The Ideal Structural System in Hospital Buildings

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Introduction

General hospital is functional building it has different departments provide, medical care, rehabilitation and service for the patients. These depend on medical and none medical equipments which helps medical and none medical staff in the process of diagnostic, treatment, help and advice to the patients. Also these departments providing services to patient registration, documentation and all required need for the inpatients as well as outpatients in hospital. The main departments listed as follows:

- ***Diagnostic department***
- ***Treatment department***
- ***Administration department***
- ***Services department***

The above departments have their requirements to be fully achieved depend mainly on medical equipment and staff for each department. To obtain all of these requirements, each department will have their own capacity and volume in accordance to the capacity and specialty in the hospital which depend upon the space grid columns.

Analysis

Clinical activity of each care department at hospital depend on medical and none medical equipment. Advance medical equipment technology change unpredictable compare to the design and construction timescale. Therefore design of the grid space and area built for main departments in hospital building are fixed to accommodate any future changes in medical equipment or furniture. To reach and obtain the required area needed for each department it accommodate in the research furniture and medical equipments which maintain the required area regardless of any future changes in technology. Taken into consideration the medical and administrative staffs in these departments as follow:

1 - Inpatient Ward

Fix furniture required for a patient room is bed, locker, chair and dining table as Figure 1, this show how the distribution of furniture and the area required. Whereas Figure 2 show all activity taken care by medical staff around the patient bed such as staff moving around bed, using wheal chair, trolley or serving food to the patient in bed. Therefore the required dimension for patient room with one bed is (3.60 * 3.00), two beds (3.60 * 4.8) and four beds (7.20 * 4.8) as shown in Figure 3. In addition to that each room should be added to it the area of bathroom (shower & w.c).Where as Figure 4 show the functional distribution to it relationship with horizontal

movement in the main corridor which can be obtained for structural Grid based on the following dimensions: (7.20 * 7.20), (14.4 * 7.20), (14.4 * 14.4).

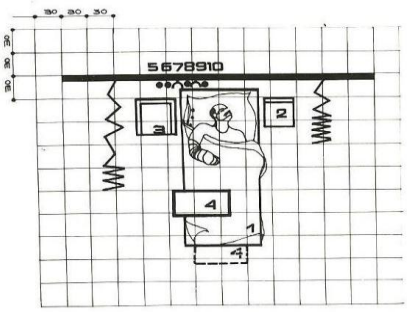


Figure 1 Furniture needs for the patient bed

1. Bed
2. Locker
3. Chair
4. Table

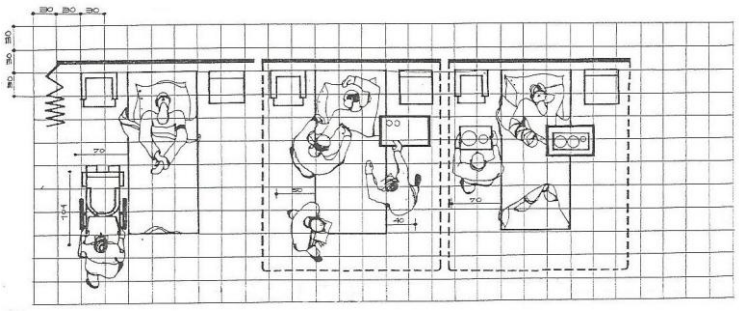
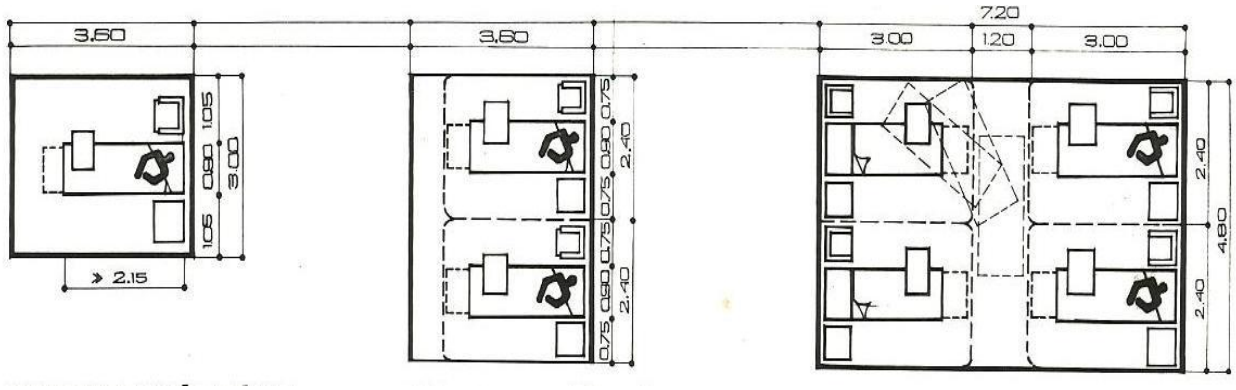


