



(RESEARCH ARTICLE)



The characteristic design of ceiling

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Abstract

The ceiling as part of the building functions to protect the utility and structure of the room from user visual. Moreover, it protects the user from getting affected by the problems of utility that may occur during the use of the building. The ceiling creates a complete room interior design. In considering those aspects, the ceiling needs to be designed and constructed properly according to the need and type of room. This research aims to identify the characteristics of the design and construction of ceilings. The method is a literature review and study field on various buildings. Data of design is drawn with the computer design program AutoCAD for the main concept. The result shows that the characteristics of the ceiling can be classified based on Support utility such as sprinkler, Cooling system, the material used, Type of ceiling, and ceiling height. Further research needs to consider the local influence on the design and construction system of ceilings.

Keywords: Ceiling; Design; Construction; Building

1. Introduction

The building construction requires adequate design and construction system in particular for the room ceiling. This part of the building can be seen by the user and influence them in terms of the vibe of the room and the safety structure provided. The ceiling is functioning to protect the utility and structure of the room. The user needs to have a secure and comfortable feeling in a room. The problems of utility may occur during the use of the building. The ceiling creates a complete room interior design. In considering those aspects, the ceiling needs to be designed and constructed properly according to the need and type of room.

Studies on ceiling design and construction systems have been widely considering different aspects to improve its function in the building. Research includes temperature impact on ceiling design, the material used, room condition, repair of material, and types of ceiling. The use of Phase Change Material (PCM) is to reduce the air temperature in the ceiling and energy demand for cooling [1]. Under specific climate conditions, complex simulations are used with a comprehensive approach (ibid). The temperature of the ceiling can be reduced up to 27% with PCM based solution [1]. The use of PCM for cooling ceiling systems has lowered the cooling capacity to 20% due to low thermal conductivity [1]. The use of ceilings for fire protection utilities such as sprinkler systems with automatic design [2].

According to Ayuningtyas et al [3], the use of the drop ceiling type is recommended due to its function to keep the temperature so the room can reach its thermal comfort. On the other hand, the use of a Vaulted Ceiling can increase the temperature by 3 ° C. The use of interior gypsum plaster influences the temperature of the passive cooling system [4]

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Moreover, Indicators such as stored heat, solar radiation heat gain, and surface temperature have an impact on passive cooling techniques [4].

Folorunso et al [5], develop ceiling material by using waste paper or sludge which improves the physical and mechanized properties compare to asbestos ceiling. Material of the ceiling has been developed including the use of local raw materials such as casava starch [6]. The use of cassava starch increases the density of ceiling boards (ibid). Compared to other ceiling materials the use of waste for ceiling gives the result of a modulus of elasticity of 1250N/mm² to 1320N/mm²; water absorption values of between 7.5% and 14.5%; thermal conductivity values of between 0.07kW/MK and 0.082kW/MK as well as density values of 103kg/m³ and 201kg/m³ [7]. The material of the magnesium-based board is developed with biological resistance including bacterial and fungal resistance [8]. The techniques of repairing for diagnosis and inspection of gypsum use innovative approaches due to the high impact of water [9]. Kolaintis et al [10], studied gypsum plasterboard and wood-based panels for fire protection. Gypsum plasterboard has been identified as better fire protection than wood-based panels. Gypsum material has been studied for its properties in which the Co-modified TiO photocatalysts are added for self-cleaning material in commercial gypsum [11]. There is an increase of compressive strength by 40% if the gypsum particle size is reduced due to the photocatalyst particle filling the void spaces (ibid). Levy et al [12], study the variations of ceiling height concerning consumers' process information where the concept of freedom versus confinement is shaped. Moreover, higher ceiling rooms influence the way people evaluate products emphasizing features. Types of ceilings are traditional flat drywall ceilings, exposed beam ceilings, partial drop ceilings, coffered ceilings, tray ceilings, and vaulted ceilings [13]. Types of suspended ceiling systems are panel and tile systems, concealed grid systems, stretch ceiling systems, and custom ceilings [14]. The types of the ceiling are defined based on the construction of panels which the panel and tile system is composed of a series of panels, the concealed grid system uses panels in the grid system, and the stretch ceiling system is composed of one large panel and the custom ceiling is based on the user-specific need [14].

