

Design and Application of Integrated Assembly Technology of FRG in Residential Ceiling

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Abstract. FRG material is a new environmentally friendly indoor decoration materials and popular in prefabricated construction, the paper introduces the performance and design of materials, and takes FRG in the residential ceiling integrated assembly process into a demonstration project, which showed that FRG in the prefabricated modules integrated ceiling of the whole template scheme has a great artistry and application effect. Meanwhile it provides reference for the integrated ceiling assembly modular process design of similar indoor decoration.

1 Introduction

In recent years, the development of the world integrated ceiling has focused on China. With the promotion of fabricated buildings, China's integrated ceiling has occupied a large international market, and has displayed distinctive cultural characteristics in the residential ceiling style. From the plane design to the three-dimensional development, the integrated ceiling will turn into a new, green and integrated field which promoting industry to upgrade.

2 The Material Characteristics of Green Environmental Innovative FRG

During the gradual attention and development of residential integrated ceiling in the past more than 10 years, more and more attention has been paid to functional, artistic and environmental protection in construction applications. The aluminum buckles as the initial material for the integrated ceiling, then from GRG to FRG, and there are different features among them.

FRG is a typical inorganic cementitious material, English Name: Change the nature of the ontology by liquid phase method fiber-reinforced gypsum complete mould for decoration member. It is made up of a gypsum decorative art component composed of a liquid phase modification of a alpha natural gypsum, a green fiber and a photocatalyst ^[1].

As a large common construction decoration fixture of environmentally friendly building materials, GRG (Glass Fiber Reinforced Gypsum) has arbitrary shape, class A1 fire prevention, no dehiscence and non deformation, excellent performance, strong acoustic comfort effect. Compared to GRG, FRG core performance of the integrated ceiling indoor decoration reflected in the whole mould customization, lightweight and high

strength, absorbing aldehyde, weathering and corrosion resistance, mechanical properties in bending strength can reach above Mpa15-25 (ASTMD790-2002 test); tensile strength can reach above Mpa4-15 (ASTMD256-2002 test), the thermal properties also reflects the low coefficient of thermal expansion and dry shrinkage rate of less than 0.01%, the product of FRG under the environment of cold and hot, dry and wet deformation, showing performance is extremely stable. In the integrated ceiling material selection, FRG is an innovative trend of green building materials.

3 General Situation of Integrated Assembly of Residential Ceiling

The case of Mr. Tong's integrated ceiling wants household ceiling design that has exclusive and comfortable effect which locates in the city of Heyuan, Guangdong, China. The project by the Guangdong Meisui industrial development CO., LTD. is responsible for the design and construction, and the owner offered the ceiling artwork for the bold black lines of Figure 1, the original design decorative ceiling intends to use block board and gypsum board, because of complicated shape, block board failed to meet the needs of the beauty of the shape, also face a long period and high labor cost.

Some problems proposed and need attention in examination of working drawing. On account of shaped plate curvature, arch height and angle accuracy, particularly accuracy in manual operation of the traditional process of custom-made block board is easy to produce error. Coefficient of variation of block board is a little large, the transportation and storage is inconvenient due to large shape, also facing installation and construction technology of high working, edge closing, maintenance series of technological problems.