Figure 2 Medical and services staff activity at the patient bed



a) Single bed room b) Two bed room c) Four bed room

Figure 3

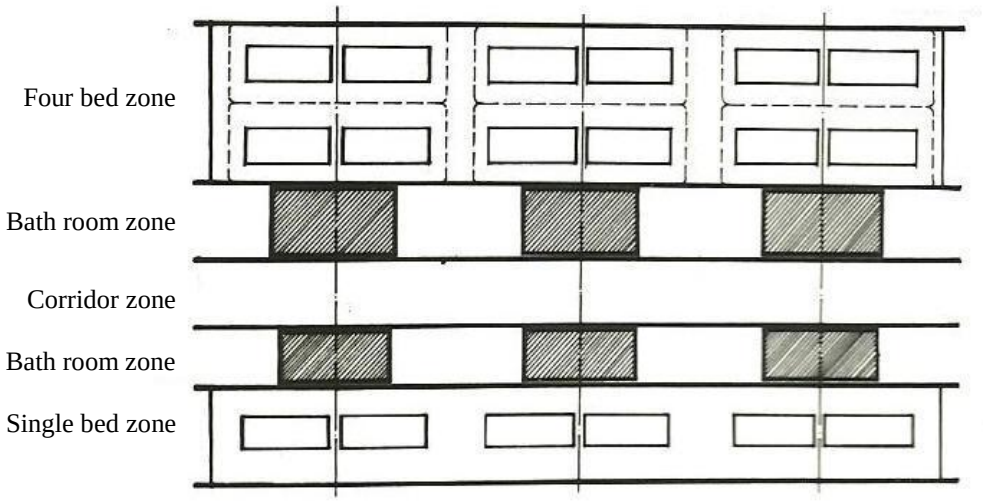


Figure 4 The facility zoning in the inpatient ward

2- Operating Theatre Department

Operating department consist of many different rooms each of these rooms has specific activity such as: preparing patients for operation, changing room for medical staff and recovery hall. In addition there are rooms attached to operation hall such as: scrub up, preparation room for sterilization of surgical tools. But mainly the focus will be in the area of the operating theater halls and main rooms in this department as follows:

a) Operating Theatre

The area of the operating theatre depends on the type functional performed on this hall. Therefore the equipment and furniture required and medical staff can be defined. Fig 5 show how the functions and furniture distrusted in the operating theater divided into three zones the middle area have been allocated for the operation table surrounded by surgical staff. The second zone provides enough space for the assistant medical staff to move around it to help the surgical staff to carryout the operation. The third zone is specified area required for medical equipments in the operating theatre. To achieve these functions incase of normal operation the area required is (5.4 * 5.4). Whereas for more complicated operation which require more medical staff than a normal operation the area required for this hall is (5.4 * 7.20).

