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RECOMMENDATIONS FOR BASIC REQUIREMENTS OF GENERAL HOSPITAL BUILDINGS

PART 3 ENGINEERING SERVICES DEPARTMENT BUILDINGS

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PART 3 ENGINEERING SERVICES DEPARTMENT BUILDINGS

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Indian Standard

RECOMMENDATIONS FOR BASIC REQUIREMENTS OF GENERAL HOSPITAL BUILDINGS

PART 3 ENGINEERING SERVICES DEPARTMENT BUILDINGS

0. FOREWORD

0.1 This Indian Standard (Part 3) was adopted by the Indian Standards Institution on 30 March 1984, after the draft finalized by the Functional Requirements in Buildings Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Construction of large number of hospitals having different bed strengths is being planned in the country in public as well as in the private sector. These hospitals must provide certain basic needs to the patients and create a good working conditions for the doctors, nurses and technicians. Optimum utilization of the national resources also demands that these hospitals should be planned and constructed in such a manner that wastage towards space and circulation area can be brought down to a minimum but at the same time they function in the intended manner. With this object in view, this standard has been prepared to lay down rational norms and requirements for efficient planning and construction of general hospital buildings in the country.

0.3 The purpose of this standard is not to offer design solutions for a medical care facility, but to lay down optimum requirements for both spatial and environmental needs of the various sections of a hospital building.

0.4 The considerations in planning a hospital building should, no doubt, ensure the design of each section for its individual efficiency. Nevertheless, the hospital building as a whole, would function efficiently and economically only if all the sections are coordinated by arranging them in appropriate places based on their functional relationships. This could be achieved by compact and efficient planning, functionally correct and operationally efficient economical relationship and disposition of various components, functionally logical internal detailing of departments to save on time, money and efforts. This standard, it is hoped, will be of help to architects, engineers and authorities concerned in fulfilling the dual objectives of economy and optimum utilization of space.

0.5 The aim of any hospital planning is undoubtedly to offer the best medicare to the patients and best working conditions for the staff. While planning a hospital one ought to create, appropriate spaces and environmental conditions for the treatment of patients, efficient working conditions for the doctors and nurses who treat, for the technicians who maintain and operate certain machines and for the staff who handle the various hospital as well as a engineering services.

0.6 To facilitate planning and framing of the structural grid, a usable space planning module of 14 m^2 based on basic space unit of 3·5 m^2 has been stipulated in order to rationalize the requirements for various facilities in the hospital. This space planning module is derived by assuming planning grid of 1·6 m. Six such grid units, that is 3·2 × 4·8 m, will lead to a carpet area of about 14 m^2 after deducting the space taken by walls. All floor space requirements recommended for various facilities in respective table of the various sections of general hospital are based on above basic space unit. Fractional variation in floor spaces in actual planning may be ignored.

0.7 This Part 3 of the standard covers basic requirements of engineering services department buildings. The other parts of the standard namely Part 1 and Part 2 cover basic requirements of administrative and hospital services department buildings, and medical services department buildings respectively.

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1. SCOPE

1.1 This standard (Part 3) covers spatial, functional and environmental requirements of engineering services department buildings.

1.1.1 This standard does not cover requirements of dispensaries and health centres and also does not cover the requirements for specialized hospitals such as teaching, tuberculosis and cancer.

2. GROUPING OF GENERAL HOSPITALS

2.1 For the purpose of this standard, the hospitals have been divided into the following five categories:

Category A	25 to 50 beds
Category B	51 to 100 beds
Category C	101 to 300 beds
Category D	301 to 500 beds
Category E	501 to 750 beds

3. SECTIONS OF AN ENGINEERING SERVICES DEPARTMENT BUILDING

3.1 Various departments which an engineering services building should have for comfort and well being of patients, shall be as follows.

3.1.1 *Civil Engineering Department*

a) Building maintenance,
b) Horticulture,
c) Water supply and plumbing, and
d) Drainage and sanitation.

3.1.2 *Mechanical Engineering Department*

a) Air-conditioning, and
b) Refrigeration.

3.1.3 *Electrical Engineering Department*

a) Illumination, and
b) Ventilation.

3.1.4 *Miscellaneous Services Department*

a) Gas supply,
b) Transport and communication,
c) Fire protection, and
d) Waste disposal.

4. TOTAL AREA

4.1 The total area to be provided for a hospital complex shall depend on the availability of land. However for guidance an area of one hectare for every 25 beds is recommended.

5. SITE PLANNING

5.1 Hospital sites with high degree of sensitivity to outside noise should be avoided but may be compatible with other considerations such as accessibility and availability of services. The buildings should be so planned that sensitive areas like wards, consulting and treatment rooms and operation theatres are placed away from the outdoor sources of noise. While planning the hospital buildings the importance of landscape elements such as open areas, horticulture, to increase the comfort conditions inside the buildings and also in the surrounding

environment should be kept in view. Orientation of building shall conform to provisions and recommendations contained in IS : 7662 (Part 1)-1974*.

