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Study on Prefabricated Panel Design By Using Aluminium Extrusion

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ABSTRACT
The purpose of this study is to get efficient home needs from modular panel house and have a comfort factor and describe the design of the modular panel type house. This research method used the descriptive quantitative method, with research subjects describing the modular panel house design with its criteria. With the modular panel house building method would be easier with low costs compared to conventional because the industrial process was carried out with prefabrication, and pay attention to ecological factors in the building. Designed modular panel houses are built at low cost, taking into account thermal comfort factors and have eco-architectural values so that they can influence people's interest in this type of house.
Keywords*: prefabricated panel, Aluminium Extrusion*

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I. INTRODUCTION

Prefabricated structural panels are a form of building product that can be manufactured off – site and assembled on – site, providing an alternative to traditional site – based construction.
They can allow faster construction times, improved quality due to more coordinated supply chain processes, and manufacture in factory environments with controlled conditions. However, detailed design must be provided early in the process as any inaccuracies in or late changes can have a significant impact on cost.

The two main types of structural panels are open and closed:

➢ Open structural panels are a pre – assembled wall framework which are later fitted with other elements (such as insulation, vapour control layers, external cladding, and so on) on site. While this is quick and flexible compared with traditional construction, it still involves a lot of site work.

➢ Eye contrast, closed structural panels are complete pre-assembled wallpanels with the other elements included, such as, pre – filled

➢ Closed panels tend to be larger and heavier, often necessitating a crane for on – site assembly.

TYPES OF PREFABRICATED PANELS

Some of the most common types of prefabricated structural panels include:

CONCRETE INSULATED PANELS

These companies use robust insulated concrete with a brick outer leaf, and can be manufactured with external windows and doors. They are designed to have a service life of more than 60 years.

STRUCTURAL INSULATED PANELS (SIPs)

Structural insulated panels (SIPs) are a form of sandwich panel system that incorporates insulation, predominantly used for residential and light commercial construction. They take the form of an insulating foam core sandwiched between two structural facings. SIPs are manufactured under factory – controlled conditions off - site and can be installed quickly once on – site. The benefits of using SIPs are that they are high strength, high – performance, and can be fabricated to fit nearly any building design.

TIMBER FRAME PANELS

There are several different types of timber frame systems, ranging from open stick – built systems to closed panels that pre - filled with insulating, wiring, plumbing and so on. Basic timber frame walls comprise studs fixed in place with sheets of plywood or oriented strand board (OSB). When nailed to the studs, the open panel becomes a rigid box into which insulation can be added on site. A waterproof barrier is wrapped around the frame followed by the external wall cladding. Closed panels are delivered to site with these elements pre – installed, minimizing the on – site work required.

LIGHTWEIGHT STEEL FRAME PANELS

These tend to be open panels and overcome the risk of cold bridging by locating insulation on the external side of the frame.

INSULATED CONCRETE FORMWORK (ICF)

ICF, also known as permanently insulated formwork (PIF), is an insulated in situ concrete system based on hollow lightweight block components. The block components, usually made of expanded polystyrene tied together with plastic, or steel ties, lock together removing the need for mortar. This creates an on-off – site technique, which can be much quicker to install and provides better insulation than other construction methods.

ALUMINIUM EXTRUSION

Aluminium extrusion is a process by which Aluminium alloy material is forced through a die with a specific cross – sectional profile. Aluminium extrusion can be likened to squeezing toothpaste from a tube.

➢ A powerful ram pushes the Aluminium through the die and it merges from the die opening.

➢ When it does, it comes out in the same shape as the die and is pulled out along a run out table.

➢ The force applied can be likened to the force you apply when squeezing a tube of toothpaste with your fingers.

➢ As you squeeze, the toothpaste emerges in the shape of the tube's opening.

➢ The opening of the toothpaste tube essentially serves the same function as an extrusion die. Since the opening is a solid circle, the toothpaste will come out as a long solid extrusion.

EPDM rubber (ethylene propylene diene monomer rubber)

EPDM rubber (ethylene propylene diene monomer rubber) is a type of synthetic rubber that is used in many applications.

EPDM is an M-Class rubber under ASTM standard D – 1418, the M class comprises elastomers having a saturated chain of the polyethylene type (the M deriving from the more correct term polymethylene) EPDM is made from ethylene, propylene, and a diene comonomer that enables crosslinking via sulfur vulcanization. The earlier relative of EPDM is Epr, ethylene propylene rubber (useful for high – voltage electrical cables), that contains no diene units and can only be crosslinked using radical methods such as peroxides. Dienes used in the manufacture of EPDM rubbers are ethylidiene norbornene (ENB), dicyclopentadiene (DCPD), and vinyl norbornene (VNB).