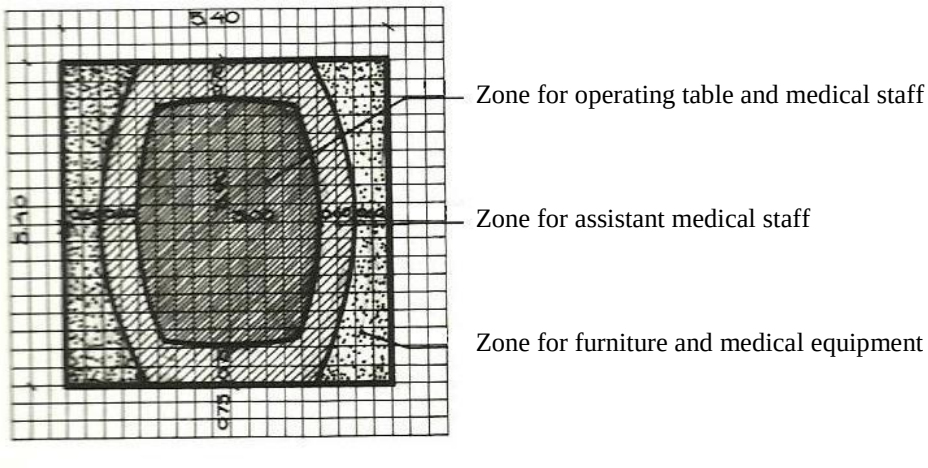


Figure 5 Zoning in operating theater.

b) Induction Room

The patient is prepared in this room before operating. This room is provided with required furniture for patient anesthesia with all medical staff trained for this job. The area of this room is (3.6 * 4.80), some cases the patient anesthesia take place in operating theatre on operating table. In this case precaution should be measured to prevent any anesthesia gas which may affect medical staff during the operation.

c) Recovery Hall

The area of this hall depends on number of operating halls, specialty and type of operations carryout in this department. To determine the required time to stay in the recovery hall, the area required for each bed it shown in Figure 6. This show the patient bed, furniture and movement of medical /assistant staff around it. Therefore the area required for clinical service is (2.10 * 2.70). To expand the capacity of the hall to accommodate six beds it requires area of (7.20 * 7.20) as shown Figure 7.

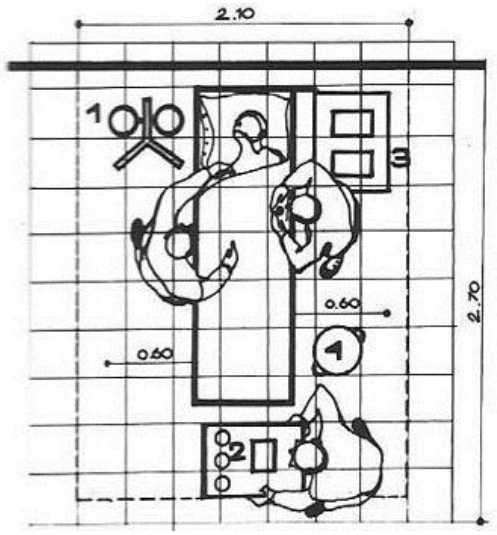


Figure 6 Furniture and functions required for medical staff to rehabilitation the patient.

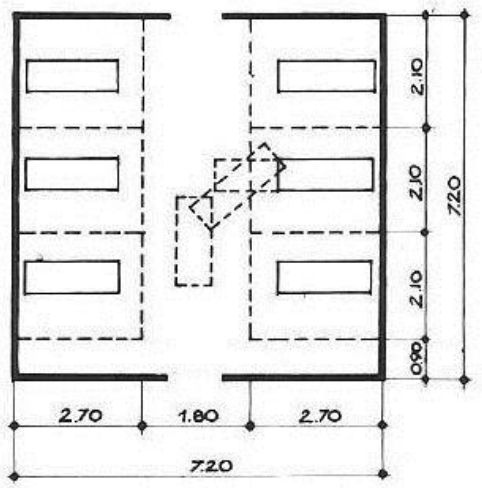


Figure 7 Space required for the recovery lounge with a capacity of six beds.

d) The Functional Zoning for Operating Departments

The organization of functional relationship for the operational department depends on the choice of one of the designed system for this department, including clean and dirty corridor. This system is easy and safe does not need complicated technology and it is recommended to use in the non-industrial countries. For more detail Figure 8 show the operational department for tow halls with attached preparation, anesthesia rooms and corridors connecting them to secure horizontal movement to get the services for these rooms. Therefore all functional activities distributed into zones each one have their own function (dirty and clean corridor). By using same principle can be double number of operational halls to be four halls as shown in Figure 9. Also the number can be increase by using Grid structure with these dimensions (7.20 * 7.20) or (7.20 * 14.4) or (14.4 * 14.4).

