SHELTER

Dáithí Ó Broin

<u>CONTENTS</u>

INTRODUCTION

When considering the growth and development of mans shelter from the cave to the high technology modular system building of the present day, it is perhaps best to "start at the beginning, work through to the middle and then proceed to the end."

There is some dispute as to whether or not man did in fact commence his property speculation in the form of tree and cave dwellings. Man is by nature anatomically unsuited for the hectic climbing and swinging life which tree dwelling would involve. Most tree houses have been attributed to uses of lookout posts, storehouses or places of refuge from enemies or wild animals perhaps. Trees however did provide a source of material from which a more adaptable and comfortable residence could be manufactured.

On the other hand caves could only have been utilized in the limited areas where they occured and indeed it has been found that whereever there are caves man has taken advantage of them. It has also been found though that the lack of this preferental form of dwelling may be the main cause for the development and evolution of the domestic dwelling.

A lone hunter or traveler faced with the dilemma of having no cave in which to pass the night would seek shelter underneath a bush or by digging a pit and using skins or clothing to form a roof. Wehn applied to a number of people the situation requires a little invention. It being doubtful that a large enough bush would be present to cater for a family, then a number of bushes, or their limbs would need to be joined to form a type of hut.. Examples of this are to be found in many parts of the world, as in Australia and Somalia.

Here a party of natives would settle for a night behind a wind - screen of leafy boughs. Interlacing the boughs overhead provided more cover when the weather took a turn for the worse.

This creativeness can be found all over the world and varies depend - ing on climate, materials available, culture and also the available local skills. Africa displays residences of wood, grass, reeds, mud and occasionally stone. In its northern deserts appear tents of animal hair and skins. Tents are also to be found in Asia, where skins and brushwood supplement the cloths. Again mud and straw dwellings are to be found. In the Americas materials range from the stone structures of the Incas to the wigwams and earth lodges of the Pawnee. Adobe houses are also found and the Eskimos make use of timber, stone, whale bones and of course ice and snow.

These materials above have been used alone and in conjunction with each other to form the conerstones of modern architecture local climatic conditions and dangers have influenced their uses and evolved designs which although unique are assimulated in many modern structures.

Where dangers of flooding or preditors were evident houses were often constructed on piles or stilts. Examples of these are to be found all over the world, as in the communal "long houses" of Austrialian New Guinea.

Mud walled houses have also been built on piles, as found in Africa. Here also a variety in shapes is to be found with houses which are hemispherical, peaked, asymetrical, high walled, and some only a few feet high. Rectangular houses are also to be found. Many mud houses have additions or "lean-to's" of a different material such as reeds or palm trees.

How then have these materials evolved down the years and how much have their uses changed? Today examples of all the mentioned materials may be found in use as they were hundreds of years ago. In the more developed countries however new materials have replaced old and new building techniques given rise to new structures. Concrete has replaced mud and the individual home replaced the communal lodge. And even over the past few decades great changes in building systems have been made. It is in this direction we now follow the development of mans shelter.

SYSTEM BUILDING

It is strange that while the industrial revolution provided us with superb methods of producing our cloths, transport appliances, furniture and electronic equipment, methods of building have progressed little in a hundred years.

But this is changing now. System building is bringing the building industry into the machine age and will enable all of us to live in clean and healthy surroundings, pleasing to our aesthetic feelings and at a cost which will be favourable to everybodys pocket.

Everything new has its opponents. Yet just as the mud thrown at horseless carriages did not stop the development of the car industry, progress in building will proceed in spite of all opposition.

What advantages lie in a system building? The buildings can be erected more quickly than traditional methods and a much smaller labour force is needed on site. Such buildings are often lighter in weight than conventional buildings and thus there is a saving in materials and foundation costs, the latter being due to the shallower foundation needed. Furthermore they are often more suitable for the purpose for which they are built, better insulated, with improved systems of heating, ventilation and layout. Moreover most systems involve the prefabrication of many components in a factory, where conditions are such as to avoid the seasonal unemployment of building operatives. Workers can do their jobs under greater conditions of comfort and have the help of better mechanized appliances that would not be possible in the mud and slush of the building site.

System building also allows the practise of modular co - ordination. This universal system links the requirements of the designer, manufacturer and builder by co - ordinating dimensions of materials and components, through the use of a basic module, specifying a system of tolerances and establishing a modular grid reference system by which all components are located.

Advantages also include;

(a) The simplification of the planning of buildings by use of a modular reference grid.

(b) Facilitating the design of standard components which may be used in various combinations in a variety of building types.

(c) The facility of substituting alternative materials and changes in specifications without the necessity of replanning. This gives flexibility to the original design.

(d) Provision of structural and mechanical integration giving greater standardisation of services required.

But this does not mean that it is necessary for all buildings to look alike. In fact the reverse is true. In traditional building it may be necessary to standardize the houses of an estate in order to keep costs of materials and building down. More variation may be possible when strictly modular prefabricated sections are used. In system building a large variety of different surfaces are also used; ceramic, polished concrete, tiles,exposed aggregates of all types, coloured and textured concrete, and brick.

In fact the range of materials used by the building industry today is so wide that it is best to look at it under a series of headings. Rather than looking at a material and see to what use it could be put instead now the technical construction requisit is viewed and a material chosen whicw will best suit the needs of that construction. Materials shall now be viewed in reference to their usual function. Following this the most popular materials will be examined from the point of view of historical background, properfies and production of and example of its use in the system building world.

A last word on system building. The use of system building also allows for the use of rational methods of heating, waste disposal and water supply. This allows for the rapid erection of dwellings and is of particular use to industries which need to provide assurance to employees that working for them will not present any problems of searching for somewhere to live.

MATERIALS OF BUILDING

How best to view the materials of building. In system building construction takes the form of assembling units, sub units and panels according to a grid plan. Depending on the system chosen a set pathway of construction from foundations to roofing will be available and should be followed to achieve best results. Rather like the construction of a model aircraft from a provided kit, a system building, although free from a repetitive outlay, must make proper use of unit parts.

Materials may then be viewed from the concept of having seperate structural, jointing, surfacing, insulating, etc., units. The major subdivisions in materials would then be as follows.

Structural Materials	-	The materials used to provide the main components of a building.
Jointing Materials	-	Used in the bonding of the structural materials.
Surfacing Materials	-	Used to give aesthetics to the structures.
Insulating Materials	-	Similar to the surfacing materials but used for practical rather than aesthetic reasons.
Miscellaneous	-	Materials which cannot be directly included into any of the above headings.

A more detailed breakdown of each subdivision now shows use of individual materials for its relevent property. Structural materials comprising of (a) frames in steel, reinforced concrete, prestressed concrete and timber, used for beams stonchions, roof trusses, etc., (b) Load bearing components such as natural stone, bricks, concrete blocks, (c) external cladding of stone and concrete slabs, aerated concrete slabs, timber, glass, steel (corrugated and stainless,) asbestos, and aluminium, (d) internal cladding of wallboards, plasterboards, chipboards, plywood, plastics, bricks and facing blocks. Jointing materials cement mortar, lime mortar, cement - lime mortar, putties, bonding mastics, nails, screws, and rivets. Surfacing materials (a). Flooring of hardwoods in planks, strips or blocks, plywood sheets, granolithic compositions, stone slabs, clay and concrete tiles, asphalt, cork, plastics, and rubber. (b) Walls of gypsum, lime and cement - lime plasters, tiles in ceramic or plastic. Also used are paints, distempers, and paper.

Insulating materials (a) Rain and damp proofing provided for by using concrete and clay roof tiles, slates, corrugated asbestos, aluminium, steel rubber tiles, plastics, glass, and asphalt and bituminous felt coverings. Damp proof courses of asphalt, bitumin, felt, plastics, and soft metals, covered by concrete are common for floors.

Heat insulation (b) is provided for by use of lightweight concrete blocks and slabs, wood wall slabs, insulation board, glass fiber mats, foamed polystyrene fillings and slabs, and cork.

Sound insulation (c) is also catered for by the above and also by use of heavier/denser materials.