PROPERTIES

EPDM is compatible with polar substances, e.g. fireproof hydraulic fluids, ketones, hot and cold water, and alkalies. It is incompatible with most hydrocarbons, such as oils, kerosene, aromatic compounds, gasoline, and halogenated solvents. EPDM exhibits outstanding resistance to heat, ozone, steam, and weather. It is an electrical insulator

USES:

➢ Structural joints of small and medium – sized buildings.

➢ Protective glass sealant.

BENEFITS:

➢ Odourless, non – corrosive, cure system.

➢ Cures to form an extremely tough elastomeric rubber ensuring a durable, flexible, watertight bond.

SEALENT

➢ Sealent is a substance used to block the passage of fluids through surface or joints or openings in the material.

➢ Sealents are not adhesives but some have adhesive qualities called Adhesive Sealents.

COMPOSITION / INFORMATION ON INGREDIENTS CHEMICAL CHARACTERIZATION:

Mixture

HAZARDS IDENTIFICATION

Overall Hazard Classification:	Not hazardous.
Hazard Information:	Not hazardous

FIRST AID MEASURES

Eye :	Immediately flush with water
Skin :	No first aid should be needed.
Inhalation :	No first aid should be needed.
Ingestion :	Get medical attention.
Comments :	Treat symptomatically.

BENEFITS

➢ Prefabrication technology has several advantages, such as energy efficiency revision, minimal waste and inspection, efficient construction, work speed, protection, sustainability and quality.

➢ As self-supporting ready-made components are used, the need for formwork, shuttering and scaffolding is substantially lowered.

➢ Building time is thereby decreased, resulting in lower labour costs.

➢ Reduced the quantity of waste materials relative to building on site.

➢ Reduction in construction time to allow an earlier return of the invested principal.

➢ Construction guarantees precise compliance with building codes and excellent quality assurance.

II. LITERATURE REVIEW

Tomas U. Ganiron Jr et al., (2014), having a house to call one's own is a dream and primary concern of every individual in the Philippines. Housing began before the Spanish take them first step in the Philippines shore. It was at that time when housing in the Philippines gets a big difference, difference in terms of looks, strength, size, cost and the length of time to spend during construction.

Mohd Zairul et al., (2021) The idea of circular economy (CE) started from manufacturing counterparts which are now making inroads into the construction industry. Several authors define circular economy as the new future for sustainability concept through novel flexibility metrics of buildings.

W. S. Widodo et al., (2019) Sales are very important devices to prevent fluid leaks in a bolted joint connection [1]. Silicone rubbers have been widely used as seal elements or gaskets and play important roles in piping connections in some industries such as food industries, automotive industries, oil and gas industries.

Prajjwal Paudel et al., (2016) the terminology of "prefab" is used as a short for "prefabricated buildings"; Prefab is a broad term that encompasses several different types of buildings. Technically, any home that has sections of the structure build in a factory and then assembled on site can fall under the "prefab" designation.

K N Lakshmikandhan et al (2017) Evolution of the development is construction activities around the world, the demand for construction materials is increasing exponentially. Continued extraction of natural aggregate is accompanied by serious environmental problems. Furthermore, the wall constructed with conventional masonry system contributes higher dead weight of structure.

Teng Li et al (2021) The State Grid Corporation of China is promoting the modular construction in all-round way, requiring buildings in substations to be prefabricated structures, putting forward higher requirements for standardizations and rapid construction of the engineering construction. In order to meet the needs of the modular construction and prefabricated construction, higher performance requirements are put forward for the wall panels of the building.

III. EXPERIMENTAL PROGRAMME

Test Conducted on Panel Materials

Tests on materials were performed to study the strength of the panels.

1. The tests conducted are listed below.
2. Aluminium Extrusion
3. DGU (Double Glass Unit)
4. Gasket (EPDM)
5. Sealent

ALUMINIUM EXTRUSION

Machine: valgro Aluminium Profile Polishing Machine

➢ Aluminium Profile polishing test: they are always die line, scratch, marks on the surface of the aluminium extrusion profiles after the extrusion factory, which affects the surface quality and market competition of the aluminium profiles. Polishing machine can solve the problem effectively.

➢ The aluminium profile polishing machine is used to have brush hairline

and satin finish on aluminium extrusion prior to anodizing.

➢ Abrasive brushes clean the surface of aluminium and eliminate extrusion line scratches and marks.

DOUBLE GLAZED GLASS UNIT

➢ DGU (Double Glass Units) integrate multi – glass panes into a single-window structure. **Double**

glazed glass units have become more popular due to higher energy costs. The glass panels in Double glazed glass India are divided by a spacer and a still film of air or stream. The glass is then fixed to the window frames that are designed larger to match the two points.