2. Methods

The method of research is conducted through literature study and field study. Related works on the study of ceiling design and construction are explored. Vary places are observed based on different types of ceiling and room functions. Areas of study include the private and public areas in North Sulawesi, Indonesia, and Yokohama, Japan. Data is collected by picture taking. Based on the literature study, data from the field study is analyzed to achieve the characteristics of the ceiling based on the design and construction system used. The data on the design and construction of the ceiling is drawn with the computer design program AutoCAD for the classification list.

3. Results and Discussion

3.1. Characteristics of Ceiling

The design of the ceiling is analyzed based on the design principles of color, repetition, contrast, harmony, texture, and shape. Construction of the ceiling is explored based on the material used, joint system, and utility system available.

The characteristics of the ceiling can be seen in Table 1.

Table 1 Characteristics of The Ceiling

No	Characteristic	Source
1	Support utility: sprinkler	[2]
2	Cooling system	[1]
3	Composite material from waste	[7]
4	Type of ceiling	[13]
5	Ceiling height	[12]

The types of ceilings in the building vary based on many aspects. Aspects include function, room size, material, room height, utility available, and design approach, The types of ceilings can be seen in Table 2.

Table 2 Types of Ceiling

No	Type Of Ceiling	Source
1	Traditional Flat Drywall Ceiling	[13], [15]
2	Exposed Beam Ceilings	[13],
3	Partial Drop Ceiling	[13],
4	Coffered Ceilings	[13], [15]
5	Tray ceiling	[13], [15]
6	Vaulted ceiling	[3], [13], [15], [16]
7	Suspended Ceiling	[14]
8	Drop Ceiling	[3]
9	Domed Ceiling	[16]

The type of ceiling based on the survey varies. Different types of ceilings are developed including modern ceilings due to the improvement of materials and facilities for ceilings. Based on the survey types of ceilings include drop ceilings, flat ceilings, up ceilings, domed ceilings, curve ceilings, slope ceilings, combined ceilings, and industrial ceilings. The most common type of ceiling is the flat ceiling. The type of drop ceiling can be seen in Figure 1.

**Figure 1** Drop Ceiling

The type of Drop ceiling such as the office ceiling can be designated with different colors to strengthen the focus on the room. This type of Ceiling has been used for many types of rooms. Up ceiling can be seen in Figure 2.

Based on the survey there are Up ceiling in the large lobby at the hotel and an Up ceiling with utility and decoration of light at the restaurant. Moreover, the up ceiling such as for the meeting room shows the type of design that boundary the large area to a focal point area as the center of the meeting room. Below this ceiling is a board meeting member area. Type of up ceiling in a large room such as a shopping Centre.

Combine Ceiling attracts users due to its rich combination including texture and color. The combined ceiling can be seen in Figure 3.