Miscellaneous materials. Cast iron, asbestos cement and plastics for gutters. Lead, copper and polyethelene pipes for fresh and waste waters. Clay, concrete and pitch fibre pipes for drainage and sewer works. Sanitary ware mainly in glazed earthenware, vitreous china, stainless steel, enameled iron, or glass fibre re-inforced plastics. Door and window furniture makes use of timbers, metals and plastics.

Thus are generalized the various materials used in the building industry. A glance at the listings though will show that some materials appear a number of times under different headings. In reference to system building then this may not be the best context in which to view the materials. It is important however as a basic guideline to help create a picture of how each material can be used. To clarify the matter somewhat the materials will now be further classified. This time it will simply be by type. A small clear list of headings will then be formed which will include the most popular materials used in system building. As an aid to understanding why these materials have been chosen and how they are used, each material will be viewed from historical, methods of production and favouring properties, and also an example of the material in use in the systems building scheme will be shown, where possible.

Detailed examination of each material is outside the span of this work as the time factor needed to investigate the ever changing uses is much to great, as would be the final amount of data to be presented. In some cases therefore materials will be treated in general context, but reference shall be made to more detailed works should the reader wish to pursue any individual materials investigation.

WOOD

Wood is perhaps one of the most universally used materials in building and has always been a prominant material in the construction industry for many reasons. It is easily worked, has durability and a natural beauty. It has great ability to absorb shocks from sudden loads and in addition it has freedom from rust and corrosion. It is comparitively light in weight and is adaptable to a countless variety of purposes. Its one drawback is that unless protected it will have a tendancy to decay if it is subject to prolonged wetting or certain types of insect attack.

In prehistoric times wood was used for buildings almost everywhere. This is evident by the many traces and remains found by archeological excavation. Wood was the usual material throughout the high middle ages for all buildings excepting those of great importance, as for example castles, churches, and palaces. Although these do lend to the use of wood in substructures, (such as porches, lean-to's etc.,) and in roofing structures.

It is unfortunate that the manner of building with wood in early times has lead to the disappearance of many of the all wood structures. Little was known of preservatives and the useful life of buildings was limited to the time it took the principle supporting members to rot. Replacement of these not being worthwhile because the rest of the structure was not usually sufficiently well built to justify it. This can be inferred from the irregulat spacings of principle posts and the lack of clear relation between them and the posts of side and end walls; irregularity which precludes prefabrication and the possibility of precise jointing together of the timbers. Surviving buildings owe their existance to a switch from using mud to stone for packing the base of the principle posts into the ground, thus eliminating the greatest source of dampness and rot.

This change probably occured during the late eleventh or early twelfth century. Since the stone base did not give us great stability as packed mud however, horizontal and vertical components of a building now had to be based against each other to give a stable structure which was rigid and self supportive. Many examples of braced wooden structures can be found in churches and houses. By the second half of the twelfth century half of the great representional halls of magrates incorporated stone bases for arcades contemporary with the stone outer walls.

From mid thirteenth century onwards this new technique of timber - working becomes commoner in many places and with that appeat regional variations in structure and ornament. Many buildings were constructed with an aisle but equal nembers are aisleless. Each building having its own individual roof construction characteristics of spreading the roof weight over the walls or transmitting it to the ground by way of trusse's positioned internally.

These characteristics are also common to the great manors constructed in this period. Development in structures then took the form of seperating entrances from the main body or room (screens to prevent draughts were supported by roof trusses called "space-truss"), provision of additional rooms (achieved sometimes by extending the roof structure and finishing of with a lipped end), to give a more spacious appearance to the main nall the roof construction was made less cumbersome with new forms of truss and less supporting posts.

Towards the end of the fourteenth century aisled nalls were becoming obsolete and indeed timber houses were much less common being replaced by stone and brick. Then timber was again relegated to the position of frames and fittings.

Nearly everywhere stonebased timber houses began to be built and a technique of prefabrication of frames evolved due to the "mass" building by people of a lower social social class. Examples of this are apparent in many old towns in the form of pubs and inn houses.

Most town houses were now constructed by means of a frame of timber with filled in walls of brick or mud. Timber was also used extensively as decorative mouldings, archways and canopys.

It was however rapidly loosing ground to brick and the Great Fire of London in 1666 dealt it a death blow. The use of timber as a structural material was diminished and it was relegated to fittings and decoration only. This trend has continued to the present although now it is being reviewed by the discovery of preservatives and fire resisting coatings. System building and prefabrication ingeneral have done much to raise the respectability of timber from the ashes of the London fire. But although the construction of schools, hospitals, commercial and industrial premises from mainly timber prefabricated components is popular, the erection of timber houses is limited.

There are strict bylaws governing such construction and although these may be harsh they are perhaps justified when old fashioned and unguarded methods of heating, such as open fires, are used. However with more modern forms of heating the fire risk should not be any greater with timber dwellings than with other forms of dwelling.

Prefabricated timber houses have many advantages over traditional brick houses, once the difficulty of siting has been overcome. The insul - ating (U - value) of the walls of most timber houses is higher than brick, thus resulting in a more insulated and warmer dwelling. As timber is lighter than brick the foundations can be lighter too. The time of erection of a timber dwelling is much shorter than that of a brick house. Timber housing is also a "dry construction" allowing for more immediate use. This means that overall, the price of the prefabricated dwelling is much lower than that of conventional brick built houses.

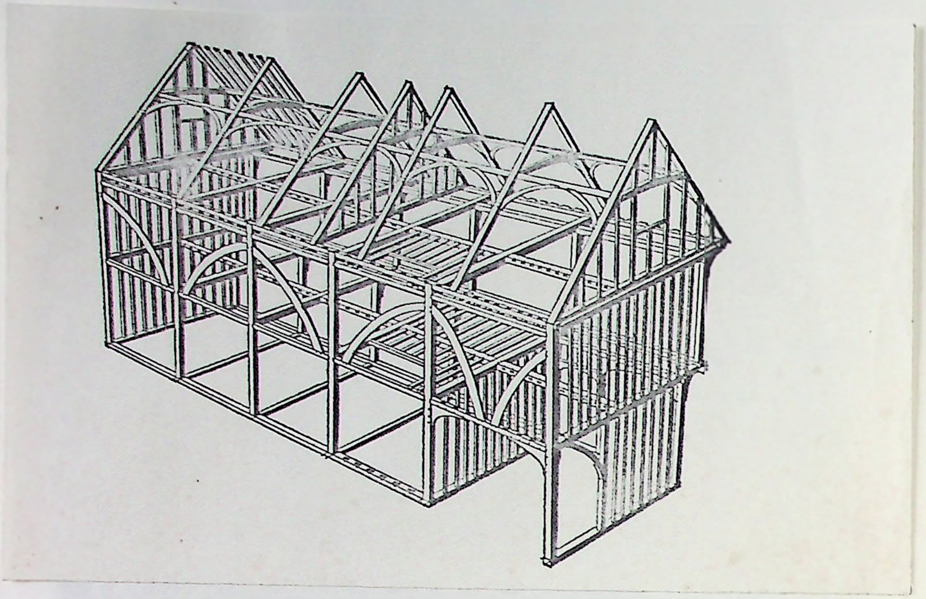
There are increasing numbers of timber formed houses on the market. These are recognized by their trade names (as are most forms of prefabricated systems) such as "Colt Homes" "Cedar Homes" "Hallam Timber" etc.

To illustrate the type of construction involved a short summary of some systems will now be given.

Colt Houses : Cedar wood is used here which has been impregnated by vacuum and pressing, with copper sulphate to prevent rotting. Foundations for the house are in the form of concrete refts. The chimney stack and drainage system laid. Walls and partitions are then erected and bolted together on top of a damp proof course (eg. bitumin). The trusses are erected and fixed into position with ceiling panels, inter - mediate rafters, purlins and ridges. Batten frames are assembled and the roof is shingled. Utility services (gas, water, electricity) are installed. Windows and doors, supplied as frames, are glazed on site. Floors are coated with screed and all joints and miscellaneous fittings (electrics, etc.) are covered. The house is now complete.

