

Investigation of Gypsum Plaster Board under Earth Tremor

Ezisi Pius Ogugua, Umar Afegbua Kadiri, Isogun Adeyemi Monday, Lumi Zakka, Lungfa Collins Wuyep, Okoye Boniface Chukwurah, Omokhegbele O. Patrick, Ezisi Cynthia Chinyere

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ABSTRACT

The aim of this study is to investigate the behavior of Gypsum plaster board under earth tremor. The Gypsum plaster board is one of the building materials that is frequently used in construction works such as suspended ceilings, wall partitions, wall skimming. It was observed that during the recent earth tremors in Nigeria between 2016 and 2021, where some structures were damaged, no cracks were noticed on plaster board fixed in some of the residential and commercial building. In this study, we investigated the behavior of plaster of Paris (POP) On 5th and 6th floors of Sheraton hotel Ikeja Lagos, Nigeria Inter- Bank Settlement System (NIBSS) Victoria Island, O Space Nigeria Limited Ikeja G.R.A Lagos, Redeemed Christian Church of God (RCCG) ShunguleIkeja Lagos State all in Nigeria. We adopted the approach of installation by Grid Method and by Profile Method in this work. Finding show that, a balance Drywall Partition, Suspended Ceiling, and high reduce noise insulation are achieved from the investigation. Therefore, we strongly recommend the use of normal gypsum board for partitioning of walls and construction of ceilings in high rise building because of the light weight of its structure and high resistance to shakes during earth tremor provided that the foundation of the same structure is adequately reinforced, water resistance and fire resistance Gypsum board on the areas with water defects and fire defects respectively, Sound Proof Gypsum board on the area like Studios, Conference Rooms, and Cinema Halls because of high absorption of noise.

KEY WORDS: Nigeria, Earth Tremor, Gypsum Board, Behavior of plaster of Paris, Grid Method and Normal Profile Method.

I. INTRODUCTION

Gypsum is a soft Sulfate mineral composed of Calcium Sulfate Dihydrate, with the chemical formula $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$.

Gypsum board is one of the building materials that is frequently used in construction works such as Suspended ceilings, False ceilings, Cladding walls and Wall Partitions and Wall Insulations. It is covered with Cardboard on both sides and the Centre is made of gypsum material. Because of its acoustic and decorative appearance, it is widely used in residential buildings, workplaces, studios, where heat and sound insulations are required, cinema halls to large shopping Centers where lighting are required.

According to Saint - Gobain (2022), the first known Gypsum board was invented in 1894 by Augustine Sackett and Fred Kane. Moisture Resistant Gypsum plaster Boards are hydrophobic boards that are impregnated against the absorption of moisture. Knauf Moisture – Resistant Gypsum Plaster Boards comply fully with the requirements of BS 1230.

According to BhushanMahajan in (2020), Gypsum boards properties are of four types and it can be identified by their colours.

- **Normal Gypsum Boards** : These type of boards are mostly used in construction of Walls and Ceiling in the area like sitting room, Bedroom e.t.c. Milk cardboard papers are used to cover the thick core. The boards come 12mm x 1200mm x 2400mm, 12mm x 1200mm x 2700mm, and 12mm x 1200mm x 3000mm.

Applications :

- Used as covering material for interior walls and ceiling in the area like sitting room, Bedroom.
- **Water Proof Plaster Boards** : These type come with a water resistant Gypsum core and water repellent face paper. Green water resistant cardboard papers are used to cover the thick core. The boards are the same in dimension as Normal Gypsum board.

Application :

- Used as a covering material for interior walls and ceilings in residential and commercial buildings.
- It is best for both ceiling and drywall partitions in wet areas like bathrooms and kitchen.
- **Fire Proof Plaster Boards :** These type of boards are fire resistant in nature. These boards reduce chances of fire spreading to other areas. Therefore, this resistant gypsum against fire is due to the presence of water that is present within gypsum products. Gypsum plaster board of 15mm thickness would possess almost litres of crystal water within it. When a fire approaches the water, it undergoes evaporation resulting in a protective layer covering the gypsum product. This would help in stopping the spread of fire to other materials.

Application :

- Suitable for applications in ceilings and drywall where a high level of fire protection is required.
- **Sound Proof Plaster Boards :** These type of boards are used as primary sound absorption where higher acoustic quality, sound control are required or where noises are severe such as studios, Auditoriums.