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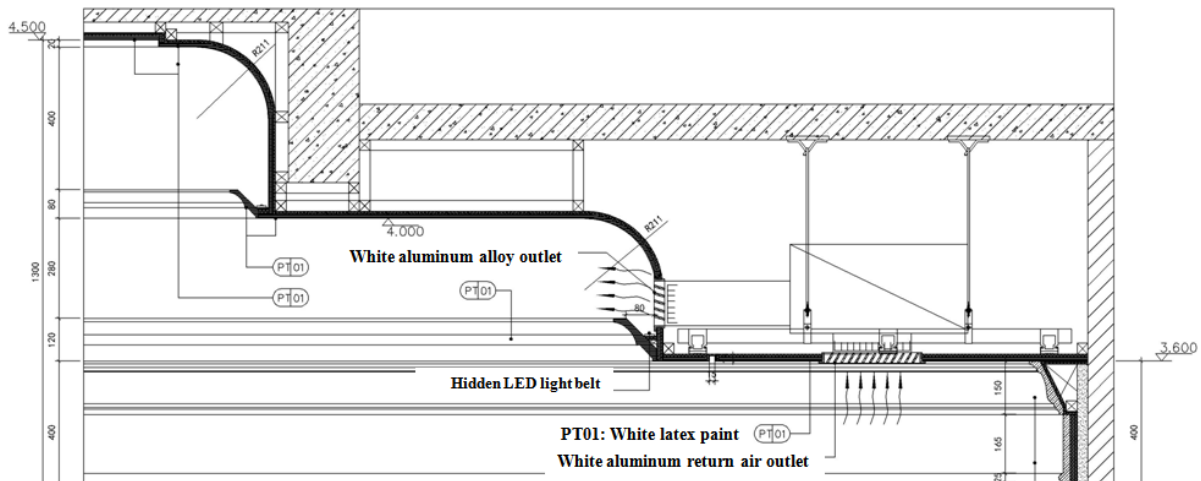


Fig. 1. The First Floor Sitting Section of the Living Room

4 Design idea of FRG whole forming mold

One of the core performance of FRG is the whole design of module, the design of the whole mold has a strong overall sense, which avoided disorderly seam fracture phenomenon, showing clean and elegant. In the process of the design of the whole forming mold, several difficulties are solved.

(1)Precision: the project process using FRG whole module integration designed to replace handmade block board, FRG as the main material, making troffer into design integration, in the design process in advance of having orifice, hole, and integrated silicone mold into molding, which solves the continuity of special-shaped wood angle for precision and complexity; for getting higher data, 3D data collection of actual space is required. The first drawing is in CAD, second is deepen in Rhinoceros software, and the establishment of 1:1 model in the process of the production, then imported CNC engraving and carving basementmembrane, through accurate mold, it can produce a variety of FRG blocks, various FRG is equipped with the mould to ensure the accuracy of whole design.

(2)Seamless forming: The sense of integrity of FRG is embodied in seamless connection. The gap between the end plate and the other plate is filled with GRG powder at the connection joint, make effective use of FRG powder material consistent seams to fill the gap and the putty powder is used for polishing. In order to avoid color aberration when condensation generating, with white latex spraying whitewash, the final effect of continuous of the whole color, like nature itself. In closing, to solve the hidden peril of cracking in splicing installation process, or multiple plates influence the roughness and other issues, this can be accurate reservation for a custom lamp box. Or late for opening, it is advisable to use opening machine to avoid excessive cracking, the gap edge necessary reserved 5mm width, and collocation of aluminum components, plus the joints the same treatment method, effectively achieve seamless effect.

(3)Installation: FRG integrated ceiling has the characteristics of assembly construction, in the approach of integrated ceiling materials, preparation of varieties, specifications, size and appearance inspection should be Check in order to improve the efficiency of installation , all materials in the transport, handling, storage, installation take protective measures to prevent extrusion impact, damp, deformation and damage the surface of the plate and corner. Considering the safety in the process of installation, the scaffolding is set up to meet the construction needs of the working face.

5 Application of Integrated Ceiling Assembly

5.1 Prefabricated Modularization Scheme for FRG Integrated Ceiling

This case takes into account the traditional ceiling method with high cost and long construction period, the FRG ceiling design is adopted, and the whole living ceiling design of FRG is designed as shown in Figure 2. The integral ceiling is made up of a customized lamp slot component and the same material inorganic high crystal composite board. The product is fixed by the light steel keel lock. The seams among the block boards by using the same material FRG powder mixed with white latex and filling sealer belt, so that the top surface does not appear gap, at the same time to solve the cracking problem of joints. The material use FRG silicone rubber mould integrated molding, the complex and changeable modeling of the pattern is well solved; auxiliary parts used in light steel joist, hanger rod, self tapping screws, explosion screws, FRG powder, sealing tape, white latex.

In the process of design deepening, we should give full consideration to the reserved holes at the ends of lamps and other devices, and divide them into integral modules as much as possible on the curved surfaces and irregular corners of the block board, so as to facilitate installation and beauty. During the production process, mold engraving, feeding, pouring, controlling size, demoulding, drying and other processes are strictly in

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accordance with the acceptance criteria, ensuring silicone mold integrated molding.

