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# INVESTIGATION INTO COMPOSITE WALLS AND ROOF CLADDING PANELS AT HIGH ALTITUDE CONSTRUCTION (A CASE STUDY OF HIGH RISE BUILDINGS IN OMU-ARAN; IREPODUN LOCAL GOVERNMENT AREA OF KWARA STATE)

**Gana, A. J, Okoye, S. S. C & Okoye. S.S.C**
Department of Civil Engineering, Landmark University, Omu-Aran, Kwara state
Department of Civil Engineering, Federal polytechnic Bida
**Emails: - doctorgana@yahoo.com, phildebo123@gmail.com**

## ABSTRACT
*This study is one of the investigations carried out on composite walls and roof cladding panels at high attitude construction on high rise. Buildings in Omu-Aran, in Irepodun Local Government Area of Kwara State. The study considered a general view on walls and roof cladding elements, composite panels, production processes and observations from panel cladding materials*
***Keywords:*** *Composite walls, Roof cladding panels, High rise Buildings.*

## INTRODUCTION
Roofing and wall systems are generally parts of the many sub-systems of a Building, and are usually installed to protect it's interior, external and human occupants from different environmental hazards. Forming part of the exterior of a building's fabric, roofing and wall systems are usually exposed to the adverse effects of weather throughout the year and also during their life time more than any other components of a building. It is noted in construction Industry that roofs and wall cladding materials experience the daily temperature variations that could be high enough as to seriously affect their performance. In addition to this, the components are also exposed to the effects of rain, snow, wind, and excessive solar radiation. In order to mitigate such effects, many manufactures usually subject building materials to rigorous testing's before ordering or shipping them for Installations. In the process, there could be however instances of material failures on site possibly because of design and manufacturing, problems, or factory testing inadequately simulating the site conditions. The general availability of numerous roofing and wall cladding materials and associated weather proofing components; which may not have been adequately filed tested, also complicate site Installation, supervision, monitoring of effectiveness, performance as well as durability, satisfactory performance of building materials is important whenever adverse exposure during the life time of the components. With this, designers, manufacturers' testers; and Installators of building components should of necessity always take into consideration the field performance factors of walls and roof cladding panels at High altitude in relation to high rise buildings.

## Wall and Roof Cladding Elements

Roof and wall cladding elements serve as a cover for the top and sides of a structure or building respectively. Such elements can be made of a single material or by a combination of various Layered of materials, or made of what is termed as a built up system. They can be manufactured on construction sites or produced in a factor and assembled on sites. Built up system basically consists of a structural part; usually a steel deck, a thermal insulation component; and a top cover usually consisting of a membrane or steel sheet of the many requirements of the many requirements roof and wall cladding systems roof and wall cladding systems must satisfy; the demand of dimensional stability is the most critical. Dimensional stability is usually known to the resistance to change in terms of the overall dimensions of the panel when exposed to various.

Dimensional stability is largely determined by the coefficient of thermal expansion of the material; and dimensional change in response to atmospheric and other stresses. In addition; the material must also avoid excessive deflection; which may not only affect longitudinal deflection, but also transverse.

Excessive in-service deflection resulting from live loads may also cause the delimitation (separation) of the deck and Insulation bonds; and also structural failures, and finally contribute towards ponding of water with its associated problems. A material usable for a roof or a wall system must also resist moisture absorption; which may contribute to premature failure as the Temperature varies and excessive internal vapour pressure develops.

## Composite panels

Over the years different types of cladding materials, such as clay tiles, asbestos tiles corrugated sheets, built up systems adverse environmental exposure. Bitumen built up roof systems, and more recently the development of what are termed as "composite materials" basically comprising of two outer covers, in filled with foam or other materials (Fig. 1) have also become more common. Materials that are incorporated in roof or wall cladding panel come in different types, shapes and materials. Some come as a single element, while others are produced as composites of different materials. One of the most commonly used composite materials is the polyurethane foam enclosed with an exterior steel skin. This system basically consists of an outer cover of metal sheets, in filled with foam like material-polyurethane. In its simplest form such types of a panel consists of a rigid polyurethane core enclosed in steel skins. The upper steel profile is usually corrugated to give it a more stable structural property. This material due to its thickness is suitable in controlling noise and heat problems and is widely used as roofing and wall

component. Element of a composite roof material, whilst being effective if used separately, may in certain cases pose a serious problem when used in combination. This possibility of incompatibly is therefore a major, design and installation challenge.