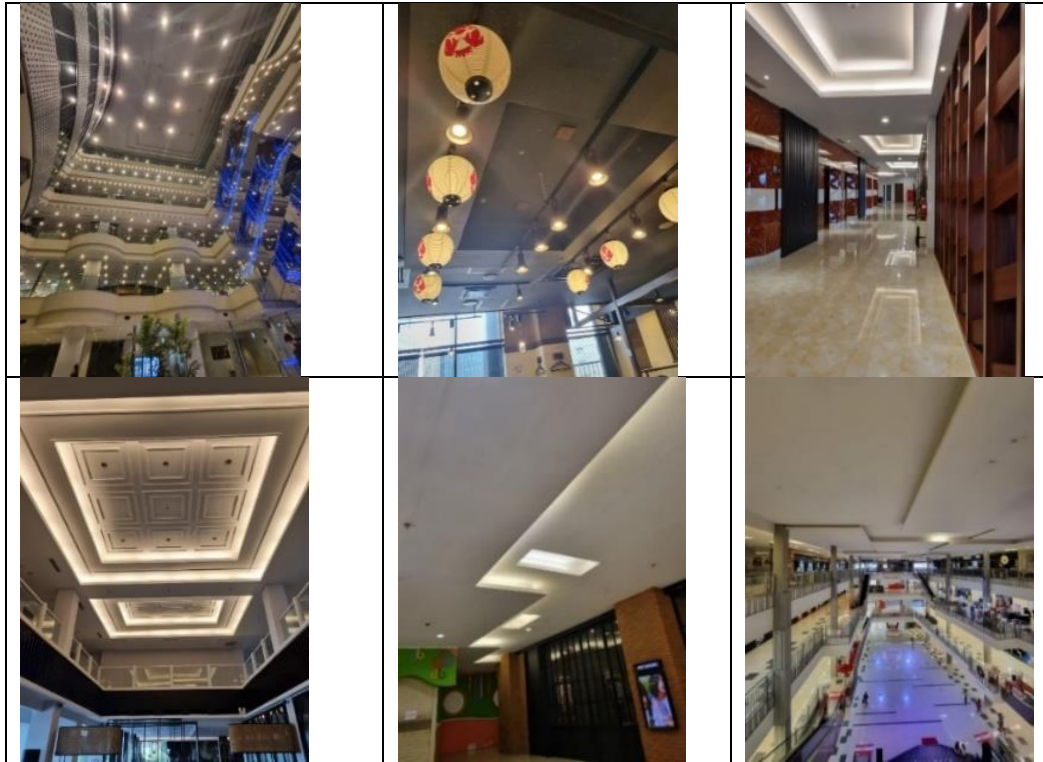


Figure 2 Type of ceiling

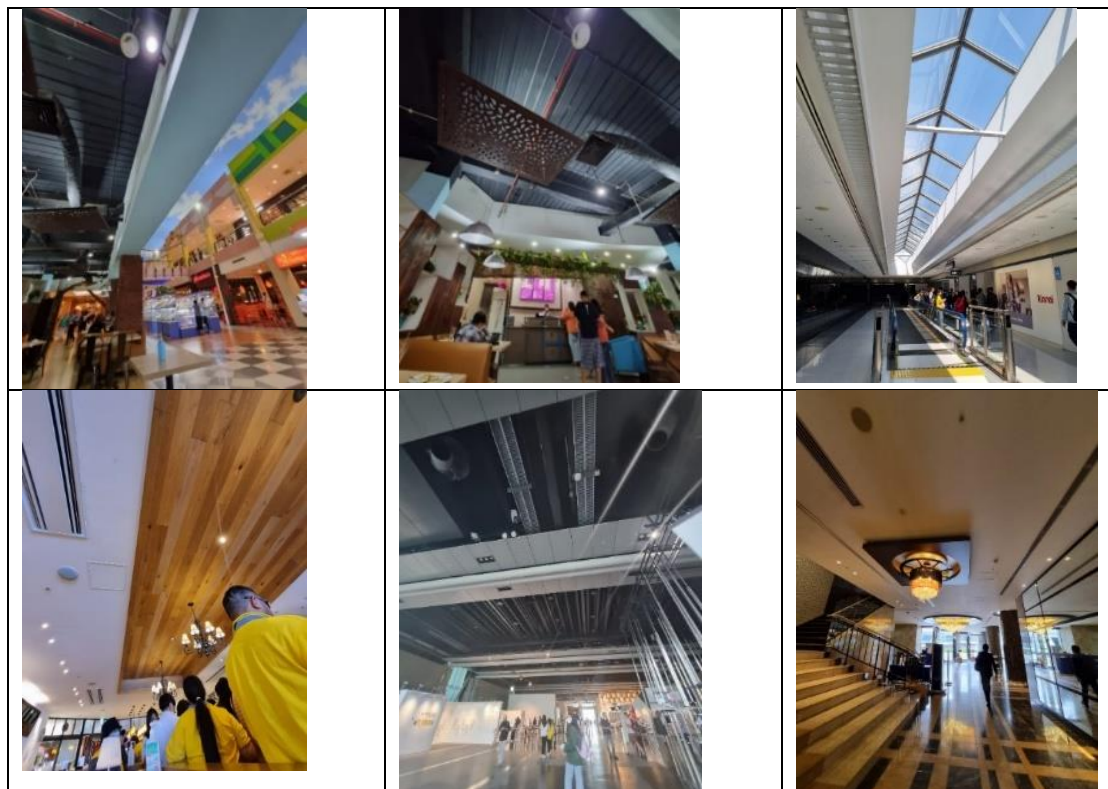


Figure 3 Combine Ceiling

The ceiling for the restaurant is attractive with many functions. The example of Solaria restaurant in Manado town square shows a hanging ceiling with a pattern and the utility exposed system. The main ceiling is a slab system with a

bondex structure. Dark colors grey and brown cover the utility and pattern to unite the ceiling design and construction. Examples of Combine ceilings in buildings in Japan such as Combine ceilings with glass, Combine Ceilings with wood, Combine Ceilings with and without ceiling or slab, and Combine Ceilings with utility and color.

