and at the same time to reduce the heat loss.

Glass concerns have developed a window
panel which is known as double glazing. Two panes of glass 1/4-3/4 inch apart would be hermetically sealed to prevent any moisture from seeping into the space between the two glasses. The glass has to be sufficiently strong to withstand the change in air pressure which is caused by the sealing process. The high cost of double glazing is expected to be balanced in a period of years due to the amount of reduction of heat loss. Besides this, no condensation will ever form on the inner pane and the heat loss through the glass area will be equivalent to no more than that of a 9" masonry wall. The introduction of the double glazed glass wall has contributed to the advancement of our lightweight construction era.

Glass blocks and toughened plate glass have also been incorporated into modern construction methods. The former does not appeal to me as a material which should be included in any "enlightening" architecture since it is made in such small modules and
Exterior facing designed by the Carnegie Illinois Steel Corporation. Stainless steel panels reinforced with horizontal carbon steel channels. Inside finish and rock-wool core is designed to meet any fire rating desired.
has to be emplaced with a mortar by hand in much the same fashion as in the case of brick laying.

Glass, although known almost from the beginning of recorded history, is a material whose usage and beauty should be employed to its fullest extent by architects to emphasize the nature of modern structures.

Another product of the industrial age which can be used readily in lightweight construction is cemesto board. Cemesto board is available in units four feet wide and in varying lengths up to twelve feet. It consists of cane fibre installation board which is sandwiched between two sheets of asbestos cement boards. It varies in thickness from 11/16 inch to two inches. It is especially applicable to the erection of exterior and interior partitions and roof decking. This material can be used favorably in conditions where the temperature is apt to rise up to
200 degrees Fahrenheit. The completed board is not fireproof but only fire retardent. The asbestos board itself, however, is fireproof. When used as an exterior wall the board does not have to be painted. The board weighs from three to five and one-half pounds per square foot and can easily be erected by one man. It has an overall heat transmission coefficient of \(0.38-0.19\) depending upon the thickness of the board. The board has a fair strength and can be used on exterior walls designed to withstand up to thirty pounds/sq. in. wind load. The designer usually places the board at four feet on centers. Perhaps one of its favorable characteristics is its ease of application. The board can be applied in large sheets as already indicated and can be fastened to wooden studs either by nailing or by a new method which shoots rivets through the board and into the studs by means of a gun. It can be easily attached to steel backing by bolts and all joints can be covered with cement asbestos battens which form an
extremely tight waterproof connection. The material is extremely applicable to industrial-type structures because of its large module, ease of application, and initial low cost.

The aesthetic beauty of this material cannot compare with such industrial materials as sheet metal, plastics, and glass; however, it definitely has a place in inexpensive structures. I imagine manufacturers can continue experiments with materials such as cement board until they have produced an industrialized material not only fireproof, thin, and in large modules, but also of a pleasing appearance.

A manufactured siding material that has been used extensively in building is corrugated asbestos. It is similar in character to cement board in that it requires no painting. Other favorable characteristics are that it is rust proof and acid proof, and completely fireproof. Most corrugated asbestos cement sidings
are manufactured to be composed of 85% portland cement and about 15% asbestos fibre. These sheets come in widths of 42 inches and are manufactured up to twelve feet long. The average sheet will weigh approximately three and three-quarters pounds per square foot. According to this figure, the largest sheet twelve feet in length would weigh about fifty pounds. We can see the number of advantages to a product of this sort if a single man were employed to erect a wall. The manufacturers feel the best method of fastening such a material would be by means of bolts and screws. This sheet itself is three-eighths inch thick so that it would take a small bolt to hold it in place.

Many people dislike the appearance of such a material because of its industrial and inexpensive look. Such materials, therefore, should be displayed to the public in better designed structures. Personally, I feel that corrugation is a fine way of eliminating the monotony of a plain surface wall. For example,
vertical boards and batten appear to have more texture than a plain flush boarded wall. In the same way corrugated asbestos enhances a wall with its rhythmical design. I foresee a material of this sort, perhaps a little thicker, more attractively finished, with simpler head, jamb, and sill connections, that will replace many of our wooden sidings today.

Sheet steel siding was being used in large quantities for industrial, commercial, and residential structures up until the present shortage. Perhaps its only quality which has proven disadvantageous is its inability to withstand rusting. However, with proper rust-inhibitive painting and galvanizing this problem can be minimized. The usual sheet metal siding with an iron base weighs approximately four pounds per square foot with a thickness of twenty gauge. It can be easily handled by one man for the sheets come in ribbed form in sizes that average two feet
in width and eight feet in length. However, these panels are available in a multiplicity of sizes since they are being manufactured by numerous concerns. The erection is rather simple since most of the joints either lap or are of male and female type connection. It is easier to construct a building of a material whose structural and metallurgical properties do not vary. It is to the advantage of the architect to use materials such as sheet metals whose properties are constant. This is a characteristic of the applicability of all industrial material.

Sheet steel has numerous advantages to give to architecture. Perhaps one of its best characteristics is its strength to weight ratio. It is vermin proof, fireproof, splinter proof, and moisture proof. Sheet steel can be easily fabricated in the shop and adapted to modular construction which should characterize present day building. It is inherently long-lived with a relatively low maintenance cost. Such a material is available in a wider range of
forms than most other material and perhaps of most importance is its adaptability to meet any purpose. Any building using a facade consisting of a steel panel with lightweight installation backing would be reducing the weight of the wall from 100 to 150 pounds per cubic foot (masonry wall) to not more than ten pounds per cubic foot. The savings in weight, time, and performance are innumerable.

Given proper consideration in aesthetics, I am sure steel paneling can be incorporated into architecture with the same pride and performance that stone and brick work gave to the traditionalist. To be used more freely in structures, the advantages of sheet steel should be given proper consideration by architects. When more emphasis is given to the possibilities of such scientifically developed material, then the proper place for industrialized materials will be found.

Plastics are nothing new to mankind, but the development of plastics which can be used
In buildings is something recent. Amino plastics such as we are familiar with today were not developed until the 1920's and were not used extensively until late in the 30's. Since this time, manufacturers have developed colorful plastics which can be used in building. Plastic is perhaps one of the most unused industrialized products in construction because of its low tensile and compressive strength. It is therefore realized that because of its characteristics it will probably never take the place of materials such as wood, metals, and concretes. However, I believe plastics have found a useful place in architecture. Plastics do have a very high quality as an insulating material and we will undoubtedly see them used more and more in this capacity.Personally, I feel that plastics will take a great share in the replacement of glass when they can be used as interior and exterior non-bearing walls.

Perhaps one of the most practical plastics developed for use as a building material has been produced by the Alsynite Company of
California. They have developed a translucent plastic of various colors which can be obtained in flat or corrugated sheets. When purchased in large units, it is felt that 50% of the cost of glass can be eliminated. The ordinary sheet of alsynite weighs approximately eight ounces per square foot. Perhaps some of its most interesting qualities are its permanent and shatterproof characteristics.

The greatest advantage of plastic over glass is the manner in which it can be installed. It can be sawed and nailed much like a piece of wood. It is indeed a material the use of which is relatively unexplored in the building industry and will be used more and more by architects who will be seeking the effects of translucent materials which can be constructed easily and cheaply.

A lightweight siding which has been used quite frequently in commercial, industrial, and some residential architecture is corrugated galbestos. "Galbestos" is the trade name.
This siding or roofing is made of sheets thirty-three inches wide running into lengths up to twelve feet. Galbestos is composed of steel metallic alloy adhesive, asphalt impregnated asbestos felt, and a factory applied sealed coating.

In buildings of an industrial nature Galbestos can be used without any backing because of its fireproof quality. It has a conductivity factor of .85 BTU which ranks relatively low for any prefabricated material with no backing. Of course, with a vermiculate or fiber glass backing the fireproof rating would rise considerably higher.