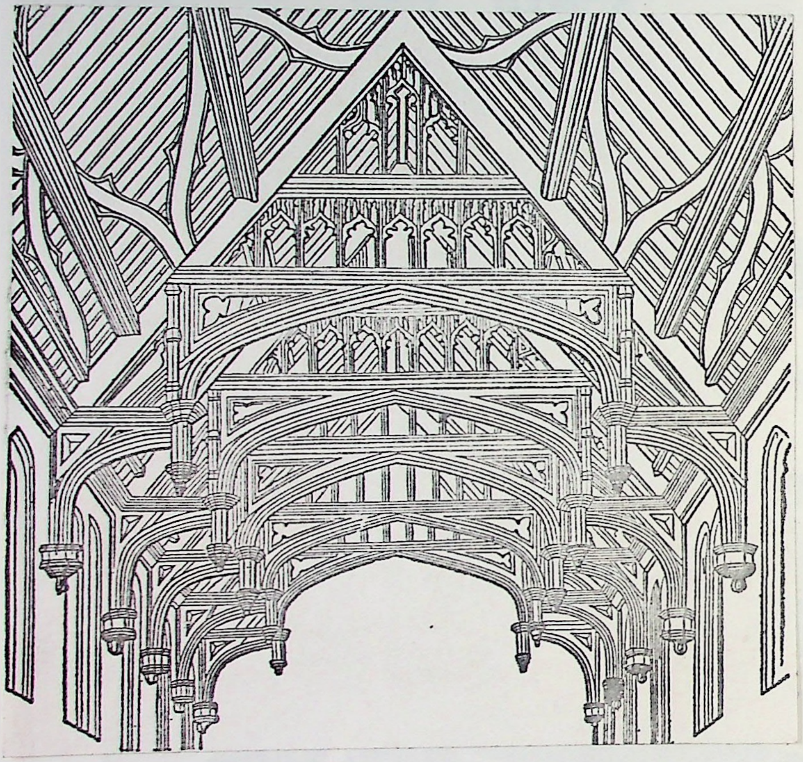
Instead of panel assembly houses may come in complete prefabricated sections as with "Cedar Homes". The one failing with timber dwellings is that the actual building is sometimes faced with brick. This lengthens the construction time yet does not really benefit the home. If facings must be used they should perhaps also be prefabricated in some way.

OLD GERMAN WOODCRAFT

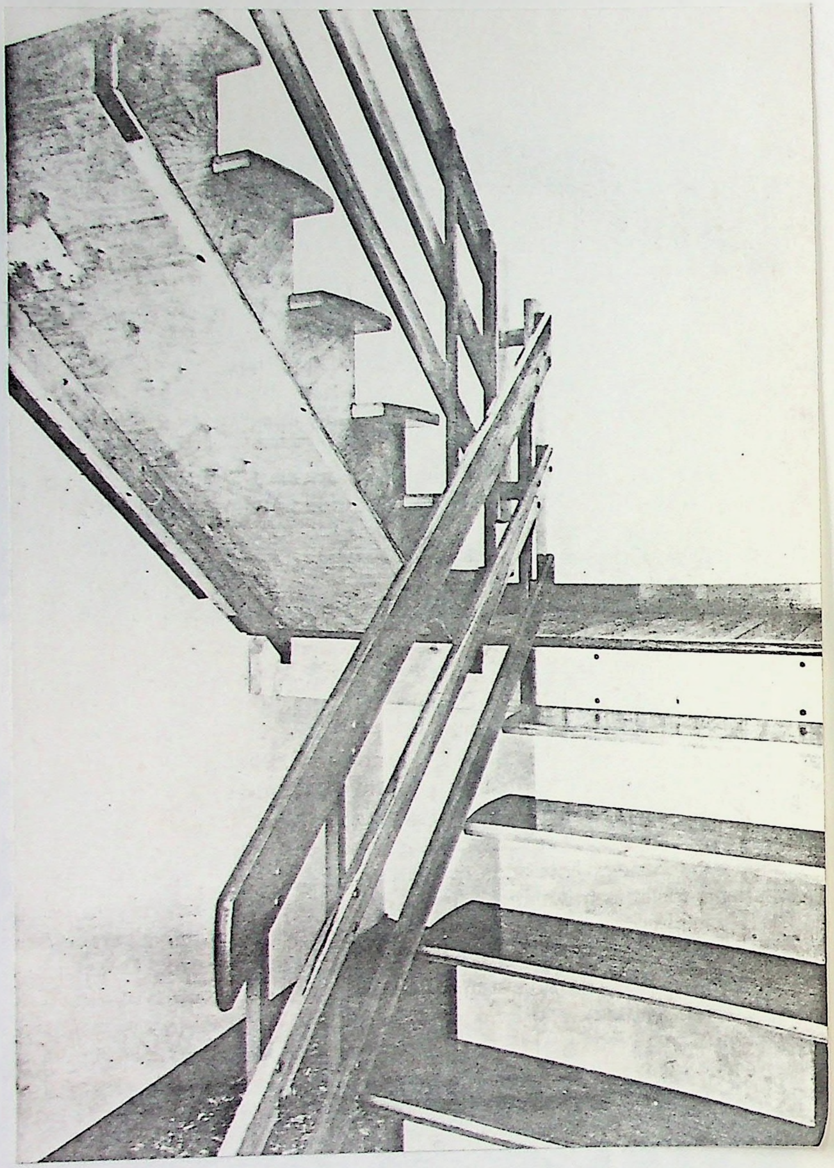


WOODEN "SKELETON"