Types of Slope Ceiling is the design of a ceiling with a slope in one direction or two directions. The sloped ceiling can be seen in Figure 4.

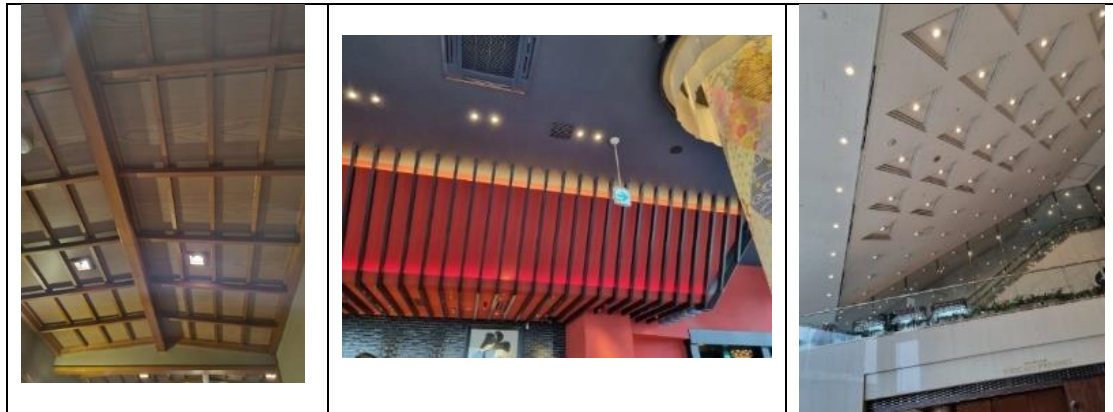


Figure 4 Slope Ceiling

A variety of slope ceilings including Slope ceilings with wood in two directions, Slope Ceilings with lights in one direction, and Slope ceilings with color and frame in two directions of the drop ceiling. Ceilings with curves can be found such as Curve Ceilings and Dome Ceiling. This type of ceiling can be seen in Figure 5.