The material is particularly attractive when used in its natural shades. The most common shades are a maroon and a black finish. One of the most attractive industrial buildings that I have ever seen was an addition to the Crouse-Hinds factory in Syracuse, New York, which was designed by the office of George H. Ketcham. The architects employed a deep maroon Galbestos throughout and used aluminum industrial windows. The deep maroon
appeared black to the naked eye and since it was trimmed in aluminum, it was indeed a building of beauty.

Recently architects have used this paneling for home architecture. True, it is more applicable to industrial buildings, but it has been used with considerable sophistication in small homes and commercial buildings. In using a corrugated material of this sort in smaller buildings, I believe it is necessary to study the proportions of vertical to horizontal in order to achieve an effect that is pleasing to one's sense of beauty.

Plywood is being used extensively in smaller buildings as an exterior surface. This is a specially prepared type of plywood which is bonded with phenon-resin glue that is water resistant. This plywood is exposed to severe weather and moisture conditions. It is therefore necessary to specify the special waterproof exterior plywood in order for the panel to withstand buckling and shrinking.
Recently the Forest Products Laboratory in Madison, Wisconsin developed a panel two inches thick covered with aluminum facing. Many wooden sandwich panels are also being produced today which are covered with plastic facings that are more adaptable to weatherproof construction.

It seems only sensible that the construction industry should adopt this system of sandwich panel construction after it had been originally adopted by the airplane industry. For use in aircraft, sandwich construction can be defined as any panel construction of three or more plies having thin, dense, high-strength sheets (usually Douglas fir) separated by a lightweight core capable of carrying sufficient shear stress to develop a highly strengthened facing material. The adoption of the aircraft-type sandwich construction promises to be an evolution in smaller construction. Since the high stresses which are of more importance in airplane construction can be eliminated in building construction, it therefore seems
feasible that the price will be reduced with quality to meet the requirements of the construction industry.

Perhaps one of the biggest drawbacks in plywood panels is its inability to meet fire-rating requirements. However, today engineers are experimenting with various non-combustible finishes which will be able to provide a maximum of fireproof protection.

Various systems have been developed to restrict fire hazards. One method is to impregnate the wood with a fire retarding solution. This has proven more effective than the usual system of painting the wood with fire retarding paints. Some of the paints are based with sodium silicate (water-glass), linseed oil-based paints, methyl-cellulose preparations, synthetic-resin formulations, casein, whitewash paints, magnesium oxycarbonate, oxysulfate coatings and water insoluble fire-retarding preparations. With the use of such preparations, fire cannot be completely eliminated but it can be retarded.
Below are some of the aging tests that the Forest Products Laboratory conducted on plywood:

1. Immersed in water at 212°F for one hour.
2. Sprayed with wet steam at 194°-200° for three hours.
3. Stored in 10° for twenty hours.
4. Heated in dry air at 212° for three hours.
5. Heated in dry air at 212° for eighteen hours.

These tests show the amount of exposure that plywood can withstand and yet remain in usable condition.

Plywood is commonly available in 4' x 8' panels from 7/16" to 1 1/4" thick, making it adaptable to shipping and prefabrication. These panels are particularly suitable to the facing of smaller buildings because of their adaptability to various sizes and their availability in various type surfaces.

It seems that the U.S. Department of Agriculture has recognized the development of

lightweight prefabricated units for construction and is doing vast research to adapt the use of wooden products to lightweight construction. In plywood, industry has found a product that will eliminate many useless man hours and truly "enlighten" many construction operations.

Copper is another sheet metal which is adequately adaptable to exterior paneling. For many years now architects have specified copper flashings on numerous structures. Even though the cost of copper might be slightly higher than other sheet metal products, it would seem that this non-corrosive metal incorporated in a panel form would save considerably in maintenance cost. The greenish tint which forms on the exterior seems to enhance the beauty of the aging material. In a competitive market such as we have here in the United States, there is no reason why the price of copper sheeting cannot be reduced sufficiently to compete with other siding.
Copper, like aluminum and sheet steel, can contribute numerous advantages in initial cost and maintenance, and ease of construction. When buildings are designed to utilize these metals for their own characteristics, then an aesthetic impression will be created. It is up to the architects to awaken the public to the value of "enlightening" materials. Musicians do not rely completely on the songs of the old masters, painters incorporate new trends. Artists are always seeking new means of expressing themselves. They use the culture of the past for background and guidance. So the architect should learn and understand the materials of past ages, and then enhance their use by the newest materials available to the fullest advantage.

Just what material can we say contributes most to the building of lightweight building types? Aggregates of a lighter weight have allowed buildings of high fireproof ratings to
be erected with less material and yet produ-
ducing the same quality of building.

We note here some of the properties of lightweight aggregates. All lightweight ag-
gregates are produced by processing various types of expanded clays. These clays are usually structurally strong and have a cellular characteristic usually vitreous and chemically inert and with inherent fire resistent quality. Most of the aggregates are of a low thermal conductivity which is gradually becoming one of the main factors for savings in heating and ventilating costs. These aggregates are vermin proof, another factor which is considered excellent especially in a semi-tropical climate.

There are two properties of expanded clay aggregates that are especially favorable for their application in the building industry: weight and fireproofness. The average weight of structural concrete is 150 pounds per cubic foot. The weight of concrete mix with a lightweight aggregate varies between 25-30 pounds
per cubic foot. This shows a substantial saving in the dead load of any type of construction.

The thermal conductivity is approximately one-sixth that of sand and gravel concrete. This property alone is valuable enough in the fireproofing of a structure. The significance of this is that less concrete or fireproof plaster need be used to protect a building. This would not only eliminate walls and columns of enormous thickness and give the owner more floor space, but it would also diminish the dead load sufficiently to reduce the size of the columns, beams, footings, and foundation walls.

Fireproofing which uses a plaster of vermiculate would also tend to give a substantial saving, for a considerable amount of form work would be eliminated by specifying a plaster of vermiculate type which has a fire rating of two-four hours depending upon the plaster thickness. It is necessary to realize these advantages when one is designing a building with "cost-quality conscious" clients in mind.
Thermo-con cellular concrete is a lightweight building material completely new to the building industry. Thermo-con cellular concrete is a lightweight building material of constant uniformity and structural properties prepared from Portland cement, water and chemicals of mineral origin. Perhaps its outstanding physical property is its ability to expand two and one-quarter times its actual size when poured in place. This lightweight concrete is prepared on the job as a liquid slurry which is mixed in a Thermo-con generator, especially built by Higgins Resources, Inc., which has patented the process. The building forms are specially constructed of plywood to be used in a modular fashion for speed of erection.

One of the better features of thermo-con is that it allows plumbing and electrical conduits to be installed before the form is cast. After the panel is formed, the lightweight concrete is emplaced easily with a hose. From twenty to twenty-five minutes after the thermo-con has been poured it will take its final form.
with an average compressive strength of 500 pounds per square inch after about twenty-eight days. The finished material is composed of countless very small and uniformly sized spherical cells. The chemical ingredients act toward the concrete much like yeast does in causing dough to rise. The concrete in its solidified form weighs forty-three pounds per cubic foot, or approximately one-third the weight of rock concrete.

There are many other advantageous qualities of thermo-con. Pittsburgh Testing Laboratories have proved it to be far superior to other masonry products in transverse bending and impact shock. For this reason it has been recommended to builders in areas where seismic conditions are prevalent.

The porous physical state of thermo-con makes it quite usable for nailing and acting as a sound deadener. It has a "K" rating of 1.4 BTU/hr/sq.ft/°F per inch thickness per degree of Fahrenheit. This alone would make this material quite applicable to fireproof type construction and any construction which needs
high insulation value.

At recent tests in the Underwriters' Lab (Chicago), this material withstood temperatures up to 2300 degrees Fahrenheit before disintegrating. On the other hand, extremely low amounts of cold transmission were noticed at 160 degrees below zero. This is a remarkable quality for any such masonry material.