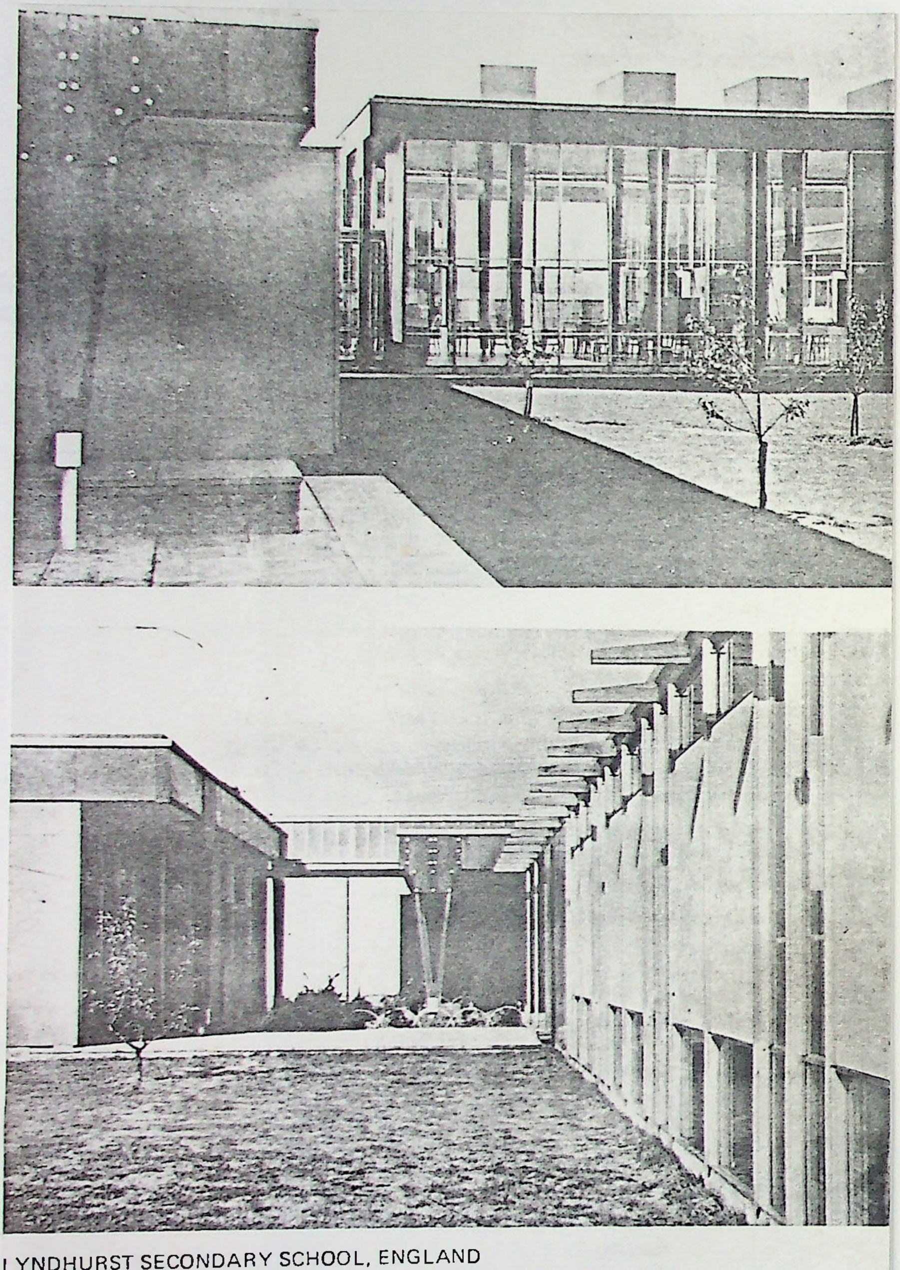
A COMPLETE BUILDING



WOODEN AILSE

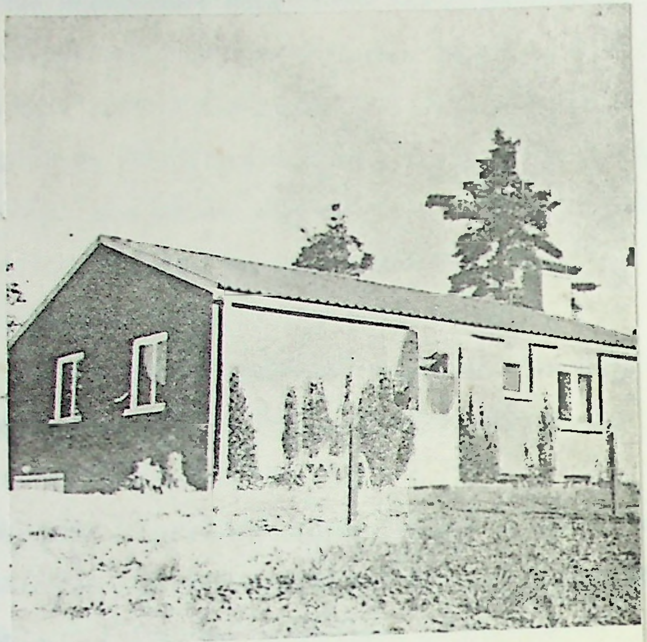


RATIONALISED STAIRCASE DESIGN

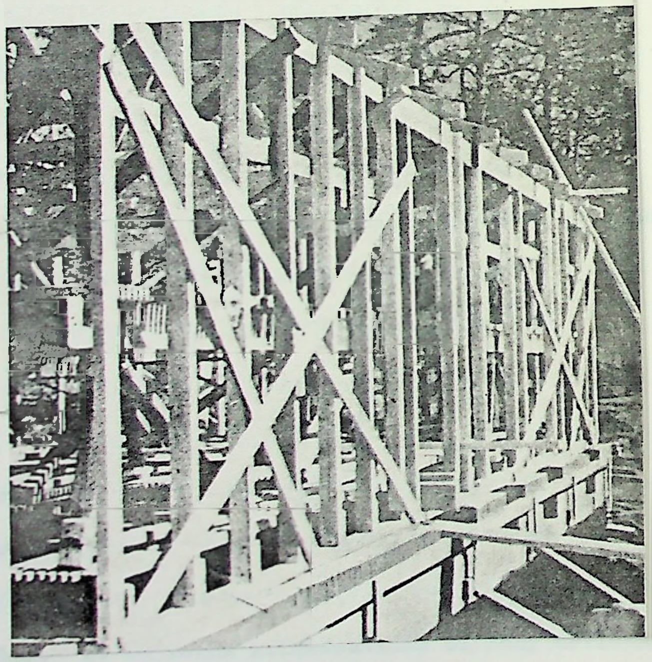


LYNDHURST SECONDARY SCHOOL, ENGLAND
Timber framed building designed on a modular basis

Timber-framed single storey house



Timber framework



BRICK

The Brickmakers Song

"A house well builded is ne'er in vain,
For it neither totters nor falls,
So you may laugh at the lash of the rain,
On the face of your sturdy walls."

Brick is the traditional building material of the British Ilse, stemming from the use of the material mearest to hand.

It was introduced supposedly by the Romans but baking clay for uses other than pottery is ancient and in fact brick loom weights have been found among Celtic remains of pre 100 B.C.

"In the late Celtic tumulus at Hale Magna, Lincolnshire, a hand made brick was found with it yellow, purple and pale red bricks were also found".

Many examples of Roman wall bricks are to be found in Britian and indeed many cases where Roman ruins have been scavenged for bricks to be used in newer buildings are also to be found. Colchester Castle and Saint Botalphs Priory Church show extensive use of Roman brick in their structures.

The process of brickmaking in the past was a more lengthy one than it is now. Roman bricks are believed to have been made by kneeding plastic earth, beating it into shape and then burning it throughly in kilns. Unfortunately there is little evidence of early brickmaking process's to be found in the British Ilse but Medieval representations can be found in an early Netherland Bible.

Although it is supposed to be a representation of Jews making bricks, it is really a picture of brickmaking in the artists own country.

Further illustrations are found in a work entitled MANOTTNIA, published in Frankfurt in 1568. It contains illustrations of many artisans, mechanics and others, among them the brickmaker.

A detailed description of brickmaking is to be found in a work published in 1761.

"The Moulder plunges his arm into the heap of earth, cuts off a piece weighing from fourteen to fifteen pounds, throws it, in the first place, into the compartment of the mould nearest him, levelling it at the same time with his hand by heaping up the material in it, the excess of which he throws into the second compartment, which was not filled up at the first charge, like the other. He levels this compartment too, by hand, heaping up the earth and filling the empty spaces. Seizing, at the same time, with his right hand, the stake, the handle of which is conveniently placed at the edge of the wetting trough, in which it has been soaking, he passes it firmly across the mould to remove all that exceeds the twenty eight or twenty nine "Lignes" of thickness the two bricks should be. He gives a tap ... to separate the two bricks ... The Carrier at once draws the mould towards him ... turning it over, he lays it with the two bricks flat on the ground and lifts up the mould."

Modern plants have been made much more efficient as a result of technol - ogical advances during the past hundred years. A more complete knowledge of raw materials and their properties, better kilns and control of burning and more and better machinery have all aided the development of a highly efficient industry.

The basic ingredient is still clay, with has some specific properties. It must have plasticity when wet, to be moulded and shaped. It must have sufficient tensile strenght to keep its shape after forming and clay particles must fuse together when subjected to high tempertures.

Most clays are mined from open pits and transferred to storage bins where they may be blended and mixed to give optimum chemical composition. It is then crushed and stones removed, further grinding follows this. The clay is then ready for forming.

It is mixed with water in a "Pug" mill until a desired state of plasticity is achieved. The clay is then transfered to dies where it may be textured. The next step is to place it in kilns and let it be dried.

After drying the bricks may be glazed with ceramics which are sprayed onto one or more of the brick surfaces. The bricks are then burned and it is now that they may be coloured by burning gases at appropriate times in the process. Cooling of the bricks then follows.

In all the process may range from one hundred and eighty to three hundred hours per cycle but a large number of bricks can be handled by the machinery in this time.

Bricks have been used not only as a structural material but also as decorative mouldings and in conjunction with other materials. The properties of brick are seen as colour, texture, size, strength, and absorbtion.