Dirty corridor

Anesthesia and preparation rooms

Halls of operations

Clean corridor

Preparation

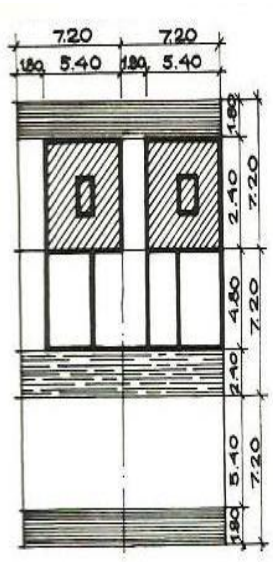


Figure 8 Zoning in two operating halls

Dirty corridor

Anesthesia and preparation rooms

Halls of operations

Clean corridor

Halls of operations

Anesthesia and preparation rooms

Dirty corridor

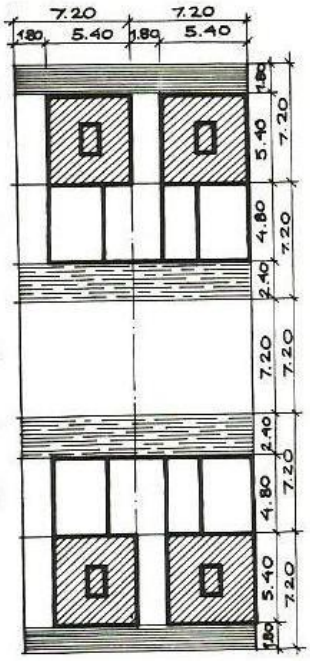


Figure 9 Zoning in four operating halls

3- Intensive Care Unit

One of the key departments in the hospital the capacity, number of beds depends on other departments with their number on patient beds and operational halls. The required area for one bed is shown in Figure 10, also it shows the extra area required for medical staff while providing medical help to the patient. Therefore the dimension required for one bed is (3.60 * 4.80). The way functional distribution in this unit by zone and clarify the locations of staff room so that they are integrated as shown Figure (11) and gives Grid structure dimensions (7.20 * 7.20) or (7.20 *14.4) or (14.4 * 14.4), where you can choose one of the Grid structure in accordance with required capacity of beds at this unit.

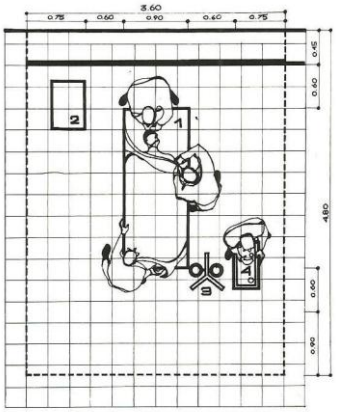


Figure 10 Space required for a single bed in the intensive care unit.

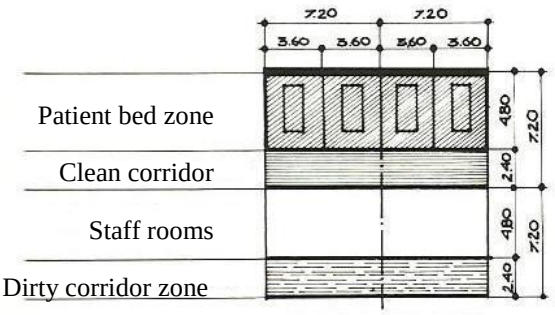


Figure 11 Distribution of events o intensive care unit with four beds.