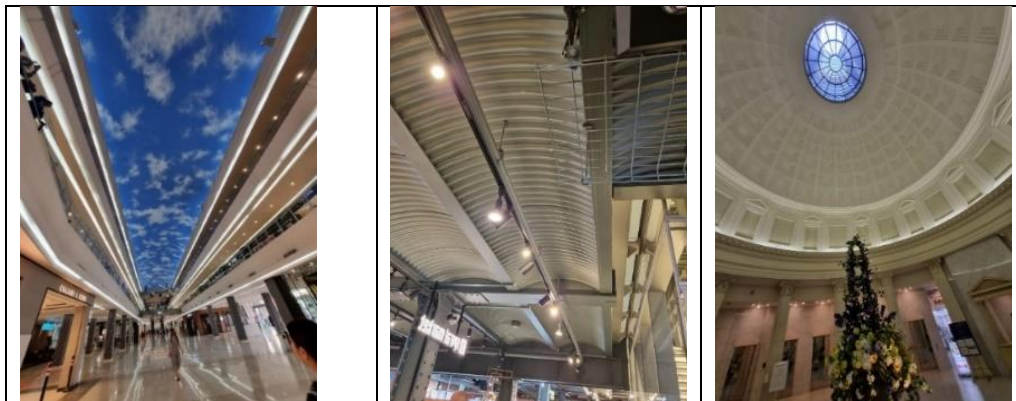


Figure 5 Domed and Curve Ceiling

Curve ceiling for large rooms such as the Mall is designed with paintings of clouds in Manado Town Square. For small rooms, the curve is designed with two curves. The curve is continuous to other rooms with utility and steel structures. The domed ceiling is designed with texture and glass in the middle for rooms such as the lobby of the hotel in Yokohama. The most common type of ceiling is the flat ceiling. The flat ceiling can be seen in Figure 6.

The variety of flat ceilings such as Flat ceilings with panel and border lines. A flat ceiling has been designed for in large room with the pattern. Also, a Flat ceiling with texture for a large check-in room at the airport, a Flat ceiling with eye-catching color for the entrance, Flat ceiling with lights for a high ceiling. Flat Ceiling with lines texture. Flat Ceiling with gypsum and color, Flat Ceiling with frame, glass, and light. A flat ceiling for a modern museum is designed with a moving ceiling. In this ceiling, the direction of the panel can be changed. The ceiling has also been developed in terms of design and construction to reduce less material by using a slab as the base of the ceiling. This type of ceiling has the design of industrial characteristics. The industrial ceiling can be seen in Figure 7.