The material can be finished with a special cement-based waterproofed material called Therma-Seal. It appears to be a lightweight concrete that will lend itself to high speed, mass production and low cost. Since it is relatively new to the construction industry, it should add some interesting construction developments.*

COST OF HARD ROCK CONCRETE WALL vs. THERMO-CON CELLULAR CONCRETE WALL

Wall Size - 8" thick x 10' high x 40'6" long.
Total Square Footage - 405 sq. ft.
Total Cubic Footage - 270 cu. ft.
Total Cubic Yards - 10 cu. yards

**HARD ROCK CONCRETE**

All prices and labor costs shown are as of Oct. 9, 1950, New Orleans, La. Prices & labor costs shown are averages obtained from 3 leading contractors in New Orleans.

**READY MIX CONCRETE**

10 cu. yds. @ $12.50 cu. yd. $125.00

**LABOR - Placing costs**

10 cu. yds. @ $ 5.00 cu. yd. 50.00

**LABOR - Forming costs**

405 sq. ft. wall x 2 = 810 sq. ft. forms
810 sq. ft. x $.30 per contact foot 243.00

**MATERIAL - Forming Costs**

3-12 bd. ft. Req'd./contact foot of forms
3.5 bd. ft. x $.105/bd. ft. matl. = $.3675/contact ft. material cost

**MAXIMUM USES EXPECTED - 3**

$.3675 x 3 = $.1225 / contact ft.
810 sq. ft. x $.1225 / contact ft. 99.23

**REINFORCING**

80#/cu. yd. x 10 cu. yds. = 800# Reinforcing

**MATERIAL COST - REINFORCING**

800#/x $.06 per lb. = 48.00

**LABOR PLACING COSTS - REINFORCING**

800#/ x $.03 per lb. 24.00

Total cost per sq. ft. in place $ 1.45
Total cost per cu. ft. in place 2.18
Total cost per cu. yd. in place 58.92
THermo-Con cellular concrete

All prices and labor costs shown are as of Oct. 9, 1950, New Orleans, La.

Thermo-Con Admixture Batches Reqd. 13.475, say 13.5

THERMO-CON ADMIXTURE

13.5 batches x $2.50 per batch $33.75

PORTLAND CEMENT

13.5 x 8 = 108 sacks cement
108 sacks x $1.25 per sack 135.00

PLACING LABOR

13.5 batches x $2.00 per batch 27.00

LABOR - forming costs

405 sq. ft. wall x 2 = 810 sq. ft. forms
810 sq. ft. x 20 sq. ft. (erected forms/M.H.) = 40.5 M.H.

40.5 M.H. x $2.00/M.H. = 81.00

FORM AMORTIZATION COSTS

810 sq. ft. x $.04 per contact foot 32.40

MATL. COSTS - REINFORCING 4" x 4" x 6/6 wire mesh

972 sq. ft. mesh x $.0455/sq. ft. 44.23

$353.38

Total cost per sq. ft. in place $ .8725
Total cost per cu. ft. in place 1.31
Total cost per cu. yd. in place 35.34
## RE - CAP

| HARD ROCK CONCRETE vs. THERMO-CON CELLULAR CONCRETE |
|---------------------------------|---------------------------------|
| **HARD ROCK CONCRETE** | **THERMO-CON CELLULAR CONCRETE** |
| Material Costs | Material Costs |
| $125.00 | $135.00 |
| Placing Costs - Labor | Placing Costs - Labor |
| 50.00 | 27.00 |
| Forming Costs - Labor | Forming Costs - Labor |
| 243.00 | 81.00 |
| Forming Costs - Material | Forming Costs - Material |
| 99.23 | 32.40 |
| Forming Costs - Amortization | Forming Costs - Amortization |
| | 32.40 |
| Reinforcing Costs - Material | Reinforcing Costs - Material |
| 48.00 | 44.23 |
| Reinforcing Costs - Labor | Reinforcing Costs - Labor |
| 24.00 | (in forming costs) |
| **Total cost per sq. ft. in place** | **Total cost per cu. ft. in place** |
| $1.45 | $0.8725 |
| **Total cost per cu. ft. in place** | **Total cost per cu. yd. in place** |
| 2.18 | 35.34 |
| **Total cost per cu. yd. in place** | |
| 58.92 | 35.34 |

Facts taken from pamphlet published by the Thermo-Con Corporation of New Orleans, Louisiana.
<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>Thickness of Wall (in.)</th>
<th>Material for Attach. (lbs.)</th>
<th>Disc. in. (lbs.)</th>
<th>Head &amp; Stil (lbs.)</th>
<th>Erection Face in Place (lbs.)</th>
<th>Insulation Inside Deck (lbs.)</th>
<th>Face Back-up (lbs.)</th>
<th>Total Cost (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cast Aluminum</td>
<td>4</td>
<td>16.38</td>
<td>19.86</td>
<td>2.50</td>
<td>4.39</td>
<td>23.77</td>
<td>2.50</td>
<td>27.02 (4)</td>
</tr>
<tr>
<td>Cast Aluminum 2 hr. F.4.62</td>
<td>4.5</td>
<td>16.38</td>
<td>19.86</td>
<td>2.50</td>
<td>4.39</td>
<td>23.77</td>
<td>2.50</td>
<td>27.02 (4)</td>
</tr>
<tr>
<td>Sheet or Extr.Altinum 4&quot;</td>
<td>4</td>
<td>5.66</td>
<td>8.88</td>
<td>2.50</td>
<td>2.70</td>
<td>16.56</td>
<td>2.03</td>
<td>22.51 (5)</td>
</tr>
<tr>
<td>Stainless Steel 2&quot;</td>
<td>2.5</td>
<td>7.20</td>
<td>12.48</td>
<td>2.70</td>
<td>4.05</td>
<td>2.50</td>
<td>2.50</td>
<td>16.20 (4)</td>
</tr>
<tr>
<td>Stainless Steel 2 hr. F.4.62</td>
<td>2.5</td>
<td>7.20</td>
<td>12.48</td>
<td>2.70</td>
<td>4.05</td>
<td>2.50</td>
<td>2.50</td>
<td>16.20 (4)</td>
</tr>
<tr>
<td>Copper</td>
<td>7</td>
<td>6.75</td>
<td>13.63</td>
<td>2.70</td>
<td>2.03</td>
<td>10.13 (2)</td>
<td>2.03</td>
<td>22.75</td>
</tr>
<tr>
<td>Stainless Steel Concrete 4&quot;</td>
<td>3.5</td>
<td>3.50</td>
<td>6.75</td>
<td>2.70</td>
<td>2.03</td>
<td>11.25 (3)</td>
<td>2.03</td>
<td>22.75</td>
</tr>
<tr>
<td>Glass Wall</td>
<td>1/4 in. Wire Glass 2&quot;</td>
<td>1.13</td>
<td>8.44</td>
<td>6.75</td>
<td>5.06</td>
<td>20.25</td>
<td>5.06</td>
<td>20.25 (4)</td>
</tr>
<tr>
<td>Reinf. Brick Masonry</td>
<td>4.5</td>
<td>10.13</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>32.27</td>
</tr>
<tr>
<td>Precast Concrete</td>
<td>4</td>
<td>16.86</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>32.27</td>
</tr>
<tr>
<td>2 in. Limestone</td>
<td>4</td>
<td>13.50</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>32.27</td>
</tr>
<tr>
<td>2 in. Marble</td>
<td>4</td>
<td>20.25</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>32.27</td>
</tr>
<tr>
<td>2x2 in. Terra Cotta 6&quot;</td>
<td>6</td>
<td>24.30</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>32.27 (3)</td>
</tr>
<tr>
<td>Masonry, Metal Veneer w/ 8&quot; of Back-up</td>
<td>4 in. Face Brick 13&quot;</td>
<td>3.36</td>
<td>2.08</td>
<td>2.89</td>
<td>2.08</td>
<td>2.08</td>
<td>2.08</td>
<td>22.83</td>
</tr>
<tr>
<td>4 in. Granite Veneer</td>
<td>13</td>
<td>3.36</td>
<td>2.08</td>
<td>2.89</td>
<td>2.08</td>
<td>2.08</td>
<td>2.08</td>
<td>22.83</td>
</tr>
<tr>
<td>4 in. Limestone Veneer</td>
<td>13</td>
<td>3.36</td>
<td>2.08</td>
<td>2.89</td>
<td>2.08</td>
<td>2.08</td>
<td>2.08</td>
<td>22.83</td>
</tr>
<tr>
<td>4 in. Terra Cotta 13&quot;</td>
<td>13</td>
<td>10.13</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>32.27</td>
</tr>
<tr>
<td>4 in. Steel</td>
<td>4</td>
<td>10.13</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>32.27</td>
</tr>
<tr>
<td>Cast Aluminum</td>
<td>13</td>
<td>16.88</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>31.28 (3)</td>
</tr>
<tr>
<td>Sheet or Extr.Altinum 11&quot;</td>
<td>6</td>
<td>6.75</td>
<td>2.50</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>6.75</td>
<td>32.27 (3)</td>
</tr>
<tr>
<td>Porcelain Enamel Steel</td>
<td>11</td>
<td>8.44</td>
<td>2.50</td>
<td>2.70</td>
<td>2.50</td>
<td>13.64</td>
<td>2.50</td>
<td>20.25 (4)</td>
</tr>
<tr>
<td>Stainless Steel</td>
<td>9</td>
<td>7.25</td>
<td>2.50</td>
<td>2.70</td>
<td>2.50</td>
<td>14.21</td>
<td>2.50</td>
<td>20.25 (4)</td>
</tr>
</tbody>
</table>