➢ **Test – Colour**

The colour of DGU glass can be normally deducted by **naked eye.**

GASKET

EPDM rubber (ethylene propylene diene monomer rubber) is a type of synthetic rubber that is used in many applications.

TEST - SHORE HARDNESS

Procedure: Spring strength and indenter geometry are specified in ASTM Standard D2240. This fixes every aspect of rubber hardness testing, including the size of the pressure foot, sample preparation the duration for which the indentor is pressed in to the material and calculation and presentation of results.

Fig: shore hardness apparatus

SEALENT

Butter flying test – (This test is to ensure the sealant base and curing agent is sufficiently mixed and consistent).

➢ Dispense a bead of two part sealant onto a piece of paper.

➢ Fold the paper in half, smearing the sealant bead to a thin film.

➢ Pull the paper apart and visually inspect the sealant smear formed.

➢ If the sealant smear contains streaks or inconsistent coloring, more sealant must be pumped thorough the lines to improve the mixing quality.

➢ If the sealant smear is of a consistent color, the sealant properly mixed and ready for use.

➢ If grey streaking continues to occur, the static mixers should be checked for possible clogged or plugged conditions.

➢ Pictorial sequence of butterfly test -

○ Apply sealant o erased white paper

○ Press together

○ Well – mixed sealant

○ Poorly mixed sealant with white streaks

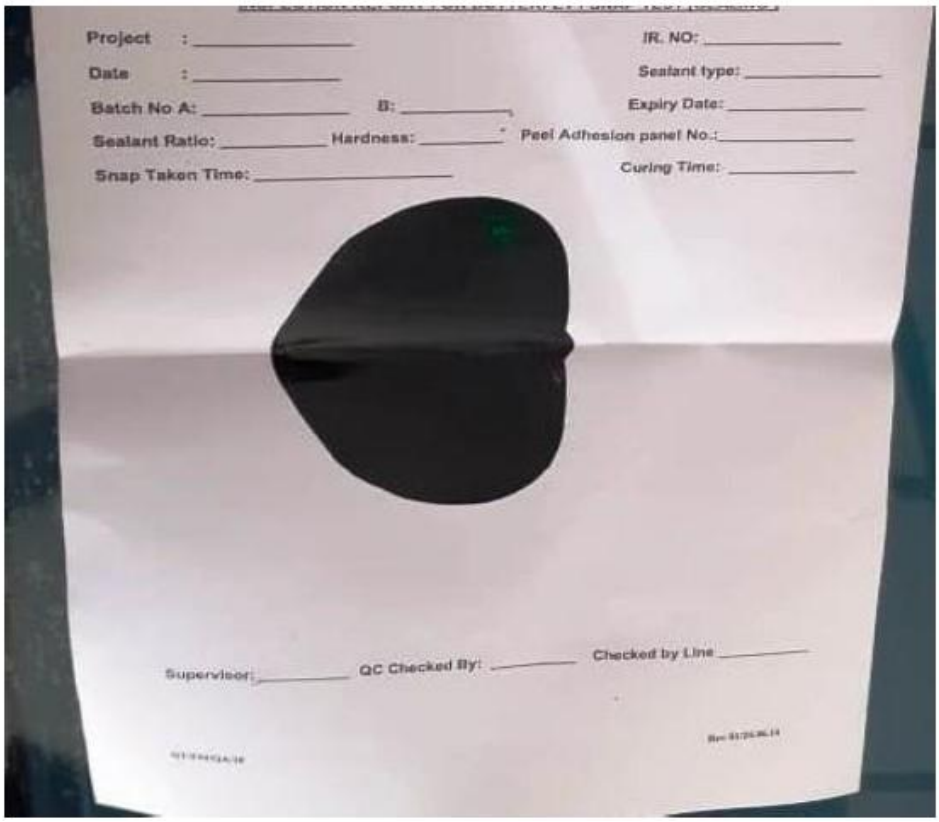


Fig: Butter flying test

Snap Time Test:

This test assists in determining the sealant working time and deep section cure time. It is a guide in determining whether the mix ratio is correct. The snap – time test is performed as follows:

➢ Fill a cup or container with sealant & catalyst mixed sealant.

➢ Place a stick or pencil into the mixed sealant.

➢ Every five to ten minutes, pull on the stick or pencil from the mixed sealant.

➢ If the sealant does not tear within itself (cohesively) when the stick or pencil is pulled out, then the sealant has not snapped.

➢ The time at which the sealant tear within itself (cohesively) when the stick or pencil is pulled out is termed the "snap time".