4- Outpatient Department

This department provides medical care for outpatient in all medical specialties needed by the patient such as examination, diagnostic, treatment and medical consultation by consultants or general practice doctors. In order to achieve this purpose it must have rooms with areas to accommodate the required furniture, equipment, medical and assistance medical staff. It also should be take into account the required area to allow patients with accompany, medical and non-medical staff to move around during this service.

Despite the difference of clinical activity of each group at hospital, most of the furniture is similar in all examination rooms with difference in the type of medical equipment for diagnostic. As result the required area for outpatient department is (3.6 * 4.8) as shown in Figures 12 to15).

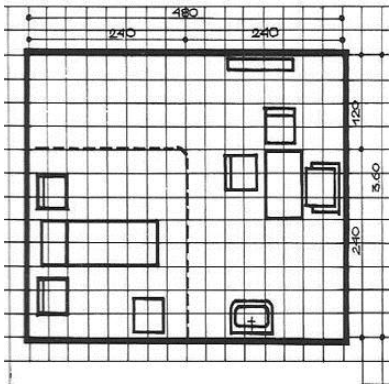


Figure 12 Space required for the examination rooms in the outpatient clinic.

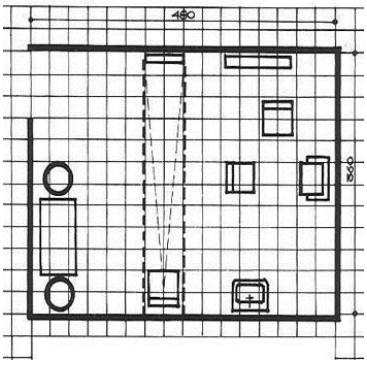


Figure 13 Eye clinics.

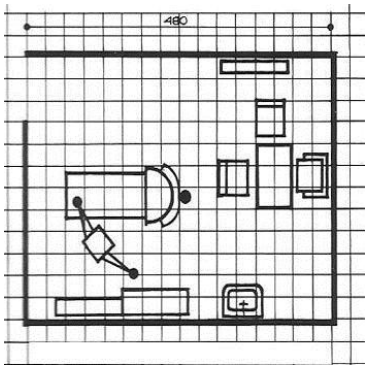


Figure 14 Dental clinics.

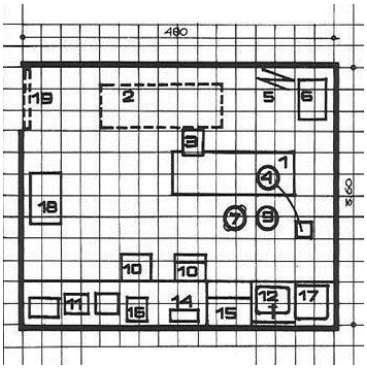


Figure 15 Treatment room.

5- Horizontal Circulation

To ensure the mobility of patients, visitors, medical and none medical staff between departments of the hospital is through the main corridors that link between these departments together and to determine how these main corridors during the functional activity such as activity transfer a patient on a trolley were in the opposite direction patient moving with nurse. Therefore the width of this corridor should be (2.7) Figure (16). In Figure (17) show the two patients moving in opposite direction the width of this main corridor should be (2.4). The previous two cases are required wide corridors were other cases need less wide corridors for people movement.

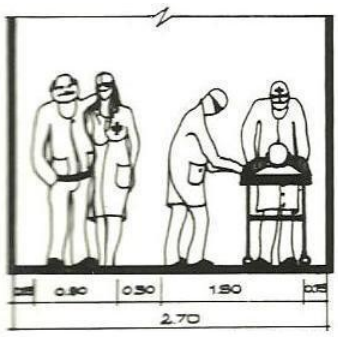


Figure 16 Main corridors.

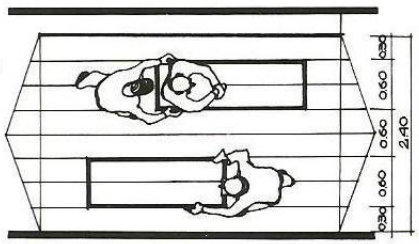


Figure 17 Main corridors.