(1) Includes plaster at ceiling at 22 cents per sq. ft.
(2) Light weight concrete
(3) Concrete sandwich
(4) Does not meet 2 hr. fire test
(5) Does not meet 2 hr. fire test without furring, lath, and plaster.

<table>
<thead>
<tr>
<th>Material</th>
<th>Allowance 1.00</th>
<th>Allowance 2.00</th>
<th>Rent Value Cost</th>
<th>Capitalized Cost</th>
<th>Total Economic Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cast Aluminum</td>
<td>27.06</td>
<td>10.00</td>
<td>12.53</td>
<td>.23</td>
<td>50.52</td>
</tr>
<tr>
<td>Cast Aluminum 2 hr.F.T.</td>
<td>27.73</td>
<td>10.00</td>
<td>12.53</td>
<td>.23</td>
<td>50.52</td>
</tr>
<tr>
<td>Sheet or Extr. Aluminum</td>
<td>14.05</td>
<td>10.00</td>
<td>12.53</td>
<td>.23</td>
<td>35.04</td>
</tr>
<tr>
<td>Forged Steel</td>
<td>22.52</td>
<td>10.00</td>
<td>12.53</td>
<td>.23</td>
<td>46.06</td>
</tr>
<tr>
<td>Stainless Steel</td>
<td>18.26</td>
<td>10.00</td>
<td>6.67</td>
<td>.23</td>
<td>32.16</td>
</tr>
<tr>
<td>Stainless Steel 2 hr.F.T.</td>
<td>15.85</td>
<td>10.00</td>
<td>3.33</td>
<td>.23</td>
<td>40.75</td>
</tr>
<tr>
<td>Copper</td>
<td>15.90</td>
<td>10.00</td>
<td>1.70</td>
<td>.23</td>
<td>38.70</td>
</tr>
<tr>
<td>Stainless Steel &amp; Concrete</td>
<td>22.75</td>
<td>10.00</td>
<td>12.53</td>
<td>.23</td>
<td>42.26</td>
</tr>
<tr>
<td>GLASS WALL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/4 in. Wire Glass</td>
<td>20.25</td>
<td>10.00</td>
<td>6.67</td>
<td>1.70</td>
<td>35.63</td>
</tr>
<tr>
<td>MASONRY GLASS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reinforced Concrete</td>
<td>23.03</td>
<td>12.00</td>
<td>16.56</td>
<td>.48</td>
<td>40.57</td>
</tr>
<tr>
<td>Precast Concrete</td>
<td>20.42</td>
<td>12.00</td>
<td>12.53</td>
<td>.48</td>
<td>32.95</td>
</tr>
<tr>
<td>2 in. Limestone</td>
<td>28.29</td>
<td>12.00</td>
<td>12.53</td>
<td>.48</td>
<td>34.07</td>
</tr>
<tr>
<td>2 in. Granite</td>
<td>35.64</td>
<td>12.00</td>
<td>12.53</td>
<td>.48</td>
<td>34.14</td>
</tr>
<tr>
<td>2 in. Marble</td>
<td>32.47</td>
<td>12.00</td>
<td>12.53</td>
<td>.48</td>
<td>33.06</td>
</tr>
<tr>
<td>4/5 in. Terra Cotta</td>
<td>39.69</td>
<td>12.00</td>
<td>20.00</td>
<td>.48</td>
<td>58.17</td>
</tr>
<tr>
<td>MASONRY, METAL VENEERS with 3&quot; Back-up</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 in. Face Brick</td>
<td>17.01</td>
<td>14.00</td>
<td>43.35</td>
<td>.51</td>
<td>74.86</td>
</tr>
<tr>
<td>4 in. Granite Veneer</td>
<td>47.72</td>
<td>14.00</td>
<td>43.35</td>
<td>105.24</td>
<td></td>
</tr>
<tr>
<td>4 in. Limestone Veneer</td>
<td>37.30</td>
<td>14.00</td>
<td>43.35</td>
<td>95.11</td>
<td></td>
</tr>
<tr>
<td>4 in. Terra Cotta</td>
<td>37.25</td>
<td>14.00</td>
<td>43.35</td>
<td>95.00</td>
<td></td>
</tr>
<tr>
<td>4 in. Cast Stone</td>
<td>24.25</td>
<td>14.00</td>
<td>43.35</td>
<td>.53</td>
<td>33.16</td>
</tr>
<tr>
<td>Cast Aluminum</td>
<td>27.99</td>
<td>14.00</td>
<td>43.35</td>
<td>.53</td>
<td>55.37</td>
</tr>
<tr>
<td>Sheet or Extr. Aluminum</td>
<td>15.45</td>
<td>14.00</td>
<td>36.66</td>
<td>.39</td>
<td>60.66</td>
</tr>
<tr>
<td>Forged Steel</td>
<td>17.46</td>
<td>14.00</td>
<td>36.66</td>
<td>.45</td>
<td>67.67</td>
</tr>
<tr>
<td>Stainless Steel</td>
<td>18.04</td>
<td>14.00</td>
<td>30.00</td>
<td>.29</td>
<td>58.32</td>
</tr>
</tbody>
</table>

(1) Allowance is made for the reduced cost of the structural steel frame in the case of the lighter walls. The figures used are based on a 20-story building with 20 ft. column spacing, and work cut at $10 per lin. ft. of wall for the lighter walls and $14 per lin. ft. for the heavier walls.

(2) The "rental value cost" of each of the walls was computed as follows: the rental value of the floor space occupied by the wall was taken as $4 a sq. ft. per year—a realistic current figure—and this was capitalized by multiplying by 10 years, giving $40 per sq. ft. as the capitalized value of rentable space. On this basis, the space occupied by a 12 in. wall has a capitalized value of $490 per lin. ft. of the space occupied by a wall 3 in. thick only $140.

(3) To locate the effect of added heating costs, particularly in the case of the all-glass wall, an amount has been added to the economic cost of each of the walls corresponding to the average office building heating cost in (New York City) for a ten year period using steam supplied from a central source.

(4) Does not meet 2 hr. fire test.

(5) Does not meet 2 hr. fire test without furring, lath, and plaster.

Prices in all cases are per linear foot of spandrel wall 6 ft. 9 in. high.