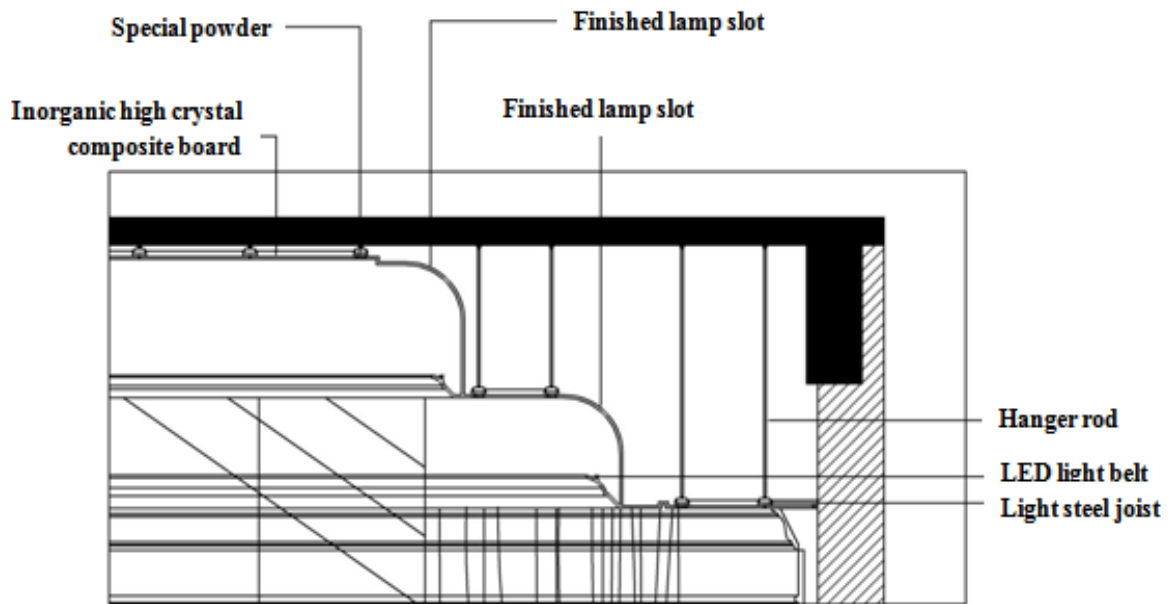


Fig. 2. The First Floor Sitting Section of the Living Room

4.2 Construction Technology Process

Projectile line positioning → light steel joist installation → FRG product installation → product crevice treatment → surface layer spraying white latex → engineering acceptance

Before the construction of the ceiling works, we need to be familiar with the drawings and worksite conditions, make sure that the equipments and pipes in the ceiling have been completed. The incoming materials are inspected according to the construction standards, and

the construction personnel are aware of the technical disclosure.

(1) Projectile line positioning

Before installation, strictly according to the drawing line, ensure the large area of finished curve surface to install and make convenient for the second and third level of the light steel joist^[2]. By using the CAD diagram, the top surface of the ceiling is divided into a proper vertical partition to form a plane (Figure 3);, a facade and a profile, and positioning of Actinobacillus is carried out.