6- Vertical Circulation

The significant of this the movement through the use of the staircase and to determine the dimensions of the stairs during emergency situation must be suitable for transfer patient on stretcher so that it should be turned around comfortably and easy over the staircase landing, so the width should be not less than (1.8) as shown in Figure 18.

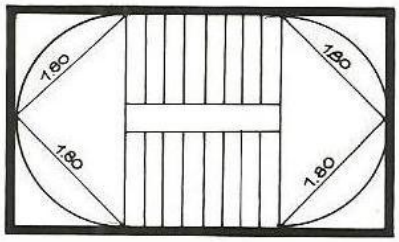


Figure 18. Emergency staircase.

7- Partition and Walls

Department duties depends mainly on medical and none medical equipment. As these equipments always undergoing development and updating continuously, this affected the shape, area and technical requirements. Therefore the area of the new equipment will be different than the old. In order to keep updating with advance technology a search for flexible (moveable) and light-weight building materials should be carried out to reduce the weight on grid structure. Such materials should be easy to install, remove and change positions according to new requirements. Some of these materials as follow:

(a) Gypsum Board

Gypsum board contains of galvanized studs on both direction vertically and horizontally. The horizontal distance (60cm) and vertical distance (120cm) fixed on ceilings and floors and covered by gypsum board as required. This material is light-weight and flexible to move around with no need plastering. Whereas the departments required radiation such as radiology, Nuclear Medicine the partition must be designed to prevent any radiation. Instead of gypsum board the partition will be used for these departments must using materials to protect radiation.

b) Partition of Thermostone Blocks:

In comparison thermostone blocks are the same as concrete blocks in their dimension were as the material is much different. The manufacture of light weight concrete and thermal insulation which gives property to thermstone blocks less weight and thermal compared to concrete blocks. As result the design of the main structural grid (beams and columns) will be much less. By using thermostone blocks will reduces the use of operating the air-conditioning cost electrical power. The installation of thermostone blocks walls is much similar to concrete blocks walls.

c) Sandwich Panel

This type of panels is prefabricated and the materials used are steel sheet painted by two faces thermally filled with thermal insulation (fume). These panels are ready to install on site with dimension (60 x 120 cm) or (60 x 150 cm) or (60 x 240 cm). They are assembling as required for each department.

8- Slab and Beam

To get ideal height for all floors on the hospital three issues must be taken into consideration, beams height in the grid system, space to allow the access of engineering services and required height for each room in the department. These are as follows:

a) Two Way System

The beams in this system are dropped into two directions to transfer loads equally on columns so the heights are equal on both sides taken into account the height of the beam while electro mechanical services pass underneath it. The size of these beams to be determined after the selected grid between the columns sees Figure 19.

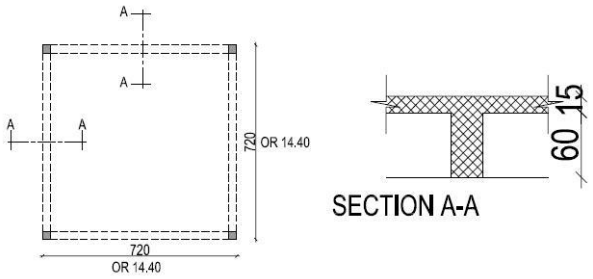


Figure 19 Two way system

b) One Way System

In this system the load-carrying beams is one-way there is no beams on the other direction which allow the engineering services and taken advantage of no beams facing. But the problem in this system when the path of these services is change which enforces it to go underneath beams. Usually the heights of beams in this system see Figure 20 is greater than in two way system.

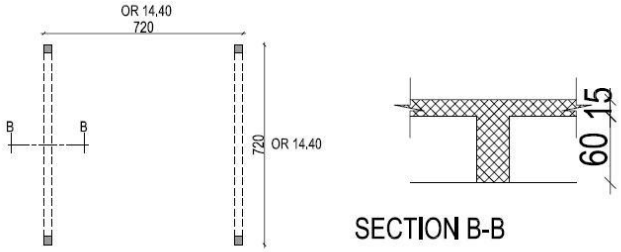


Figure 20 One way system

c) Flat Slab With Drop Panel

This system increase the thickness of the slab on the perimeter load carrying beams with distance (1.20m) by at least (10cm) note that the thickness of the slab is more than the thickness of the slab used in the two systems referred above. Despite of that more freedom is reached in distribution the path of engineering services. As result of that lower height floors is gained compare to other systems, taken into account the location vertical direction in advance before construction not after to prevent and opening in the slab in the close area to columns see Figure 21.