One of the most impressive uses of brick must surely be the fine chimneys constructed in past centuries. Not only the huge brick chimneys of industry but also the decorative, sometimes spiraling, chimneys of domestic housing. Bricks and brick work also appear in many gateways and garden details, and in the more common places as doorways, porches and windows. Bricks are solid units and may be moulded or worked to shape. Tiles are made from the same material by the same precess but are usually hollow units.

How has brickwork developed in the building industry during the past few years? Modern prefabrication techniques mainly use reinforced concrete as a basis. Brickwork is still traditionally erected labouriously brick by brick in the open, and, unfortunately, with the development of system building techniques, shows considerable disavantages over the neat sandwich units used in industrialized building. Yet brickwork has some enormous inherent advantages over concrete.

Its appearance appeals particularly to traditionally - minded members of the public and it also has far better weathering properties to concrete.

Some development work with prefabricated brick panels has recently been carried out. The types of units used are similar to most prefabricated building systems.

External walls re made from units which are produced in "story high" dimensions (2,400 - 3,000mm.). The external leaf is reinforced with steel rods and consists of facing bricks 70mm. thick held together by a cement mortar. Then follows a layer of mineral wool and an internal brick leaf. The two leaves are joined by wallties to form a coherent whole. The internal surface may be finished off, in factory or on site, by being plastered. The unit width conforms to the norms for the bricks employed. Units may be employed as load bearing elements ar as an infill and as apron panels. Internal walls are standardized and made from 70mm. thick brick with a width of 500mm., plastered on both sides. Chimneys are built in a factory using completely traditional brickwork. Due to the conditions of work, it is possible to achieve far greater accuracy and control than would be possible on site. The units are made in sizes so that the weight is minimized. Units are positioned and stacked and then bonded using a cement to form a good joint.

ILLUSTRATION FROM NETHERLAND BIBLE

Laterarius. Der Ziegler.

TEcta q; in domibus nusq̄. bene firma vacillāt,
Tuta quod à pluuijs imbribus esse solent.
Siue domo paries fiat communis in vlla,
Seu validos mūros ædificare voles.

Omnia fornaci laterarius adfero nostræ,
Cùm facili lateres prouidus arte coquo.
Me petat, & lapides sibi deferat ocyus emptos,
Alta domus ventu cuius aperta patet.
Agriopes gnatum Cinyram tam nobilis artis,
Longa repertorem fama fuisse probat.

M Figu-

BRICKMAKER c. 1568

BRICKMAKING - FRANCE c.1761

CONCRETE

Cements have been known and used for at least two thousand years. The Romans used a great deal of this material in their construction projects, many of which still stand. The cements they used were natural and pozzalen cements, made from mixtures of limestone and clay and also slaked lime and volcanic ash containing silica.

It was not until 1824 that the first step was made in producing the type of cement with which we are familiar today. The inventor was Joseph Aspclin and he produced a powder made from a mixture of limestone and clay. He called it Portland cement because when it hardened it produced a material resembling stone from the quarries near Portland, England.

Although the method of making cement has been improved upon since that time the basic process has remained. Modern cement is made from materials which contain lime, silica, aluminia and iron components. Raw materials are pulverized and mixed in proportions such that the resulting mixture will have the desired chemical composition, sometimes being moistened, kiln baked and recrushed.

Cement has many useful properties. Among them are its fineness, soundness, short setting time, and consistancy. It is used in conjunction with sand and/or lime to creat a mortar which can then be used as a jointing compound in block and brickwork. Concrete is an artifical stone made by binding some inert material with a paste of cement and water. Among the materials used are sand, gravel, crushed stone, cinders, furnace slag, clay, and perlite.

In general cement has been used as a jointing or filling agent and as the raw material for the construction of building blocks. The concept of building with concrete structural members which have been cast and cured in a factory have stemmed from this and has found acceptance in recent years.

Prefabricated, reinforced units go under the general heading of PRECASTE CONCRETE and the rapid growth of its use is one of the important developments in the construction industry.

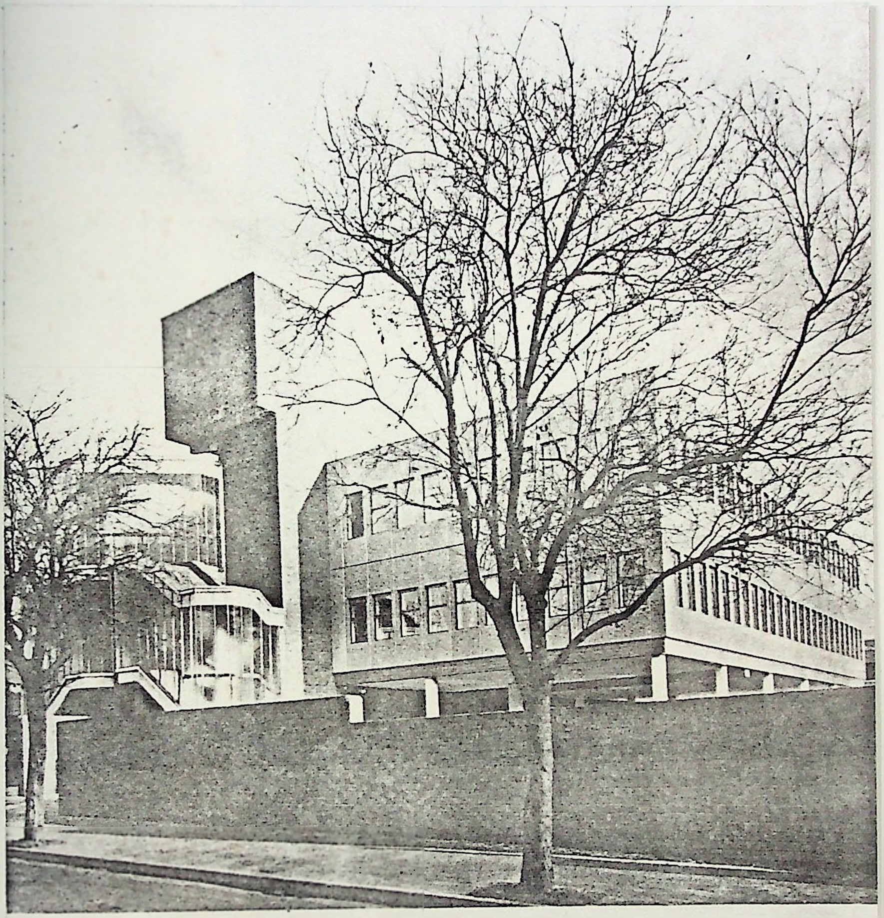
Popularity has been gained for a number of reasons. When concrete was first used on site it was poured into moulds or formers, allowed to cure, the formers removed, placed at a higher level or different position, and the process repeated. The weather conditions prevailing on site determined the quality of the caste and at times proved detrimental. Now casting and curing conditions can be rigidly controlled in a factory layout. Where mass production of a unit is possible, formers can be made very precisely of steel ensuring very smooth surfaces. The structural members can then be produced on masse at a plant while excavations and foundations are taking place on site.

Plant production is not normally subject to delays due to adverse weather conditions, as so often happens on jobsite production operations. Many structural units are precaste therefore including floor and roof slabs, columns, girders, beams, and joists, wall panels and stairways. Whole wall sections can be precaste to include fittings, and floors precaste to include heating and drainage systems.

There are a multitude of different examples of precaste concrete construction. The one failing in common with many of them is the method of finishing. Bricks are sometimes used and this really defeats the idea of prefabrication it would be better to use prefabricated facing panels and so speed up operations.

Concrete is perhaps one of the strongest prefabricated components and it is probably for this reason it gets most use in the building world today.