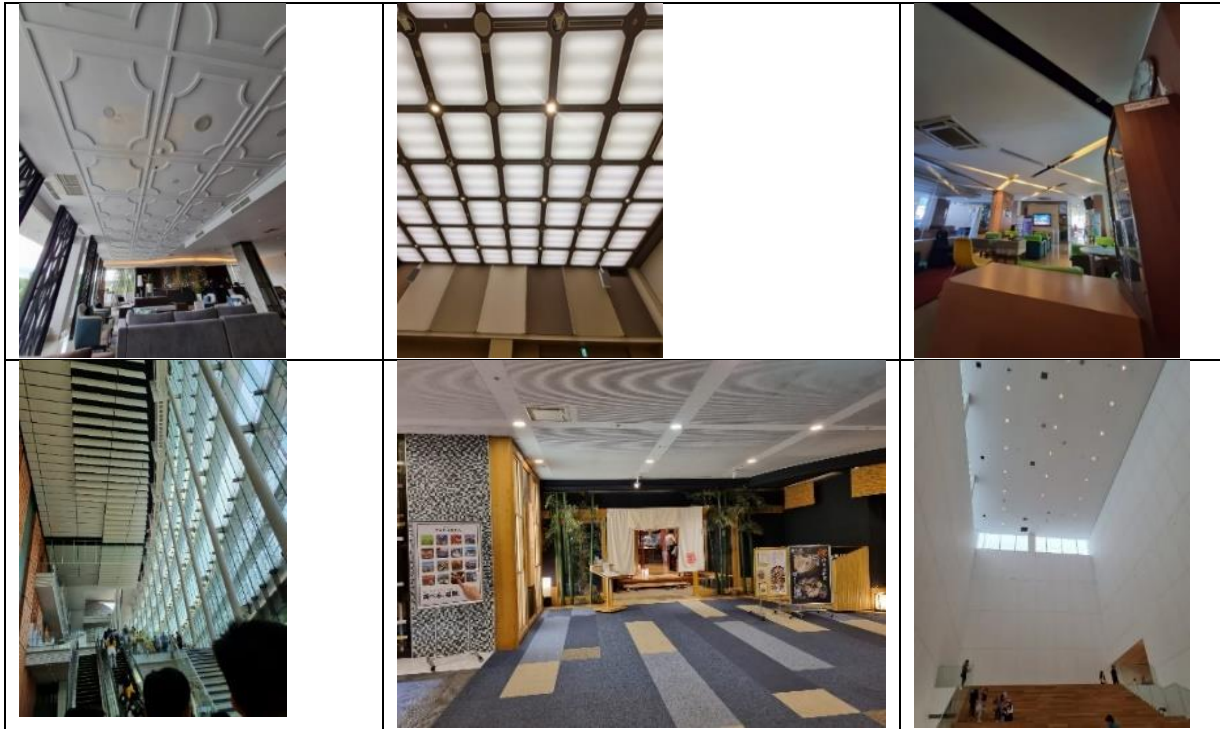


Figure 6 Flat ceiling

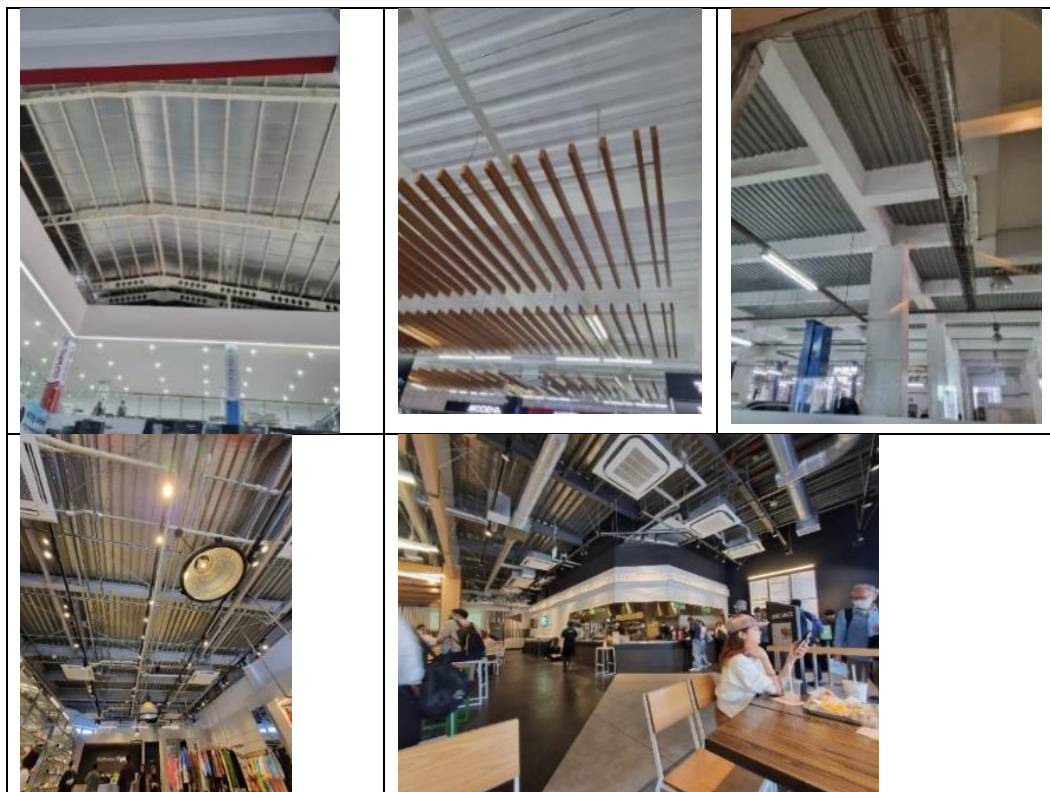


Figure 7 Industrial ceiling

The industrial ceiling is used for industrial rooms such as car service centers and electronic shops. Industrial ceilings use slabs as ceilings with utility and structure at shops and restaurant

The ceiling has to be constructed well to avoid problems with user activities in the room. However, the impact of utility and facility available on the ceiling can cause damage. Damage to the ceiling includes broken ceiling due to accessed

water from the roof or concrete slab on which the ceiling hangs. Damage to the ceiling is also caused by the uneven surface of the ceiling and the crack between the joint ceiling. The damage to the ceiling can be seen in Figure 8.