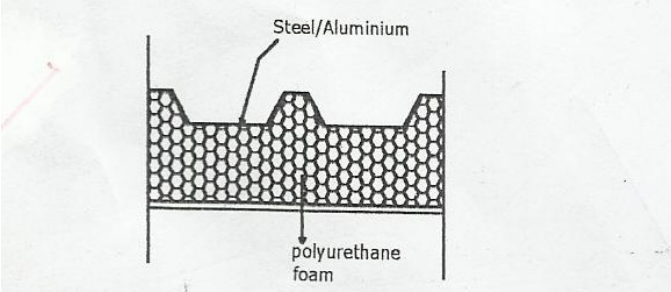


**Fig. 1: Cross section of a typical composite panel**

## Polyurethane

The main component of such insulating/cladding materials is from the category of thermosetting materials, materials that set into durable and heat resistant state after being heated. Because of the linear and highly crystalline molecular arrangement Thermoplastic polyurethane structures from an abrasion-resistant material hence their application in various industrial and construction works. Polyurethane foam material may come in either soft pen-called polyurethane foams or hard form and have a wide range of applications. Soft polyurethane foams are used in products such as in seat cushions, mattresses, and packaging and hard polyurethane foams are used as insulation in various household appliances such as refrigerators, freezers, etc. one of the wider applications of this materials is also as one component of roofing and wall covering cladding materials.

## Production Process

The polyurethane core material is basically composed or two chemical reaction resulting in heat and gas bubbles to form a foam which sets rigid within three minutes. The polyurethane foam can be produced by mixing the basic chemical components. This mixture also requires a blowing agent such as a Freon, Refrigerant 11 (monofluorotrichloromethane $CCL_3F$) that forms foamed cells that expand the polyurethane foam resin's volume, a surfactant to control cell size and wall rigidity, a catalyst, to control the reaction rate between the two chemical components and fillers, light weight bulky inorganic materials that must

be chemically compatible with the urethane polymer used to cut material costs or alter a physical property.

**Standwich panels may be produced in one of the following three methods.**

1. The continuous Process: in this process the between two mixture is injected between two layers of coiled sheet which is profiled through rollers. The final sandwich is then cut to the desired length.
2. The horizontal process: Panels are injection foam falls on the lower surface and then rises to meet the upper sheet of steel. One possible short coming of this process is the degree of adhesion and foam properties between the two faces may not be uniform. The foam may also spread and rise unevenly thus trapping small pockets of air and with susceptibility of blistering.
3. The vertical method: In this method the moulds are positioned vertically so that the foam can rise in contact with both surfaces. It is believed that this helps to avoid some of the problems of horizontal process.

## Observations from Panel Cladding Materials

(1) The cladding materials used on most buildings was basically composite polyurethane panels. The roof panels were imported from the Middle East, while the wall panels were imported from the Far East.

(2) The composite roofing materials contained 30mm thick polyurethane core materials enclosed with a steel skin of 0.42mm thick (26kg). The top surface has a 25mm corrugation at 253 average areas of $6m^2$. The life expectancy of the panels was estimated to be at least 25 to 30years.

The wall cladding panels have dimensions of 1500x1500mm with a 50mm polyurethane core covered with 1.5mm thick aluminum sheets bonded to either side with a liquid polyol –structural adhesive.

(3) Temperature variation tends to remain higher for a significant time of the day, starting late in the morning and continues to rise in the afternoon from the western side with a liquid polyol-structural adhesive.

(4) Temperature variation tends to remain higher for a significant time of the day, starting late in the morning and continues to rise in the afternoon from the western side of the panel walls to the higher environmental surface temperature than the Eastern side. The maximum temperature measurement recorded on Building panels from past records are shown below:

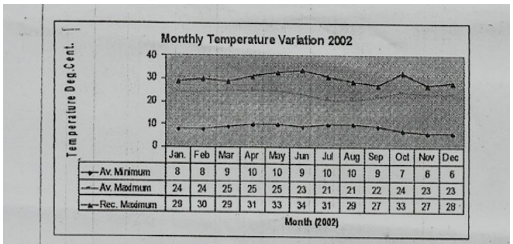


Fig. 2: Temperature variation

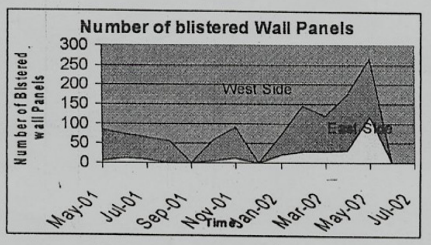


Fig. 3: Number of Blistered wall Panels Vs time of year

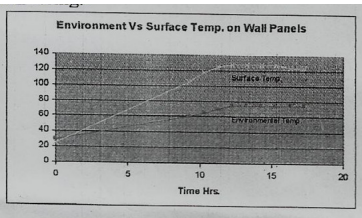


Fig. 4: Environmental versus surface Temperature on Panels under test

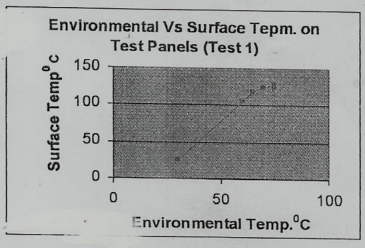


Fig. 5: Environmental versus surface Temperature on Panels under test

(5) The Altitude factor:- The combined effects of altitude and Temperature variation observations indicated that the variation of Temperature (i.e the external surface Temperature) of the panels recorded 85°c, while the interior surface at 24°caccording to the factory tests, Considering the Temperature difference between the external and the Internal surfaces of the panels; with an average thickness of 50mm polyurethane foam; this implies that the effect of the altitude change will equally affect the drop in the external pressure. The result on this is the graph shown below:-

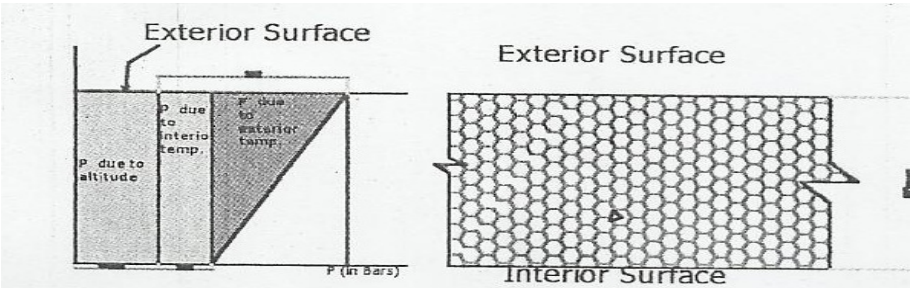


Fig. 6: Combined effects of altitude and temperature variation

## RECOMMENDATION

The construction of high Rise building is generally increased in the entire Local government of Irepodun, therefore, it is important that:-

(i) The selection of construction materials of necessity should take into consideration the various environmental factors.

(ii) Adequate care should be taken whenever such construction materials are imported during installations.

## CONCLUSION

(i) The cladding panels although manufactured from different locations has exhibited the same type of blistering phenomenon during construction Installation on different types of high rise buildings

(ii) As a permanent solution to the blistering phenomenon, the wall cladding panels were permanently covered with exterior aluminum panels of 4mm thickness production as a single panel.