Taken from "Total Costs for conventional and Thin walls show that space saving has greatest effect on 'economic cost,'" Architectural Forum, March, 1950, p. 84.
<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>GENERAL DATA</th>
<th>DATA ON 4 IN.</th>
<th>&quot;F&quot; Factor</th>
<th>Cost in place in wall (Incl. mortar or cement and reinforcing)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aggregates</td>
<td>Concrete Mix</td>
<td>Wt. per cu. ft.</td>
<td>Wt. per sq.ft.</td>
<td>Strength per cu. ft.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&amp; Comp.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cinders</td>
<td>40-50</td>
<td>1c-2s-5ci or 1c-10ci</td>
<td>100-120</td>
<td>33-40</td>
<td>1.12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1100 lbs.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expanded Slag</td>
<td>40-60</td>
<td>1c-4.9 fines</td>
<td>100</td>
<td>25</td>
<td>.51</td>
</tr>
<tr>
<td></td>
<td></td>
<td>--5.25 coarse</td>
<td>700 lbs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shale, Slate</td>
<td>40-60</td>
<td>1c-3.4 fines</td>
<td>100</td>
<td>25</td>
<td>.75</td>
</tr>
<tr>
<td>&amp; Clay Base</td>
<td></td>
<td>--5.4 coarse</td>
<td>700 lbs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pumice</td>
<td>30-50</td>
<td>1c-14(3/8&quot;)</td>
<td>50</td>
<td>17</td>
<td>.23</td>
</tr>
<tr>
<td></td>
<td></td>
<td>750 lbs.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>St. Louis</td>
<td>$7.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chicago</td>
<td>8.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pitts.</td>
<td>11.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>New York</td>
<td>12.50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diatomite</td>
<td>20-40</td>
<td>1c-6(fines up to 3/8&quot;)</td>
<td>55</td>
<td>18</td>
<td>.20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>750 lbs.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>St. Louis</td>
<td>$27.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chicago</td>
<td>34.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pitts.</td>
<td>37.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ferlite</td>
<td>5-20</td>
<td>1c-7 to 1c-12</td>
<td>55</td>
<td>13</td>
<td>.25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(fines up to 3/8&quot;)</td>
<td>40</td>
<td>13</td>
<td>.19</td>
</tr>
<tr>
<td></td>
<td>New York</td>
<td>$10.80</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pitts.</td>
<td>12.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(approx.)</td>
<td>3/8&quot;)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>500/1200 lbs.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vermiculite</td>
<td>6-12</td>
<td>1c-4 240 lbs.</td>
<td>30</td>
<td>10</td>
<td>.20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1c-8 70 lbs.</td>
<td>22</td>
<td>7.4</td>
<td>.16</td>
</tr>
</tbody>
</table>

(1) Carloads or truckloads
(2) Pittsburgh
(3) Fire-resistant attachment

"Enlightened" Structures...
The Charles Eames home in Santa Monica, California which employs industrialized products.
How much do we dare "enlighten" our homes to give them the significance of this industrial age? Many people feel that a home must be built of heavy material, such as stone or wood, to give a "homey" atmosphere. I would say that this was relatively true when people were living in secluded areas, driving a horse and buggy, and gathering their materials from nearby woods and quarries. What changes have allowed us to vary this antique manner to fit this present age?

The use of industrial products in a home is well exemplified by Charles Eames in his home located in Santa Monica, California. Mr. Eames does not try to conceal construction with any type of material. He allows his lightweight steel frame to be exposed both on the interior and exterior. The building can still achieve the air of home without the use of the heavy materials which the average home has used so extensively.

Some of the features which "enlighten" the architectural expression of this construction
are the exposed open web joist, the steel roof and wall paneling, the cemesto panel, the exterior plaster panels and the extensive use of glass.

The house actually was an experiment to see how industrial one could become and yet retain the essential feeling of a home. A steel fabricator's catalogue actually was the basis for the construction design. The house is erected much like a lightweight factory but the completed effect is much different. This example of modern architecture is expressive of the industrial age and yet the combinations with the various wall panels have been brought together in a manner that would express beauty as well as the machine age. Beauty can be expressed with a logical design incorporating industrial products.

From a financier's point of view, the building was a complete success. First, where else can one build a home today for $1.00 per cubic foot and yet obtain all of the qualities of spaciousness and beauty which Eames has
achieved? In the economics of home building, it has always been of interest to note the cost of material as compared with the cost of the labor which has erected the same. In traditional frame construction, the cost of labor to erect framing lumber is about 50% of the cost of material. In the Eames' house the cost of labor was about 33% of the cost of steel. Now the 17% reduction certainly seems a factor which home builders should consider. If industrial-produced homes can be built cheaper with use of industrial and affiliated labor techniques and yet obtain the same amount of character, then why not use this talent which this age has benefited the architect with? What is the architect waiting for before he throws away his sticks and stones?

According to Mr. Eames, the pros and cons for the industrialized home are as follows:

PRO

1. Steel could be designed to very close tolerances.

2. Labor costs could be drastically cut:
   Entire structural steel was erected by five men in sixteen hours. Three days later, one man had finished the roof deck. After that, all other trades
could work continuously under cover.

3. Skeleton frame could be filled with an endless variety of interchangeable sheet materials (but one or two had to be rabitted).

4. Space sensation was greatly enhanced by lightness of steel.

5. Poor carpenter workmanship was a worry of the past.

6. There was no condensation in any part of the house during the past year. Layers of warm air under the ceiling did the trick.

**CON**

1. Steel costs more than wood, especially if transported far.

2. Steel must be well protected against weather.

3. Residential wiring and plumbing are still hard to integrate with factory-type structure.

4. Carpenters are easier found than steel-workers.*

---

*"Like a Chinese Kite," Building, September, 1950, p. 96.
A view of the Philip Johnson home in New Canaan, Connecticut showing expansive use of glass in home architecture.
What could be more expressive of architecture of the industrial age than glass? Philip Johnson is more aware of this than many present-day designers. His home in New Canaan, Connecticut has the "enlightened" look. The structure is a simple rectangle 56 x 32 1/2 feet with 10 1/2 feet of glass from floor to ceiling completely enclosing the structure.

In this house nature and industry are allowed to work together to express the feeling of living. Johnson has not incorporated asbestos board, steel panels and open web joists such as Eames used in his home. There is a great deal of character difference in the two. The latter home is a complete industrial product, designed completely from a fabricator's catalogue. The former is a more subtle, sophisticated home with no interior walls except for a round ten foot brick cylinder in one portion of the home enclosing both the toilet and the fireplace. Furthermore, Johnson does not attempt to hide
the structural elements. Six exposed steel columns are employed to hold the roof. The interior is as completely exposed as the house itself is open to the heavily wooded areas surrounding it.

Here we see the usage of glass reflecting the industrial age to its fullest extent.

When a commercial building can be designed to show a substantial saving of 12% in ultimate cost without a reduction in building quality, the architect is performing his duties efficiently. Many possible building projects have been abandoned because of the rising costs since World War II for business men have felt that projects of any large proportions were not feasible at the current building costs. The costs should be reduced at least 10% to make these projects economically reasonable. This certainly seemed a fair reduction for the business men had to compete with companies
The Prudential Insurance Building in Los Angeles, California, which saved 12% of ultimate cost by incorporating lightweight materials. Walter Wurdeman and Welton Becket, architects.
owning buildings erected more than ten years ago for possibly one-half of the present rate.

Such was the case with the Prudential Building in Los Angeles, California, designed by the architects Walter Wurdeman and Welton Becket. The architects were confronted with the problem of reducing the cost without sacrificing the quality of design and material. It was then decided to analyze the rising cost of the many building items which combine to make a completed building. The architects then would try to reduce the costs of the building items which have increased the largest percentage in the last two years. The analysis disclosed that the rise in the cost of certain parts of the work were far in excess of the average rise in building cost.

Building costs could be reduced in one of three ways. There could be a reduction in the quality of the building, there could be a reduction in labor costs and there could
be a reduction in the material costs.