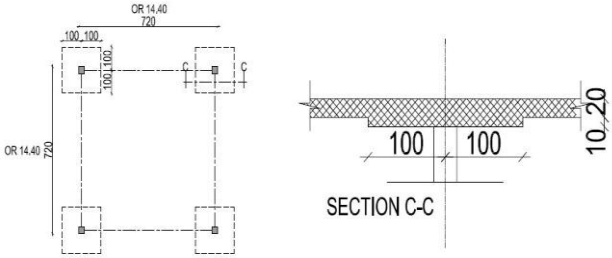


Figure 21 Flat slab with drop panel

d) Wheffel or Rib Slab

This system consist of main beams in two-way link between columns and dividing the area between them by secondary beams with dimensions between axes (1.80 x 0.90) height is less than the height of main beams. Bear in mind the main beams is less height from beams in two-way direction in addition to that the thickness of the slab between these beams have less thickness up to (7cm) with the possibility to make opining in this slab to pass engineering services. Also this system can be used to cover the grid shell with dimension up to (14.4 * 14.4) with height beams can pass comfortably underneath engineering services in all direction Figure 22. This system also can be implemented using scaffolding made in advance from plastic material with dimension as the dimension of secondary beams (1.80 x 0.90) which gives the concrete clean (fair-face) and high quality in addition to the speed of construction compared to wood scaffolding.

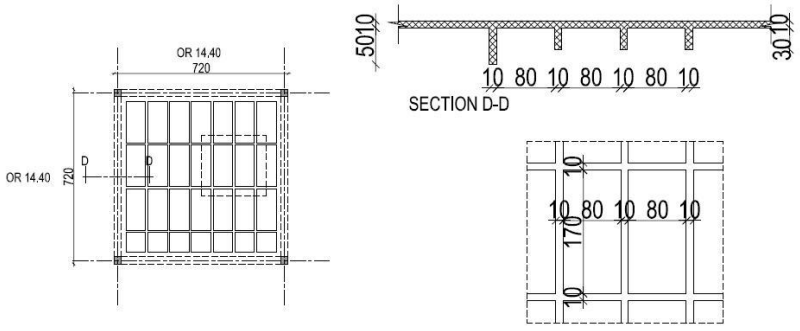


Figure 22 Wheffel or rib slab

9- Conclusions and Recommendation

Based on the areas that have been reached to maintain all the functions on each department at the hospital are been show in Figure 23 and corridors that link departments together with vertical movement between floors can be summarized dimensions required for the halls and rooms in departments within the divisions of the structural grid system is (7.20x7.20) or multiplication (7.20x14.20) or (14,20x14.20). Walls and internal partitions that are surrounded rooms, halls and position of corridors that fall into structure grid and don't obstruct with it and be identical to the subdivisions. The other part of the structural grid such as beams and slabs, specification, dimensions and its system depend on services and electromechanical passing beneath and within the space allowable to it and above falls ceiling. The path of vertical and horizontal of these services should be located in order to reach all hospital departments to avoid any intersection that happen between them. The location of vertical path within structural grid to enable transfer services from one floor to other whereas the path of these services in each floor are usually in the main corridors. These are link departments together, each department the services divided inside to division electrical, air-conditioning, mechanical, communication and fire fighting system. The height between falls ceiling and slab depend on services and the depth of drop beams on structural grid. The recommended height between the floor and falls ceiling for main corridors is (2.40). For the patient wards, administrative rooms and outpatient the height is (2.70). Whereas for operating halls the minimum height recommended is (3.00) in some cases may required more than that depend on the lighting system above operating table.