Figure 8 Damage of Ceiling

The characteristics of the design and construction of different types of ceilings can be classified into 8 types of ceilings based on survey and supporting literature. The design is related to the visual aspect whilst the construction is related to the unseen inside part of the ceiling. This characteristic can be seen in Table 3.

Table 3 Characteristic Ceiling Design and Construction System

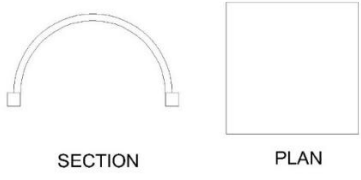
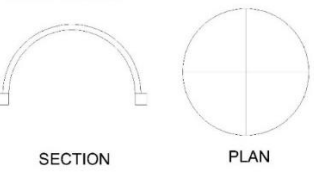
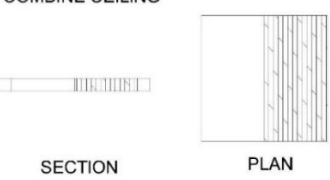
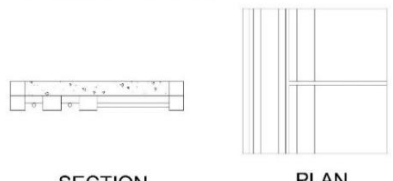
No	Type of ceiling	Characteristic Design	Construction System
1	Flat Ceiling	Plain Wide area for utility Need variation of color, texture, and repetition	Need a frame for a large room Low and high ceiling
2	Up Ceiling	Focus area Attractive design	A strong system of joint material Applicable for Small and large room
3	Drop Ceiling	Focus area Need proper area due to eye-catching design	A strong system of joint material
No	Type of ceiling	Characteristic Design	Construction System
4	Slope Ceiling	Slope design in one or two directions Utility challenging Attractive design Wider space	The structure can be exposed Strong system
5	Curve Ceiling	Attractive design Rich in texture and color	Supporting material and structure Small long room and large room

6	Domed Ceiling	Attractive design Rich of texture Eye-catching For specific function rooms such as the hotel lobby	Strong structure for large dome
7	Combine Ceiling	Attractive design Rich of color, texture	The strong joints of different material
8	Industrial Ceiling	Develop design for many functions room Expose slab Utility exposure requires neat finishing	The strong joint of different construction systems and utility

The different types of ceilings should be designed and constructed well to achieve a quality room in which comfort, is safe, and easily maintained. Based on the characteristics of the ceiling design and construction, the list of ceiling main concept designs can be seen in Table 4.

Table 4 Main Concept Design of Ceiling

No	Type	Main Concept Design
1	Flat Ceiling	<p>FLAT CEILING</p> <p>SECTION PLAN PLAN PLAN</p>
2	Up Ceiling	<p>UP CEILING</p> <p>SECTION PLAN</p>
3	Drop Ceiling	<p>DROP CEILING</p> <p>SECTION PLAN</p>
4	Slope Ceiling	<p>SLOPE CEILING SLOPE CEILING</p> <p>SECTION PLAN SECTION PLAN</p>

5	Curve Ceiling	<p>CURVE CEILING</p>  <p>SECTION PLAN</p>
6	Domed Ceiling	<p>DOME CEILING</p>  <p>SECTION PLAN</p>
No	Type	Main Concept Design
7	Combine Ceiling	<p>COMBINE CEILING</p>  <p>SECTION PLAN</p>
8	Industrial Ceiling	<p>INDUSTRIAL CEILING</p>  <p>SECTION PLAN</p>

The ceiling design can be developed into many designs from the main concept with the aspects of rhythm, repetition, contrast, balance, color, and texture. Such a concept needs to be integrated with material, construction system, and utility.

4. Conclusion

The ceiling is part of the room that has been designed and constructed in many different ways to support each room's function. Research on ceilings and surveys of many places with varying rooms extract the characteristics of the design and construction of the ceiling. The types of ceilings are divided based on the literature study and their implementation in different types of rooms. The development of the ceiling is attractive in terms of the rich color, texture, material, structure, and function. The proposal list of the main concept design needs to be explored more in building design and construction.

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict of interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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