A reduction in the quality of material was immediately nullified for it was felt that the limit of reduction would result only in a high maintenance cost. Since labor and material costs were not likely to be reduced the only alternative was to design a building of the same quality but using less material and labor.

The best manner to reduce this excess cost was to analyze each of the forty-six operations that complete a building and try to reduce the operation where the cost had risen the most. Operation cost rises varied from 23% up to 320% since 1940. Form cost was known to be at a maximum rise of 320% and plumbing costs had risen to 286% of the cost in 1940. Carpentry had risen 185% while on the other hand tile work, metal sash, and linoleum had risen only slightly."

Little could be done with the reduction

---

"Harry Bennet, article on Prudential Life Insurance Building, Building News, March, 1948."
of the plumbing item since material and labor were the main cause of such a rise. It was felt, however, that the cost of form work could be reduced by eliminating as much form work as possible. This could possibly be accomplished by building walls with concrete blown from guns in order to save labor and materials. Also a lighter concrete would eliminate the heavy support needed for the construction of form work. The elimination of deep reveals and the simplification of fireproofing steel framework would also help to reduce forming. It has been roughly estimated that the dead load of a building is approximately five times the design of the live load for which the building is ultimately erected. With a reduction in the dead load it follows that a nearly proportional material savings will be effected, particularly in the reduction of structural reinforcing bars and footings. The problem now is to reduce the weight and yet obtain a structure which is strong in erection and high in fire proof rating.
The architects then decided to erect a building of steel framework enclosed with vermiculite fire proofing since the local building code had been revised to permit the use of vermiculite plaster as a fire protection of the entire structural frame. As a further step in the reduction of dead weight and construction cost some of the front walls had the steel frame fire protected by means of a lightweight gunite blown on to steeltex backing attached to the structural members. The gunite was placed as a hollow shell on both the inner and outer faces of the steel spandrel and other structural members. This construction resulted in the dead weight savings in these structural walls of approximately 50%. This largely eliminated the use of normal form work. Perhaps one of the most important results of this construction has been the reduction of dead weight to live weight proportion, as stated earlier in this paper, the usual dead load to live load proportion is 5 to 1.
This proportion was reduced to 3 to 1 by using a lightweight construction method. Several factors enter into these weight savings. Most important of these were the use of lightweight concrete and vermiculite plaster. The following table summarizes these items of dead weight savings:

**Prudential Insurance Building**

14,500 yds. ltd. wt. Cone x 1,350 lbs. saving equal 19,500,000 lbs. or 9,800 tons

**structural steel saving** 1,000 tons

Vermiculite fireproofing saving 1.5 x 150 equal 225 lbs.

**concrete**

Vermiculite

4 x 6 25 lbs.

\[
\frac{200}{12.5} \]

15 lbs. x 520,000 equal 7,800,000 lbs. or 3,900 tons

**Precast stone facing**

120,000 sq. ft. @ 15 lbs.

1,800,000 lbs. or 900

**Total saving** 15,600

Dead weight as designed 32,000 tons

Design live load, 1st story columns 14,300 tons

Tonnage of structural steel 3,620

---

*Harry Bennet, op. cit.*
In these studies of weight and cost savings, many interesting factors developed. We believe it worthwhile to point out a few of these conclusions.

The average cost of fire protection of structural steel beams with concrete is from 1 1/2 to 2 times the cost of the structural steel beam itself as laid down in the fabricator's yard prior to the costs of fabrication and erection. The weight of stone concrete fire protection for an 18" beam is 225 lbs. per lin. ft. of beam. This fireproofing weight is reduced to only 25 lbs. by the use of vermiculite plaster fire protection. The saving in weight, assuming beams to be spaced at 8 ft. centers, is 25 lbs. per sq. ft. of building area. Furthermore, the 225 lbs. per lin. ft. is 10% of the carrying capacity of the 18" beam on a 25 ft. span. It also developed that vermiculite plaster fire protection can be provided for a cost of less than the cost of forms required for concrete fire protection. It was estimated by the use of
14,000 yards of lightweight concrete that 1,000 tons of structural steel was saved. Structural steel costs approximately 180 dollars per ton erected for this building and although there was an added cost of five dollars per yard of lightweight concrete, nevertheless by the savings in tonnage of steel $180,000 was saved. Other savings which have not been analyzed came about through the reduced amounts of reinforcing steel and footing dimensions.

Architects have proved the worth of the adoption of lightweight construction.

The author feels that further reduction in cost could have been achieved by the use of a light exterior wall facing. For example, if an aluminum panel had been used instead of a tile facing, it would have reduced the weight from 20 pounds to 1/4 pound per square foot. Besides this reduction, the inner wall could have been reduced to a 4 inch
"Lightness without weakness, strength without weight"—slogan of the architectural firm of Wurdeman and Becket which designed the General Petroleum Building in Los Angeles, California.
discrete fireproof wall. This 4" discrete has a four hour firerating as against a four hour fire rating for an 8 inch concrete wall. The complete thickness of the wall could have been reduced approximately from 13 to 8 inches. The wall would have had a "K" factor of .12, approximately twice that of an ordinary masonry wall. There would result an overall saving in heat loss reduction and air conditioning efficiency.

Another building which has contributed considerable influence to lightweight construction is the General Petroleum Building in Los Angeles, California. Ironically enough, the building was designed by the same architects who designed the Prudential Insurance Building, namely, Walter Wurdman and Walton Becket.

This building is located on a corner lot in a congested downtown area. The design is of a contemporary nature and the construction is based predominantly on the advantage of lightweight materials.
The architects were attempting to construct this building at a cost comparable to prewar prices. They did achieve a reduction in price over ordinary construction methods, but it did not approach the savings of the Prudential Building. The 530,000 square feet of building was erected for $11,000,000. Nevertheless, the architects were substantially instrumental in saving from 10-12% of the total cost.

The architects were determined to lower the cost not by reduction in the building quality but by savings in labor and material. The slogan for this firm of architects was "lightness without weakness, strength without weight."

The building was to be erected with the lightest of materials in the easiest manner to reduce the dead load and save labor cost. By the use of a lightweight concrete and blown concrete walls, these savings were as follows:
12,200 yds. lt. wt. conc. x 1,350 lbs. savings = 16,500,000 lbs. or 8,300 tons

Structural steel 1,000 "
Vermiculate fireproof savings 1,000 "
Hollow wall construction 2,800 "
Total savings 13,100 "

Dead weight as designed 25,800 tons
Design live load, 1st story columns 8,300 "
Tonnage of structural steel 3,220 "
Tonnage of steel joist 570 " *

Besides these savings, the temporary form work was reduced to a minimum along with the size of footings and foundation walls which, incidentally, had to be specially designed because of the seismic condition of that area of California.

What could have been done further to "enlighten" this building? Preferably a lighter material on the exterior replacing the tile finish could have been adopted adequately.

Administration Building of Trinity College, San Antonio, Texas, O'Neil Ford, Bartlett Coche, and Harvey Smith, architects. The architects incorporated contemporary structural methods and lightweight panels throughout.
Let's estimate that 120,000 square feet of terra cotta wall surface was used. If the depth of the tile was four inches and it weighed twenty pounds per square foot, then the total wall load would have been approximately 2,400,000 pounds. An aluminum wall surface could not have weighed more than one-half pound per square foot; therefore the wall load could have been reduced to 60,000 pounds. This could have roughly saved 2,340,000 pounds or 1,170 tons by further enlightenment of this building.