Application :

- Suitable for applications in studios, auditoriums, hospitals, cinemas etc



Fig 1. SOUND PROOF BOARD

II. MATERIALS / METHODS

1. **Gypsum Board :** Gypsum board consists of a core of set gypsum surfaced with specifically manufactured paper firmly bonded to the core, BhushanMahajan, (2020). Gypsum board also is known as drywall, plasterboard, or wallboard.
2. **Screw Machines :** Screw machines are type of metal working lathes, which are used to machine hard materials into precisely designed components.
3. **Drilling Machine:** A Drilling machine, also called a drill press, is a powerful tool used to cut a round hole into or through metal, plastic, wood or other solid.
4. **Drilling Bit :** A drill bit is the cutting device located at end of a drilling machines drill string.
5. **Dowels :**These are round piece of rod driven into a wall so that other pieces can be nailed to it.
6. **Bolts, Nuts and Washers :** These are the essential tools we used to hold the profile hanger.
7. **Iron and Rubber Fishers :** These are the essential tools we used to hold wall angle to the wall.
8. **T-Square :** T – Square is a tool used by draftsmen (installer) for drawing horizontal lines.
9. **Joint Tapes :** These are used when treating a drywall joints or ceiling joints to provide a strong bond where the two pieces meet.
10. **Measuring Tape :** This is an instrument used to measure size or distance.
11. **C-Channels :** These are structural channel also known as Parallel Flange Channel (PFC) used to framed drywall vertically.
12. **U – Channels :** These are non- structural channel used to framed drywall horizontally.
13. **Trimming Knives :** These typically measure between 6 to 8 inches curved blade that are flexible enough to maneuver all manner of tight spaces.

14. Pencil : This is an instrument for writing or drawing.
15. Mineral Wood Fibers : These are used as insulation material for sound proofing.
16. An Adhesive Applicators : These are used to apply adhesive materials to various unstable door frames or unstable joints.
17. Wall Angles : These materials are fixed on the wall with the help of rubber fisher and screw nail and later gypsum boards are screwed on it for ceiling construction.
18. Threaded Rods : These materials are used to suspend profile hanger with the help of nuts and washer.
19. Tapping Line : This is one of the tools used in plaster construction to get straight line alignment.
20. Screw Guns : These are used as one of permanent mechanical fastener to hold U – Channels.
21. Spirit Levels : These are devices used to check whether the ceilings or walls are level.
22. Profile hangers : These materials are used to hang profiles during plasterboard installation.
24. Drywall Saws : These tools are used to cut gypsum boards.

METHODS OF APPLICATION (GYPSUM BOARD)

We have two major wall applications of Gypsum board

1. Dry wall application
2. Acoustic wall Application

DRY WALL APPLICATION

This type of application is used in the residential building, Churches, Mosques, Studios, Shopping Malls etc. It is used to substitute for block wall in construction work with the help of installation materials and tools like U and C-channels, Normal profile, Screw machine ,Screw nails ,Drilling machine etc.



Fig 2 DRYWALL INSTALLATION IN PROGRESS

ACOUSTIC WALL APPLICATION

This is the type of gypsum board installation that is required for enhanced sound proofing and sound control. It is found in interior walls of hotels, school, hospitals, restaurants, music rooms, conference rooms and bed rooms.

Sound Proof gypsum boards are used as primary sound absorption where higher acoustic quality is required or where noises are severely limited such as studios, auditoriums etc.

The following seven steps are involved in Dry wall application

1. WALL CONTROL

The cladding wall is determined and pencil is use to mark the line on which the U-Channel is to be fixed.

The mark on the floor is transferred to the ceiling with the help of long plum and drawn to the ceiling with the help of colored tapping line.

2. ARRANGEMENT OF METAL PROFILES

Measuring tape is used to determine the height of the cladding wall and C-Channels are cut according to this height. U-channels are cut according to the floor length and ceiling length respectively. This is done to accommodate the C-channels up and down base on their individual height.

3. FIXING U-CHANNELS AND C-CHANNELS

The U-channels are mounted to the floor and ceiling with the help of 10mm iron Fishers plus 12mm long screw nails plus washers using a drill machine and screw machine. The C - Channels are arranged in 60mm spacing.