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# APPENDIX

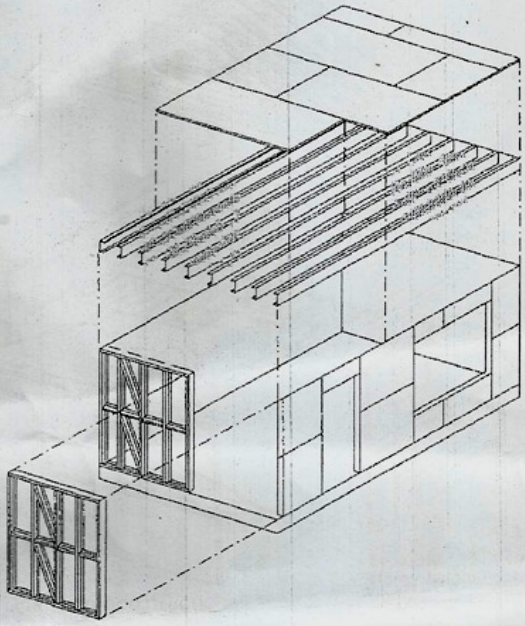

*Fig. 5.33* Site assembly of light steel wall panels

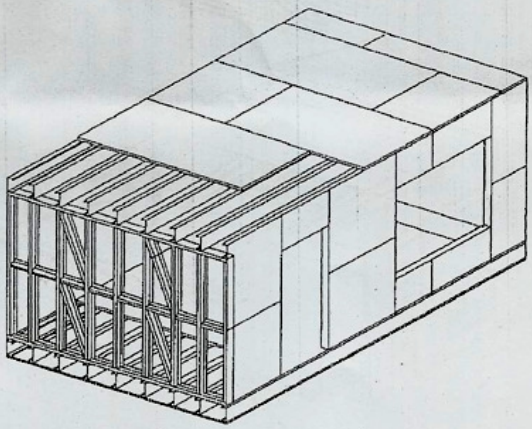

*Fig. 5.34* Modular construction using light steel framing

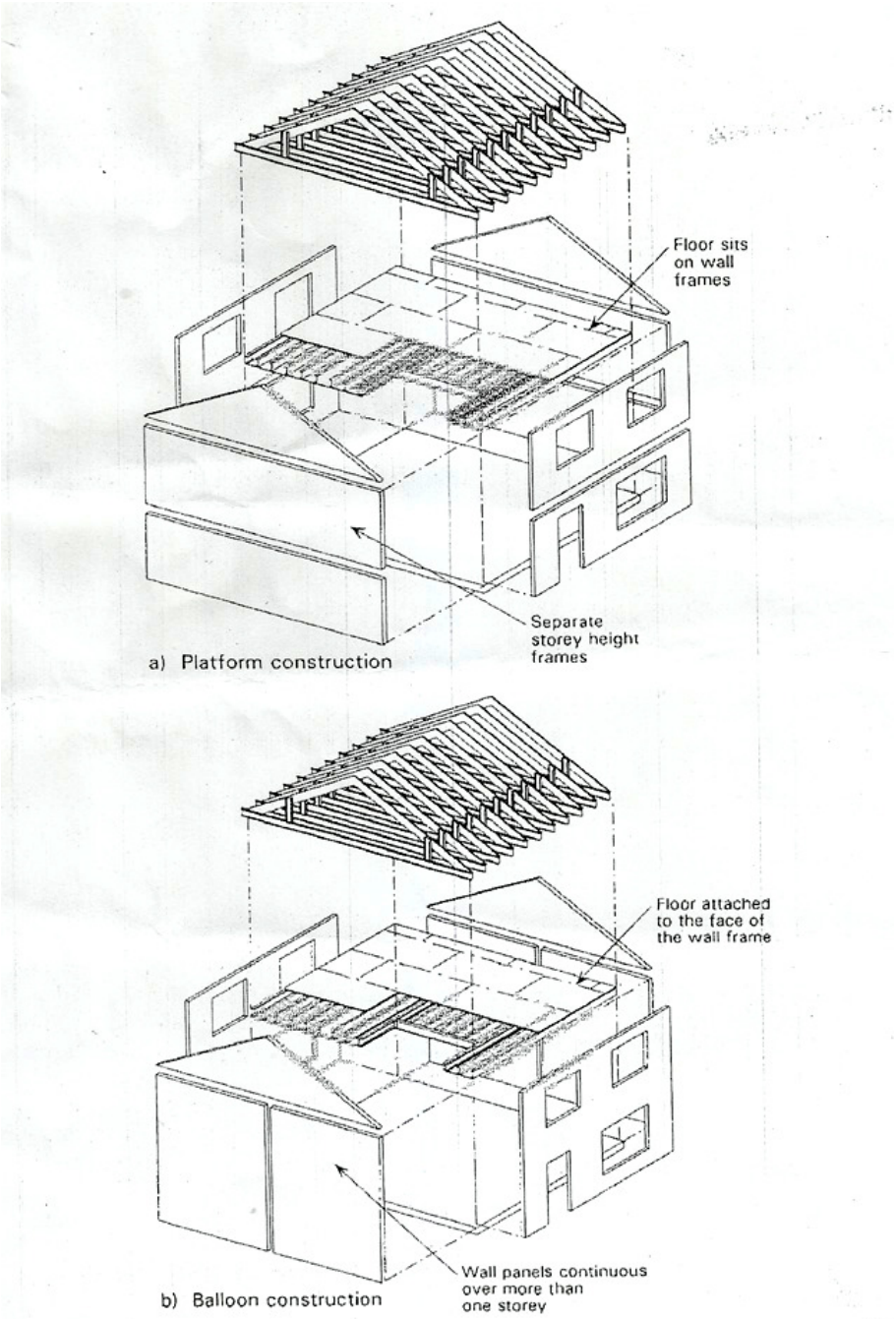


*Fig. 5.35* 'Platform' and 'balloon' forms of panel construction