One of the most functional of college buildings to be attempted in this modern age is the Trinity College in San Antonio, Texas. The architects, O'Neil Ford, Bartlett Cocke, and Harvey Smith, have incorporated curtain walls and concrete slabs in floors and roofs. Not only have they achieved an industrial effect which seems to enhance the open planning, but also they have proved that "enlightened" contemporary buildings can be built far more
SECTION OF ADMINISTRATION BUILDING AT TRINITY COLLEGE
Administration Building of the Aluminum Company of America at Davenport, Iowa. Harrison and Abramovitz, the architects, used aluminum panels throughout.
THE U.S. PLYWOOD CORP HAS DESIGNED AN EXTERIOR WALL PANEL WITH PORCELAIN ENAMELED STEEL FACINGS BONDED TO HONEYCOMB INSULATION CORE. THE INNER AND OUTER SURFACES ARE NOT IN CONTACT. PANELS ARE SET IN FRAME FORMED BY INSULATED, EXTENDED-ALUMINUM COLUMN COVERS.
economically than traditional structures. This set of buildings not only incorporated curtain walls which lighten the structure, but they also utilize the Youtz-Slick method of pumping concrete slabs on the ground and then jacked them up the column into position. The architects enlightened the wall by using a 3 1/4 inch panel which was composed of fluted aluminum and rigid fiber glass insulation. This panel was erected between the floor and the sill of the window. The window in turn extended clear to the ceiling.

The completed building is an expression of method and function which makes no bones about the use of industrial materials, glass, metal, fiber glass, to express structure and contemporary functional designs.

The Aluminum Company of America, realizing the advertising value of aluminum building, hired the architects Harrison and Abramovitz
TYPICAL SPANDREL SECTION
OF ALCOA ADMINISTRATION BUILDING
to design an administration building and an aluminum plant at Davenport, Iowa. The designers were to use as much aluminum in the building as possible. The results were 47 acres of structure enclosed in lightweight aluminum.

The administration building has a 4-inch lightweight concrete backing and an aluminum facing, 4' x 7' x 3 3/4", weighing 162 pounds a piece. The total walls were 9 1/2" deep. This is a excessively thick wall for a lightweight structure, but the building was designed to meet a four-hour fire rating just like any city structure.

The plant was also enclosed in aluminum panel walls but here the architects used a much lighter panel. They felt that a prefabricated sandwich panel 1 5/8" thick would shelter the plant walls sufficiently.

An amazing fact is that the walls enclosed 3 1/3 miles of plant. The glass in the building is green heat absorbing and provides a beautiful contrast to the metallic surface of the aluminum.
Picture showing the erection of a "breathing wall" at the Consolidated Vultee Factory in Fort Worth, Texas.
Here is a building group which expresses lightweight architecture to its fullest extent. Nowhere in the structures is heavy masonry used. The buildings are truly representative of an industrial age.*

Another good example of a building utilizing industrialized architecture is the Consolidated Vultee Factory in Fort Worth. This building was designed to combat the extreme southern sunlight and heat. Its lightweight shell efficiently accomplishes with only six inches of thickness what ten to twenty feet of stone could not even begin to do. Here the architects have conquered heat and vapor control, sound absorption, and light reflection in a wall of steel panel, fiber glass, a vapor seal, and an interior wall of expanded metal lath. Here we see a massive well-built wall not constructed solely to enclose the building, but rather a lightweight sandwich panel which will provide a precise and specialized

---

WALL CONSTRUCTION OF
CONSOLIDATED VULTEK FACTORY
action.

Because the building was located below the 35° January isotherm, the wall panel was not designed to retain any heat in the winter as would be necessary in any building in the northern part of the United States. The function of the wall was to reflect as much heat as possible since over 300 days per year would be relatively hot. This was accomplished by placing the reflective material on the outside. This wall has the unique distinction of being a breathing wall. This would be of particular advantage in the summer when any interior heat would be absorbed in the fiber glass and released through the top of the wall. How industrialized can we become!

What building today could be more explanatory of our industrialized civilization than the crystal Chapel of Bruce Goff. Goff has put an end to the idea that any building incorporating industrial products looks like a flashy box. He has utilized glass panels to
Interior of the proposed "crystal chapel" to be located on the campus of the University of Oklahoma, Norman, Oklahoma.
achieve "a wig-wam type design and yet obtain an ultra-contemporary structural method."

The panels of glass are prefabricated with two tempered plates of pink glass to reduce glare. The completed building appears to be a glittering crystal reflected against the pools. The use of materials in this building leaves little doubt in one's mind as to the standard of civilization which the structure expresses. No age but a scientific one such as ours could produce such a light airy structure. It figuratively floats off of the ground for the eight inch structural beams are hardly visible. No less than one-quarter inch of glass encloses the complete building. Architects should follow Goff's imaginative use of industrialized materials, incorporated with a modern structural system, to obtain a truly representative contemporary architecture. One can see beauty and feel
The Equitable Savings and Loan Association Building of Portland, Oregon, designed by Pietro Belluchi. This building shows the use of an aluminum and glass facade.
admiration in his soul as he looks upon such
an "enlightened" structure.

One of the most ardent believers in ex-
pressing the modern age through architecture
is Pietro Belluchi. Belluchi is convinced
that building facades should express not only
the construction but also have an industrial-
ized emphasis on the materials which reveal
the structure. He feels that brick, stone,
and tiles are not expressive of an American
style.

The Equitable Savings and Loan Association,
of Portland, Oregon, designed by Belluchi has
attempted to express the prefabricated methods
of this country by using sheet aluminum to
cover the spandrels and columns. The infill-
ing material is completely glass.

This building may be the first one to
fulfill the statement of "crystal and metal
towers." Above the first floor there is not
one square inch of masonry. The cold aluminum
bordering the huge blue-green panels of heat-
Model of the Lake Shore Apartments in Chicago, Illinois, Mies van der Rohe, architect. This building is to have floor-to-ceiling glass walls.
for human beings. The use of glass from floor to ceiling as an exterior wall has a most spacious effect when one looks from the inside to the outside. The facade is very similar to that of the Equitable Life Building of Belluchi, except that in this building, there is a break at the window sill and glass carries down to the floor. In Bellucci's building, the space between the window sill and the floor is covered with aluminum and backed with masonry. The overall effect of the floor to ceiling glass is breathtaking. It is especially adaptable to a building on a site such as this which overlooks the inspiring view of Lake Michigan and North Shore Drive. Mies van der Rohe has incorporated the industrial look in his design by adopting a minimum of exterior wall through the usage of materials expressing our culture—namely, glass and sheet metal. A favorable reaction to this type of apartment building might set the trend toward enlightened architecture in future apartment construction.
The Lever Brothers' Office Building, New York, New York. Skidmore, Owens, and Merrill, architects. This new-style "baby skyscraper" has a skin of glass and metal.
absorbing glass is strikingly beautiful. Belluchi's arguments for the new look were lighter weight, quicker installations, and low maintenance. Here is a situation where the building code officials would not allow the lightweight aggregate to be used as a backing. The building code requires that the architect back the aluminum facing with a four-inch concrete wall.

The amount of cement used for backing up the aluminum is still quite small in comparison with the seven and a half feet of flat glass which encircles the building on every floor (36,700 square feet). However, a substantial amount of dead load could have been reduced if a lightweight back-up material had been incorporated into the structure. The building is a fine example of enlightened architecture.

A most unusual design for apartments is the Lake Shore Apartments in Chicago. The architect employed the use of metal and glass facade to achieve the effect of a "crystal cage"
There is no question as to the fact that this building was designed in recent years. Any person looking at this building twenty years hence will recognize a building incorporating industrialized material, and will immediately realize that the product could not have preceded the relatively recent industrialized age. A building such as this gives architecture its own true style.

Many authorities claim that the most distinctive and outstanding office building erected since World War II is the Lever Brothers' Office Building in New York City. The architects—Skidmore, Owens, and Merrill—combined the products of our industrial age to enclose a building which is not only "enlightened" in appearance, but also in planning.