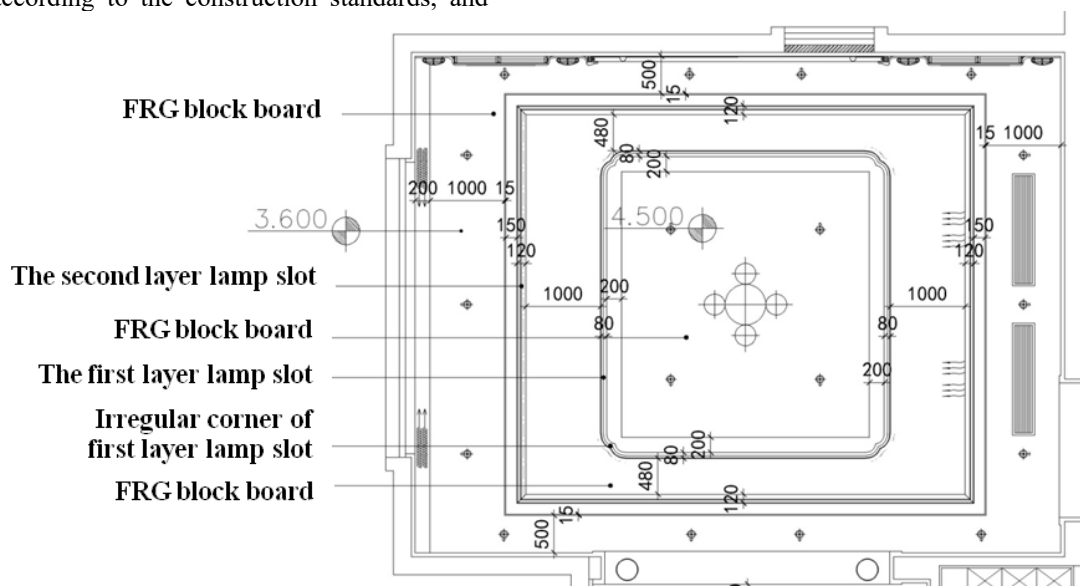


Fig. 3. First Floor Living Room FRG Drawing

(2) Preliminary installation

After placing the positioning line, the expansion screw, the hanger rod, and the light steel joist are laid

according to the point position, and the light steel joist frame is adjusted according to the national standard.

(3) Product installation

Supporting material of ceiling use light steel joist and according to the requirement of positioning line to prepare the hanger rod and auxiliary accessories, and change the traditional manual wooden cutting and lumber fixed keel, which improves the overall sense of flow lines and smoothness, and principal position according to the construction drawings, then determine to install and check.

(4) Gap treatment

Crack is a common disease of all decorative surfaces, and the influencing factors are many and complex. Especially after cracking, it is very difficult to repair^[3]. Therefore, the first treatment is particularly important. In order to better solve the noise reduction function, the living room ceiling can also produce good acoustics. When processing, use of FRG powder grout in the gap, On the one hand, make sure the block board and powder are made up with the same material, for reducing the influence of the coefficient of variation; on the other hand, the strength and the density of the block board are reaching unanimity. Particularly in the process of solidification, the chromatic aberration caused by successively drying can not be too obvious. At the same time, slots reserved for a certain width can make the FRG powder bond better, filled the weak part of the pore, and reduced the late cracking and reduced the background noise. Further, in order to bond more firmly, after making up the surface smooth, paste the sealing

belt on the gap, or the elastic putty powder is added, which can scrape the powder in horizontal or vertical direction, and usually also need to polish and clean the surface in advance.

(5) Surface treatment

General to create a sense of beauty, in the surface layer evenly coated with white latex, note the sagging or color chromatic aberration, according to the needs in the product surface layer it can also apply with three-dimensional relief texture, colored painting, metal finishes to a variety of realistic decorative effect, which are making the overall integrated ceiling appear seamless, continuous, smooth and comfortable.

(6) Acceptance of work

The engineering case of integrated ceiling acceptance according to JGJ 345-2014 "*Technical specification for ceiling engineering of public building*", CECS 255-2009 "*Technical specification for installation of ceiling systems in buildings*", GB50325-2010 "*Code for indoor environmental pollution control of civil building engineering*", GB50210-2001 "*Code for construction quality acceptance of building decoration*" of the relevant provisions of approval, the whole integrated ceiling in this case design by FRG prefabricated modularization has been verified for acceptance by the customer satisfaction(Figure 4).



Fig. 4. First Floor Living Room FRG Real View Diagram

5 Conclusion

FRG integrated ceiling has excellent decorative effect. Even damaged, it can immediately maintenance and leave no trace, but it also needs to avoid heavy weight, avoid contact with gasoline and diluent, and also pay attention to make it soak in water for a long time while water leakage. FRG is lightweight, can be personalized customization of the whole, also is a green innovative constructive materials in 2017. With the modular design

and assembling design, integrated ceiling has a commendable performance. This case successfully achieve the project acceptance, in the following 3-5 years, FRG integrated ceiling is expected has a broad market space, and will be favored, usher in a huge development space.

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