4. FIXING NORMAL PROFILES

The normal profiles are used as a bracer between two C-channels in order to achieve a balanced profile installation with the help of tapping screws at appropriate distances.

5. INSTALLATION WORKS AND INSULATION

Rock wools or mineral fiber material, electrical wiring and plumbing fittings are fixed before putting the panel boards. In modern construction, access panels are created for easier maintenance of the concealed accessories inside.



Fig 7. ACCESS PANEL INSTALLATION



Fig 8. CONCEALED MECHANICAL AND ELECTRICAL INSULATION

6. PLASTER BOARD SCREWING

At this stage of construction, the boards are placed in a vertical horizontal other vice versa.

The Standard dimension of those plaster boards are as follows.

- ❖ 1200mm x 2400mm
- ❖ 1200mm x 2700mm
- ❖ 1200mm x 3000mm

7. COATING AND FINISHING SURFACE

After installation of plaster boards, the joints are treated using joint tapes and ready mix joint compound.

After these steps, 3mm thick skim coat of Plaster of Paris (POP) are applied on the surface of the plaster board. Also, undulations are checked on the board using long plum and possibly re-skims if there is one. The boards are left to dry for at least 24hrs before sanding and painting.



Fig 9: SKIMMING WORK IN PROGRESS

GYPSUM CEILING TILES INSTALLATION

We have two major patterns of installation

1. Installation by Grid method
2. Installation by Profile method

These grids can be installed on a decking or wooden noggin using iron fisher tied with aluminum binding wire or non-flexible wall angle respectively.

1. INSTALLATION BY GRID METHOD.

In this method, profile work is achieved by using combination of aluminum profile of

definite dimensions such as 600mm, 1200mm and 2400mm.

Also the grid installed is further partitioned in such a way that it will accommodate the 600mm x 600mm gypsum ceiling tiles. Either the runner (2400mm) and distributive runners (1200mm and 600mm).



Fig 3. Sample of Installation by Grid Method

2. INTALLATION BY PROFILE METHOD

In this type, profile is suspended with the help of iron fisher drill inside the decking, then screw the threaded rod, washer, nuts and profile hanger.

After profile installation, the profile is check for undulations before gypsum panel board is screw to the profile with 6mm board screw.

NOTE: Profile to profile is screwed with tacking screw while board to profile is screwed with board screw (6mm black screw).

After a balance gypsum board installation, the joints are treated with joint tapes and adhesive compound before a balance skim coat. (Screeding) is applied.

The sanding and painting is applied at least 24hrs after skim coat. (Screeding).



Fig 4. INSTALLATION BY PROFILE METHOD



Fig 5. PROFILE HANGER AND PROFILE

Fig 6. PROFILE FRAME WORK (THREADED ROD, NUTS, WASHERS, IRON FISHERS, PROFILE HANGER AND TACKING SCREW)



III. RESULTS AND DISCUSSIONS

From the analysis of the both methods used for this research, we noticed that the installation by profile method was more stronger and firm than installation by Grid method. Acoustic Drywall installations have more significant sound absorption than normal drywall installations.

Moisture resistance (MR) plasterboards perform better than normal white plasterboard in wet areas. While Fire resistance (FR) plasterboards are best for areas that are susceptible to fire outbreak than Moisture resistance (MR) plasterboards.

4. BhushanMahajan, Properties of Gypsum Board and Application of Gypsum Board. Civiconcepts, 2020.

IV. RECOMMENDATION

1. From the analysis of the above methods, we strongly recommend the use of normal gypsum boards for the partitioning of walls and construction of ceilings in high rise buildings, because of the light weight of its structure and high resistance to shakes during quakes (Earth Tremor) provided that the foundation of the same structure are adequately reinforced.
2. We recommend the use of moisture resistant gypsum boards in the areas with water defects like bathrooms, toilets and kitchens.
3. We recommend the use of fire resistant gypsum boards in the area like kitchen because of fire outbreak.
4. We recommend the use of sound proof gypsum boards, that is perforated in one side and laminated in the other side in such areas like studios, conference rooms, cinema halls, because of high absorption of noise.

V. CONCLUSION

Installation by profile method was the most effective method of plasterboard installation. It produced the highest level of stability and strength. Installation by Grid method produces higher stability and strength.

Acoustic Drywall installation produces the highest level of sound absorption and strength.

Sound proof Gypsum plasterboards are the boards with the higher level of sound absorption and strength.

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