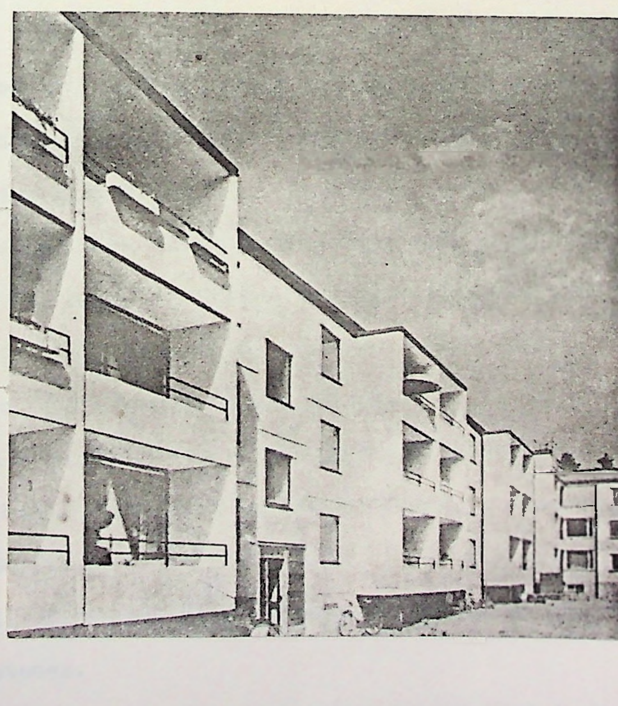
IDA MODULAR FACTORY
Erecting precast concrete cladding units



MODULAR BUILDING AT PENRITH

Block of 215 flats under construction

Flats completed



STONE

The term stone usually designates blocks or pieces of the basic material rock. It is (with timber) one of the oldest building materials known to man.

Because of its unique characteristics, stone has been regarded as the prefered material in the construction of permanent buildings. It was in fact the predominant material used in buildings built prior to the turn of the twentieth century.

Stone is produced by quarrying. Long lines of drill holees are wedged open to crack or split the rock. Power saws are then used to cut it to final shape. Different saws give different textures to the stone, this can also be achieved by further machining or hand finishing.

A good stone will have strength, hardness, workability, durability, colour and grain, porosity and texture, ease of quarrying and accessibility. Stones which, in general, satisfy those requirements and which are commonly used include:

(1) Argillite - used as a floortile, stair treads, coping stones, interior wall base, interior window sills and exterior window ledges.

(2) Granite - an igneous rock used for flooring, wall panelling, column or mullion facings, stair treads, flagstones.

(3) Limestone - this has similar uses to granite.

(4) Travertine - used mainly for decorative purposes.

(5) Marble - again a decorative material used for facing.

(6) Serpentine - this has similar uses to argillite and is also used in panelling.

(7) Sandstone - a building stone, used to produce Ashlar or square cut stones.

(8) Slate - similar uses as above stones but mainly used in roofing buildings.

The above stones have been invaluable to the development of mans shelter. They appear readily in many architectural works even to the present day. Stone however has little footing in modern system building. Apart from using small cut pieces of granite in precaste panel units, or the use of limestone as a medium with glassfibre and metal to produce insulated spandrel panels, natural stone has been replaced by manmade brick and concrete.

There has been little or no attempt to utilise stone in ready made wall modules the preference being to use it merely as a facing element for concrete or block construction.

METAL

Following the Industrial Revolution metals have begun to play a great part in building systems. A variety of metals have commonly been used, notably steel, aluminium and copper.

Each metal is mined from the earth in the form of an ore. This ore is treated to remove the pure metal either by a thermal or chemical process. In some cases an alloy is formed by uniting different metals to form a new metal which shares the properties of the original ones.

Until recent times the most used metal has been steel. It has appeared in various forms such as strengthening and reinforcing material in precaste concrete or as joists and girders, in the construction of framed buildings. Galvanised and plastic covered corrugated steel sheeting has a long history of use in roofing and siding and is still quite popular today.

Aluminium is now appearing as a replacement for the traditional wood framed windows and the steel frames popular during the forties and fifties. Extensions of various shapes and sizes make it possible to easily manufacture window sills, frames and trim. The aluminium offers advantages also from the point of view of maintainance since it requires no painting or protection once fitted.

Copper has been popular as a roofing material but its use as such has now been confined to buildings of public importance. Experiments have been tried in the field of other construction, such as the Copper House Project at Finnow, Germany, but copper is now largely used as a material for fixings and pipe work.

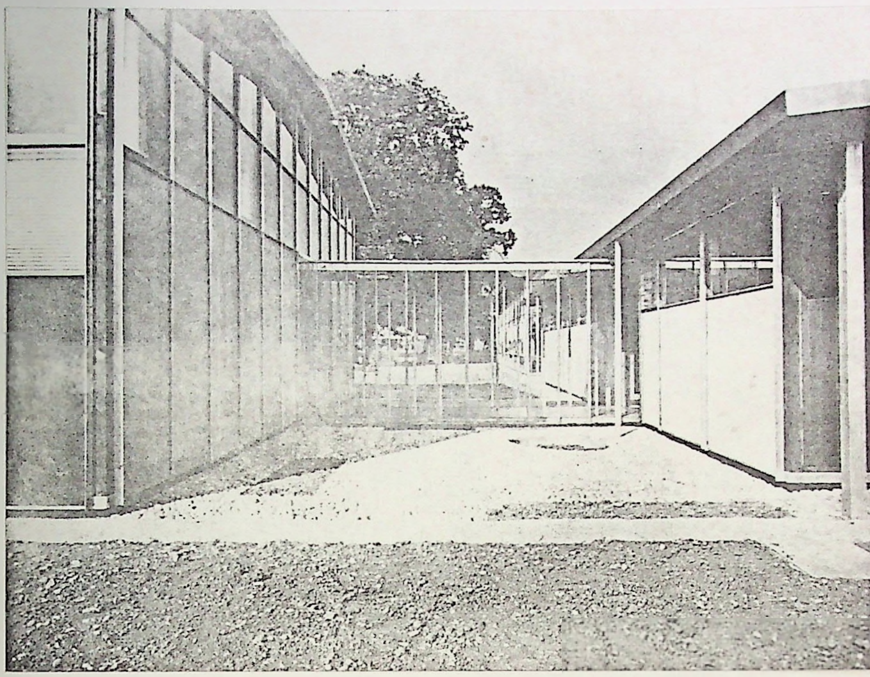
Steel has had a much better showing in construction as for example in the Rheemotel House in the U.S.A. The construction is simple and can be outlined as follows.

The ground is levelled and a concrete base raft is laid using template. This allows for the positioning of anchoring bolts and the laying of utility service lines. A central core is now positioned. This is a prefabricated unit and is the sole loadbearing part of the building. It comprises of a kitchen complete in every detail, the complete bathrooms and a heating unit.

External walls of galvanized steel sheeting are assembled around this core. The panels are joined by riveting and / or bolting. A system of overlapping joints is used to provide wind and watertight sealing. An inner sound insulation panel of gypsum is then fitted and the space between used for additional electrical and plumbing fitments.

Roof frames are bolted to the core and are canterlevered to provide overhang. The roofing is of twenty gram galvanized steel covered on top by a spray of aluminium - aesbestos paint. Glass fibre is fitted internally for thermal insulation and finally, an acoustic ceilling is hung to the bottom of steel suspension bars by means of galvanized steel wires.

The house has a marked advantage over others in that, apart from being a dry construction (bar the concrete raft) it is completely incombustable.