Picture a tower of glass and metal sitting on stilts, a little aloof from the busy Park Avenue and its enclosing grey masonry structure; this is the way in which this industrial structure
TYPICAL WALL SECTION FOR THE LEVER HOUSE
The building was constructed to be enclosed with a spandrel curtain wall of blue-wired glass with a four-inch cinder block backing and an additional two-inch insulation of foam glass. The mullion between the windows is large enough to carry any load exerted by the wind. Since this is an office building and much more duct work is required and therefore a thicker spandral, the facade of the building does not appear quite as translucent as the apartment house of van der Rohe in Chicago. Rather than having floor-to-ceiling clear glass as van der Rohe incorporated, here the architects used a translucent glass and backing from the sill down to the head of the window of the floor below. An aluminum horizontal band one-foot and two-inches wide trims the head of the window. Personally, I feel that this band would have been placed more appropriately at the floor level, for one achieves the illusion of the floor level being
A mock-up built by the architects Saarinen, Saarinen and Associates, to test materials to be used in the General Motors Technical Center outside of Detroit, Michigan.
behind the aluminum band. Nevertheless, the architects have studied cost of materials and maintenance and have built this structure enclosed in glass and aluminum not only for its aesthetic value but also for the initial and future reduction of maintenance costs.

Architects Saarinen, Saarinen and Associates realized the usefulness of an industrialized facade in their recent design of the General Motors Technical Center outside of Detroit. The buildings are designed on a five-foot module, making the structure suitable for panel facing which is used throughout. The architects felt that since these buildings had to be designed for future expansion, it was best to incorporate a facade of modular construction in order that the building would look completed at all times. They felt that most projects designed for later expansion very rarely appear symmetrically balanced. However, panels of modular type would give the building
a more finished appearance.

It was then decided to use heat absorbing doubleplated blue-green glass and metal walls in five-foot sections. To prove that something industrial can be designed in an artistic manner, the architects developed a full-sized mock-up of the exterior walls section to study the artistic along with weathering effects. The mock-ups were developed in various proportions of glass to metal used. Trees and other natural conditions were also included to study the shading effect upon the facades. The architects selected the panel which achieved the highest aesthetic quality and yet performed the desired work. Thus the completed structure is a well thought-out building artistically expressing our industrialized age.
Conclusion...
And so today, several thousand years after the dominance of classical architecture, some buildings are still being erected with similar materials and sometimes employing similar laborious methods of construction. The purpose of this paper has been to enumerate the advantages which can be secured from the use of lightweight materials when employed in architecture. I have tried to point out that thick heavy masonry walls are no longer necessary. Thin walls can perform the function of barriers much more functionally and economically. Walls are no longer needed to withstand the heavy blows of invading warriors. Heat loss, condensation, leakage, weight, cost, and aesthetic value are the functions which we should think about.

I have tried to point out that construction is the basis for all building and that new materials and building methods should be employed in present-day construction in order that a contemporary aesthetic feeling can be produced. It has been the confirmed opinion of such well-established architects as
The Boots Pure Company at Beesten, England, has incorporated glass walls to reveal a structural system. The columns are completely exposed and the horizontal lines of the floor slab tend to tie the glass to the heavier frame.

Architect: Sir Owen Williams

Eric Mendelsohn, architect, uses a contemporary facade of expansive glass windows in the Schoken Store at Chemnitz, Germany. The structure expresses the characteristic of a scientific age which is only possible by the selection of lightweight materials.

Van Relle Factory, Rotterdam, Holland, incorporates a lightweight glass wall which allows horizontal lines to flow to vertical mass elements forming effective building design completely expressed by the use of lightweight materials.

LeCorbusier, Lascaze, Belluchi, Mies van der Rohe, and Goff that industrialized materials have found their place in architecture and should be incorporated in construction much more than they have been in the past.

Designers such as Charles Eames and Philip Johnson have contributed to art the value which can be had from employing industrialized products in home architecture. Building code committees throughout the States are awakening and beginning to realize the fallacy of their traditional codes. Perhaps they are learning of new products and their ratings and are giving them the opportunities which they deserve. If these products are not given sufficient ratings, it is up to the architects, engineers, and manufacturers to see that they are allowed to be used. Everyone should benefit from our scientific research and this can be secured only if the cooperation of the building code committees is assured.
The most feasible way of "enlightening" any building besides the use of lightweight aggregate fireproof materials is through the medium of the curtain wall. I have tried to point out that these walls could be made of large modules of material such as copper, aluminum, steel, glass, asbestos, plywood, and plastic, all of which can be erected with time-saving methods thereby eliminating the laborious wall building system of the past.

Price statistics which have been compiled seem to favor lightweight aggregates and wall panels over masonry; however, I realize that these figures have been compiled mainly by manufacturers who are trying to sell their products. For this reason I cannot completely adhere to the conviction that the cost reductions are as great as they appear to be in this computed data. However, I do feel that there is a substantial savings to be considered when available products are used near their source of manufacture and
skilled labor is available.

Also over a period of years it has been proved that many of these lightweight materials require a minimum of maintenance. Since we are in an age of specialization and differentiation which always follows in the wake of scientific progress, it seems only reasonable that we are headed toward a totally differentiated and prefabricated structure. Why not prepare now?!

Since the cost of modern office buildings is now $1.20-1.30 per cubic foot as compared with $.75 in the late 1930's, it is only fair to the businessman that architects try to reduce the cost as much as possible. Wurdeman and Beckett saved 10-12% of the total cost of erection by using lightweight materials. Why cannot all architects attempt to do this same service for the public? They have shown where labor is the main factor in the rise of building costs. Today labor is producing only 81% of what it did in 1941
The Parklaan Apartment in Rotterdam, Holland exemplifies "enlightened" architecture. The building is enclosed in large moduled sheet material in such a manner as to express structure hand in hand with aesthetics.

Architect: W. van Tijen

Glazed Staircase Tower of Trade School in Stockholm, Sweden. This shows the aesthetics of a glass skin when related to another structural form.

Architect: P. Hedgvist

The Bauhaus at Dessau, Germany is a structural frame completely enclosed in glass facing. There is no attempt to hide the structure which is enhanced by the revealing transparency.

Architect: Walter Gropius & Associates
according to the Dow Service. Prefabricated materials could eliminate the need for considerable amounts of this relatively inefficient and expensive labor. To the claim that such labor-saving materials will have the effect of ruining the labor market, it might be replied that the lowered cost of construction so achieved should result in larger amounts of construction, which in turn would increase the demand for labor technicians.

With the use of lightweight panels we find that science provides us with a new method of construction which is not haphazard but designed to meet special requirements. There is little waste of time, mass, effort, and speed. These thin materials, metals, fiberboard, and plywood, use tensile strength to most advantage while employed as stressed skins.

By using industrial products construction no longer resembles structures of materials which nature supplies but instead
we use a man-made synthetic material and structural system. Once architecture was felt to be a homogeneous product of nature. No longer is this true for today we find smooth reflecting surfaces in complete contrast with the appearance of the earth but giving architecture a new expression distinctively its own. With the uniformity of machine products the everchanging natural surroundings become an indispensable element of composition to avoid monotony.

Some architects and clients feel that buildings erected of industrialized products tend to leave a "tin can" effect. There is no variety, nothing sensational. I believe that these shiny industrialized products can create an artistic facade by the proper combination of shapes and sizes. Industrial products used as building materials are still in embryo. We have not given them a chance to prove themselves.

Allow yourself to imagine the unlimited
view made possible by transparent walls. Think of the beauty of reflection upon polished surfaces. Imagine light structural framework boldly expressing construction with thin sheets of aluminum stretched between spandrels. This is the industrialized structure which only we can possibly produce. This is the architectural mode of the twentieth century. This industrialized world in which we are living has to be expressed and can be expressed by one profession alone, that of the architects.

It was not long ago that man gave up the horse and carriage for the automobile. Even today the automobile is being partially replaced by the airplane. In architecture stone structural frames have been replaced by cast iron, which in turn were eventually replaced by steel. There is no question in my mind that outmoded heavy-weight buildings have passed their prime. No longer are they necessary. They are becoming as dated as
the horse and buggy. Let us start immediately with the fine facilities which we have at our disposal. Let us employ wholeheartedly "enlightened" construction.
BIBLIOGRAPHY

Books


Periodicals


**Pamphlets**

Alsynite. San Diego, California, n.d.