➢ The snap time should be between 15 to 60 minutes the snap time is cut of the ideal range, adjust the sealant and catalyst ratio.

➢ If the snap time is not of the ideal range, adjust the sealant and catalyst ratio.

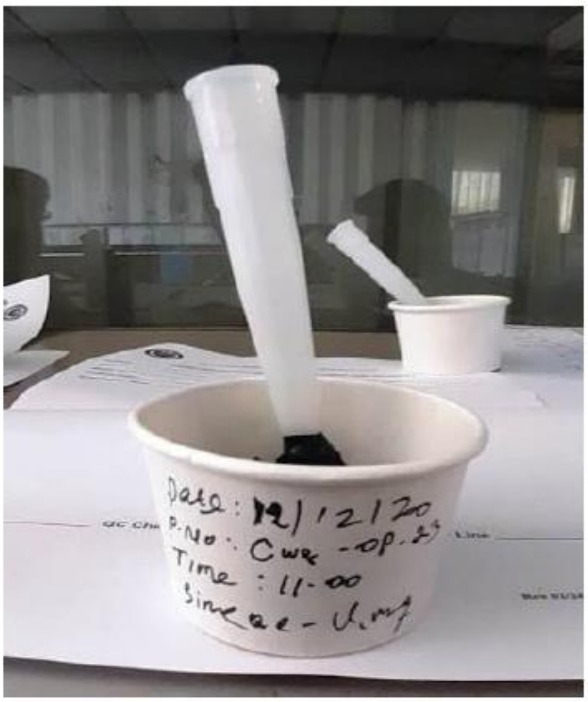


Fig: Snap Time Test

Adhesion Test:

➢ Adhesion Test will be carried out similar as per "Adhesion test" of one part sealant Test failure.
➢ If any of the test fails, another test will be repeated.
➢ If test confirm failure, QA/QC personnel will refer to the incoming inspection.
➢ When in doubt, always consult your superior.

Fig: Adhesion Test

IV. TEST RESULTS AND DISCUSSION

TEST RESULTS ON GASKET

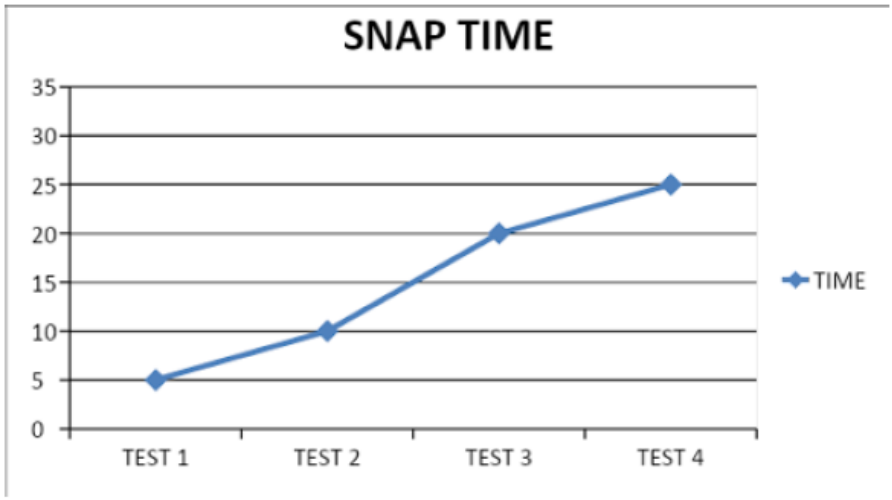
Spring strength and indenter geometry are specified in ASTM Standard D2240. This fixes every aspect of rubber hardness testing, including the size of the pressure foot, sample preparation the duration for which the indentor is pressed in to the material and calculation and presentation of results.

GASKET SAMPLE	HARDNESS (mm)
1	72
2	69
3	75
4	52

Tab: TEST RESULTS ON GASKET

TEST RESULTS ON SEALENT

This test assists in determining the sealant working time and deep section cure time. It is a guide in determining whether the mix ratio is correct



V. CONCLUSION

This study had systematized and rationalized prefabricated panels using aluminium extrusion. Today, prefabricated panels are increasingly being used in construction. This is due to the fact that many panel manufacturing companies offer customization options and a wide range of materials. The use of these panels leads to decreased building time, which results in lower labour costs. The prefabricated panels are a great way to build faster, more efficiently and with less waste. In recent years, prefabrication has been widely used in the building market worldwide. Use of the prefabricated panels is still lower, but the rate of growth for application is significant. Prefabricated panels are easy to build, and they can be assembled faster than conventional houses. Houses designed with prefabricated panels have high thermal comfort standards, lower costs and ecological values that can influence people's interest in this type of house.

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