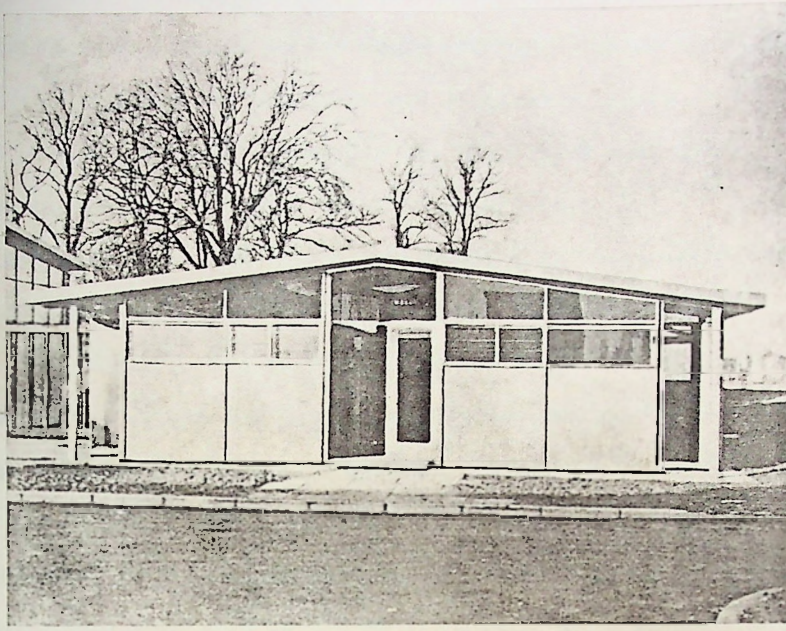


OFFICES AND LABORATORIES
HEMEL HEMPSTEAD, ENGLAND

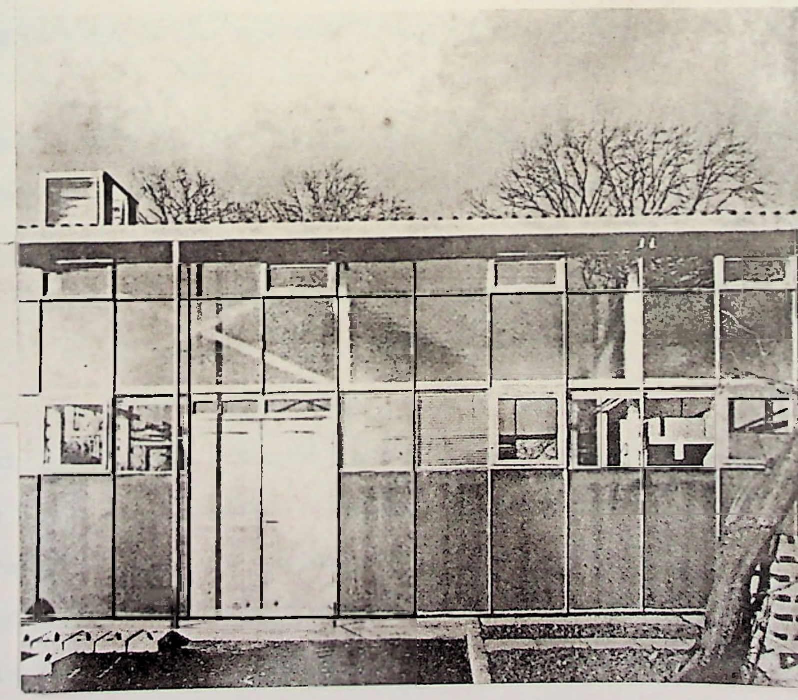
The external curtain wall is constructed of aluminium tees forming droppers and transomes fixed to the main structural frame.

Infill panels are of Eternit, vitreous enamel steel and glass, all fixed with hardwood beading.

Doors, windows and ceiling panels are in modular sizes. Floors in offices are covered with 3M x 3M cork tiles.



th elevation of
oratories



fices and
oratories

GLASS

Though the Romans were well aware of the applicability of glass to windows they appear to have regarded any extensive use of it as a luxury or a necessity to be made a virtue of. Moreover the climate of most Roman cities presented no special necessity for glazed windows.

The earliest window was probably a modification of the doorway, with light having previously being admitted by the smoke outlet or indeed provided by the fire itself. The earliest modification of the doorway was probably the half door and the double use of door and window is reflected in the architectural shape of windows which often mimic that of doorways.

The introduction of glass into windows was probably aided by the spread of civilisations from warm to colder climates. With architectural evolution the shape and size of windows have evolved from the tiny lead - latticed cottage window to the enormous stained glass windows of Medieval churches.

With glass being a filler tather than a structural member, advances in steel and concrete construction have allowed huge areas to be glassed in with the weight emphasised on a framework rather than on the glass itself.

Glass is now one of the most versitile filling materials used in system building. It can be made from a great variety of raw materials but generally it is a compound of silica sand, soda ash, and lime.

When a mixture of sand and soda is heated, the soda melts and the sand dissolves in it to form sodium silicate. Lime is added to the mix to remove moisture and a soda lime silicate is obtained. This is uneffected by moisture and acids. The molten glass is then cast into sheets and cooled very slowly to prevent cracking. The glass is then ready for use. Coloured glass can be obtained by oxidizing or reducing conditions using copper as an agent in a heated atmosphere. Wired glass, first patented in 1855, can be used where there is a fear of breakage, eg. firedoors, but shatterproof and unbreakable glasses have been developed.

It is this failing in glass of its ease of breaking which has lead to it being replaced by G.R.P. and plastics in many building projects.

PLASTICS

The term'Plastics' as it is commonly used today, refers to a large group of synthetic materials which are made from a number of common substances, such as coal, salt, oil, natural gas, cotton, wood, and water.

From these, relatively simple chemicals, known as monomers, which are capable of reacting with one another, are produced. The process of uniting monomers to form molecules of high molecular weight, is known as polymerization and the molecules themselves are called polymers.

The process can be of two forms, condensation or addition. In the former the monomers or groups of monomers unite chemically by the inter - action of active units in each one, eliminating byproducts. (usually water, hydrogen or alcohol).

In the latter, monomers attach to one another in an end to end fashion forming a chain like linear structure. This may have branches or be inter - laced and crosslinked with other groups.

Plastic products are then formed. The number of methods of forming are great and include, injection, blow, rotational, expandable bead, compression, transfer, and form moulding. There are also extrusion, thermoforming, laminating, casting, and calendering methods.

Commericial moulding of plastics began in the United States in 1845 and developed greatly through to the early nineteen hundreds. In this period the plastics used were natural moulding materials such as Lac, Gutla - Percha, and cemented asbestos. These come directly from animal, vegetable or mineral sources.

In 1869 the first synthetic plastic was invented. A Mr. John W. Hyatt invented celluloid by treating cotten fibres with acids. This paved the way for synthetic plastics and soon other plant fibre plastics were developed.

In 1884 a french chemist, Hilaire Chardonnet, produced viscose rayon. Cellophane was next invented, by the Swiss Jacques E. Brondenberger in 1908. The next synthetic plastic to appear was the rather brittle bakelite produced in 1909 by Leo H. Baekeland in New York. Then with the expansion of the chemical industry in the twenties and thirties, acetate, acrylics, and polystyrene were produced, closely followed by polyethelyne, silicones, and epoxy resins.

The nineteen sixties showed the development of high temperture and heat resisting plastics. Development increased and there are now forty plus groups or families which are of commercial value.

Properties of plastics which make them desirable for use in the building industry include transparency, impact resistance, abrasion resistance, low moisture absoption, ductility, chemical resistance, and good adhesive qualities.

With all this going for them it is surprising that plastics have really only been used as fittings rather than construction material. The one exception to this is the use of plastics as laminates. Laminating is the process of impregnating sheets of paper, glass fibre, or cloth, with a thermosetting liquid resin and then appling heat and presure to a number of sheets to form a laminated product. This may then be jused to replace sheets of glass in windows or moulded into roof shapes.

The most common laminate is glass fibre reinforced plastic or G.R.P. It consists of glass fibre reinforcement impregnated with a resin which may incorporate fillers, pigments, etc., and suitably catalysed to harden during a curing process.

For building jse G.R.P. first appeared as corrugated roofing sheets, but its use now has extended to other external claddings. It is also used in curtain wall construction by forming a sandwich of G.R.P. and a metal or plastic lattice.

It can be formed to a wide variety of shapes and finished in various colours and textures. Components made form it are lightweight and its mouldability allows the incorporation of features and details that would be impossible with other materials. In fact much design detail can be moulded into the material but it will often be advantageous to introduce additional detailing at joints, window openings, etc., by the incorporation of components fabricated from other materials from a different form of G.R.P.

There are some limitations to G.R.P. however. It has a lack of rigidity and some decline of mechanical properties a high temperatures. This restricts some of its structural uses and an allowance must be made for this in a building project.

G.R.P. is also combustable but flame retardents reduce its ignitability and improve the surface spread of the flame characteristics.