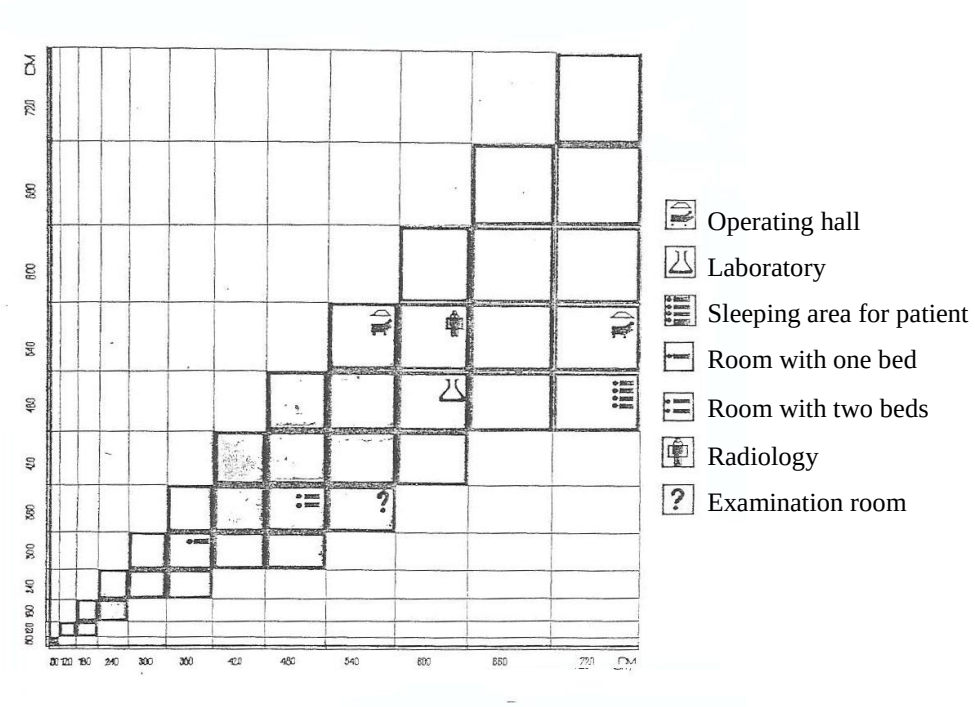


Figure 23 Functional activities in each department according to grid system.

To define the depth of the main beams within the structural grid system it depends on the slab and beam system selected by the designer.

Using light-weight partition materials should be carried out to reduce the weight on grid structure. Such materials should be easy to install, remove and change positions according to new requirements.

10- Economical Factor

- The choice of grid structural in all dimensions containing the spaces of all kinds events in hospital departments that help to control the quality of work and speed up the implementation period.

- Use a structural drop concrete beams with a little heights allow for the access of engineering services from underneath and in different directions and delivery to all sections the most direct route, this system reduces the cost of implementing these actions as a result of reducing the quantity as well as reduce the high floors of the building.

- Use plastic or metal scaffolding for the implementation of structural concrete skeleton instead of wood scaffolding, it gives the concrete skeleton clean face and compensate for the carrying out plastering and preserve the natural environment.

- Partitions and walls carrying out lightweight materials reduce the weights hanging over structural skeleton, as a results of that reducing the amount of reinforcing steel required in addition to these to obtain the partitions and walls clean, does not require plastering to it.

- Implementing the walls of light-weight materials with thermal insulation property, it provides good saving for air-conditioning system which required electrical power for operation of equipment.

- The use of lightweight materials to carryout the partitions and walls will reduce the damage resulting from accidents and earthquakes.

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- **Example of Hospital buildings:**

1. King Abdullah University Hospital (785) beds Irbid – Jordan

2. General Hospital (400) beds Typical design – Iraq – Execution in (13) Cities Locations

3. Maternity and pediatric Hospital (260) beds Typical design – Iraq – Execution (11) cities Locations.

4. Maternity Hospital (200) beds, Iraq - Omarah