The use of G.R.P. panels in facing and dome construction is still a relatively new technique. These are therefore bound to be unpredictable, but doubtlessly these will mastered with time.

CONCLUSION

It is hoped that the changes in mans use of building materials and the subsequent change in architectural standards has been adequately outlined in this document.

Man has progressed form the dingy smoke filled mud huts to the towering air conditioned apartment blocks evident in most cities. It has been a progression and yet even today examples of each type of dwelling can be found to exist in this world.

Whether the final outcome, the clinical space orientated structures, is the most prfared, is an individual choice. Many would prefer the older brick and mortar house to the dry construction hi - rise and it is unfortunate that perhaps many are swayed towards the latter for nothing more than financial reasons.

System built houses are cheaper, and in many cases they are undoubtably more comfortable, better insulated, and better designed. In most cases that is, for system building makes use of unskilled labour in the assembly of prefabricated parts and it is here that the system wavers.

The bricklayer and the woodfitter to some extent also made use of prefabricated materials. But they were craftsmen skilled in their own trade and with internal pride which would not allow them to leave a job half done or to complete a job knowing that mistakes have been built into it. The craftsmen loved equally tools, materials, and methods, loved and honoured them by always striving to make best use of them in their work.

The modern unskilled labourer knows little about the ready made units that arrive on site. The units are but objects to be assembled according to a plan and if assembly is not correct for each part, little worry is to be had by any labour. "Make do" and "four will do" would be the motto when problems arise. Units often being literally thrown together simply because the labourer does not pocess the skill to modify or correct a factory made error.

In any case there is not the same internal pressure to "get it right" as in the craftsman.

This means that close supervision is called for to ensure correct assembly of a prefabricated or system built house and that mistakes are not simply covered up by decorative panels or facings. Unfortunately such close supervision is not always possible.

Another aspect of system building and industrialized building is that they have given rise to some of the most horrific architectural structures ever to have been built on earth.

The freeing from the use of solid construction, supporting pillar rooves and indiviaual brick or on site produced facing has meant that more open spacing and more uniformed surface can be obtained.

Unfortunately this has been over exploited and has resulted in the production of either gigantic dull coloured boxes with thin lines of windows or wildly angular and/or curved buildings of garish or dull colours.

It is unfortunate also that these are the buildings which are marked as the masterpieces of industrial building as for example the grotesque ILAC centre in Dublin or the spatter of Regional Technical Colleges built throughout the country. Also unfortunate is that the decent looking prefabricated or partically prefabricated houses have been exploited by the building trade by creating massive estates where the houses <u>do</u> all look the same and where, because of the unskilled labour used, many problems to further slight the whole modern system of building.

Perhaps if tighter legislation were made to control the use of industrialized building, the system would be recognized for its good aspects of effeciency, speed of erection and low costs. Perhaps also would be stemmed the flow of people from the "little boxes" housing estates to the traditionally built bungalows which spring up more and more throughout the countryside. The flow would be stemmed by giving the residents the feeling that they had a house and hme and not just a box, similar to hundreds of others and thrown together by a group of unskilled labourers.

ACKNOWLEDGEMENTS

I would like to thank the following people for their help in the provision of information necessary for the completion of this project.

The library staff of:- Dundalk Regional Technical College.
The New University of Ulster.
Bolten Street Library of Technology and Commerce.
An Foras Forbartha.

Mr. K. Spencer. An Foras Forbartha

Mr. W. Garner. Colaiste Naisunta Ealaine is Deartha.

Special thanks is offered to Ms. M. O'Neill for typing the final draft, and to Ms. Karla Ní Giolla Bhrighde for providing the binding of the final draft.

BIBLIOGRAPHY

BOOKS

ADDLESON, LYALL. 1972. "Materials for Buildings". Two vols. Butterworth and Company.

BRE DIGEST, 1978. "Building Materials". Second edition. The Construction Press.

CRAWLEY & DILLON, 1970. "Steel Buildings". John Wiley and Sons.

DIAMANT, RME, 1967. "Industrial Buildings". Three vols. A & B News.

FROST, A.C., & MC GRATH, RAYMOND, 1961. "Glass in Architecture and Decoration". Architectural Press.

HANSON, HANS JURGEN, 1971. "Architecture in wood - A History of Wood Building and its Techniques in Europe and North America". Faber and Faber.

KHWASA & WILBY, 1977. "Concrete Shell Roofs". Applied Science Publications Ltd.

LLOYD, NATHANIEL, 1934. "A History of English Brickwork". H. Greville Montgomery.

MARTIN, DAVID, EDITOR, 1980. "Specification 80: Building Methods and Products". Five vols. Architectural Press.

MITCHELL, P.G. BRUCE, & P. REBOUL, 1968. "Plastics in the Building Industry". George Nennes Ltd.

MURRAY, STEWART, 1980. "Brickwork and Blockwork". George Goodwin Ltd.

NASH, W.G., 1974. "Brickwork". Three vols. Hutchinson Publications.

PENN, W.S., B.Sc. 1964. "Plastics in Building Handbook".
Maclarn and Sons Ltd.

PUTNAM, 1973. "Concrete Block Construction".
Americian Technical Society.

SCOTT, JOHN S., 1974. "Dictionary of Building".
Nennes and Butterworth.

SMITH, 1973. "Materials of Construction".
Mc GranHill.

TAYLOR, C.D. 1974. "Materials of construction".
Lane and Bry.

THEOBALD, PAUL, 1945. "Rebuilding our Communities."
Chicago Press.

JOURNALS

Journal	Date	Article Title or Subject.
Architectural Journal	11th. Jan. 1978.	"Prefabricated Flats, Hammersmith."
		"Housing at Farm Lane, Hammersmith."
	8th. Feb. 1978.	"Prefabricated Houses: Fireboard."
		"Stram it Again (Stramit Boards.)"
	27th. Feb. 1980.	"Psshak eighteen months on."
	27th. Aug. 1980.	"Basildon Boxes - Woodframed Housing."
	19th. Nov. 1980.	"Industrialized Construction."
	10th. Dec. 1980.	"Chipboard House."
	24th. jun. 1981.	"Holiday Homes."
	22nd. Jul. 1981.	"Holiday Homes."
	20th. Jan. 1982.	"High Tech."
Architectural Review.	Apr. 1981.	"Prefabricated Medical Buildings."
Building.	29th. Sep. 1978.	"Wood Framed Prefabricated Houses."
	12th. Jan. 1979.	"Internal Walls."
	15th, Jun. 1979.	"Peterlee - Problems."
	14th. Sep. 1979.	"Holiday Cabins."
	4th. Apr. 1980.	"Shelter Span System."
		"Aluminium Cladding."
Civil Engineering.	Jun. 1980.	"Industrial Buildings."
Concrete.	Jan. 1978.	"Industrialised Housing in North Africa."
Contract Journal.	31st. May. 1979.	"Prefabrication."
	24th. Sep. 1979.	"Prefabricated Houses."
Master Builder.	Jun. 1979.	"Prefabrication."
Precaste Concrete.	9th. Mar. 1978.	"Industrialised Housing in South Africa."
Process Engineering.	Sep. 1980.	"Prefabricated Plant."
	Jun. 1981.	"
RIBA Journal.	Jun 1978.	"Prefabricated Primary Schools."
Storage Handling Distribution	Jan. 1978.	"Prefabricated Warehouses."
	Jun. 1980.	"
Surveyor.	8th, Jan. 1981.	"Prefabricated Bungalows."

JOURNALS (con.)

Journal	Date	Article Title or Subject.
Timber Trades Journal and Wood Processing.	21st. Feb. 1981.	"Prefabricated Wood Frames."
	4th. Apr. 1981.	"
	3rd. May. 1981.	"

GENERAL

British Standards.

Comhordú Toiseach San BhFoirgníocht - AnForas Forbartha.

Encyclopedia Brittanica.

Engineers Handbook.

Mc Gran Hill Encyclopedia of Energy and Technology.

Plastics Handbook.

Tuarascáil Ar Comhordú Modúlach In Éirinn-anForas Forbartha.

World Book Encyclopedia.