6. ENGINEERING SERVICE DEPARTMENTS

6.1 The hospital engineering service should mainly comprise of civil, mechanical, electrical, gas supply, transport and communication, fire-fighting and waste disposal system. Services which are required to be provided under these departments shall be as follows:

a) *Civil Engineering*

i) Building maintenance;

ii) Horticulture;

iii) Water supply — Normal water, hot water, filtered and soft water; and

iv) Drainage and sanitation.

b) *Mechanical Engineering*

i) Air conditioning — Air cooling and heating; and

ii) Refrigeration — Cold storage, water coolers, deep freezers, etc.

c) *Electrical Engineering*

i) Lighting — General, individual and night lighting, call bells, emergency lighting, voltage stabilizers, stand by generators, etc; and

ii) Ventilation — Ceiling fans, table fans, exhaust fans, etc.

d) *Other Services*

i) Gas supply — Medical, cooking and laboratory gas;

ii) Transport and communication — Ramp, lift, telephone, intercoms, public address, etc;

iii) Fire protections — Safety against fire, first-aid fire equipments, fire alarm and fire detection system; and

iv) Waste disposal system — Incinerators.

6.2 Space Requirements — The provision of areas to be provided for above services are given in Table 1.

6.2.1 *Building Maintenance* — An office-cum-store should be provided to handle day to day maintenance works of the hospital building.

*Recommendations for orientation of buildings: Part 1 Non industrial buildings.

TABLE 1 PROVISION FOR VARIOUS FLOOR AREAS IN ENGINEERING SERVICE DEPARTMENT

(*Clause* 6.2)

Sl No.	Facility	Categories of Hospitals									
		Category A		Category B		Category C		Category D		Category E	
		Room	Area	Room	Area	Room	Area	Room	Area	Room	Area
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
		No.	m^2	No.	m^2	No.	m^2	No.	m^2	No.	m^2
i)	Civil building maintenance	1	10·5	1	17·5	1	21	1	28	1	35
ii)	Horticulture	1	10·5	1	17·5	1	21	1	28	1	35
iii)	Pump house	1	10·5	1	17·5	1	21	1	28	1	35
iv)	Air conditioning plant	1	21	1	28	1	35	1	42	1	70
v)	Stand by generator	—	—	1	17·5	1	21·0	1	28	1	35
vi)	Electrical sub-station office	2	10·5	2	14	2	17·5	2	21	2	28
vii)	Medicinal gas supply:										
a)	Manifold room with toilet	—	—	1	21	1	28	1	42	1	56
b)	Compressor room for suction gas	—	—	—	—	1	14	1	21	1	28
viii)	Communication system:										
a)	Telephone exchange	—	—	1	17·5	1	21	1	28	1	35
b)	Paging system	—	—	—	—	—	—	1	14	1	28
c)	Public address system	—	—	—	—	—	—	1	14	1	21
d)	Central music system	—	—	1	14	1	14	1	14	1	21

NOTE 1 — Air handling unit room for air-conditioning of necessary spaces and switch room to house vertical bus-bar for electric feeder services should be provided at appropriate places depending upon the layout of the building.

NOTE 2 — Feeder services, that is, cable and pipes to infrastructure in the building should be planned to run so as to afford repairs/fault detection. Provision of service floor or service gallery for the purpose may also be considered.

6.2.2 *Horticulture* — To maintain the hospital landscaping, a room to store garden implements, seeds, etc, should be provided.

6.2.3 *Water Supply*

6.2.3.1 *Normal water* — Arrangement shall be made to supply the following quantities of potable water per bed per day to meet all requirements (including laundry), except fire-fighting, in all categories of hospital:

Requirement of Water	*Category of Hospital*
350 litres	A and B
400 litres	C
450 litres	D and E

Storage capacity for 2 days requirement should be made on the basis of above consumptions. Round the clock water supply shall be made available to all wards and departments of the hospital. Separate reserve emergency overhead tank shall be provided for operation theatre. Necessary water storage overhead tanks with pumping/ boosting arrangement shall be made. The laying and distribution of the water supply system shall be according to the provisions of IS : 2065-1972*. Cold and hot water supply piping should be run in concealed form embedded into wall with full precautions to avoid any seepage.

6.2.3.2 *Hot water* — Hot water supply to wards and departments of the general hospital shall be provided by means of electric storage type water heaters or centralized hot water system of capacity depending upon the need of hot water consumption.

6.2.3.3 *Filtered and soft water* — Filtered and soft water supply is required in pathology laboratories and shall be supplied as required.

6.2.3.4 *Cold water* — Cold water supply is needed for processing tanks in film developing room and shall be supplied as required.

6.2.4 *Drainage and Sanitation* — The design, construction and maintenance of drains for waste water, surface water, subsoil water and sewerage shall be in accordance with IS : 1742-1972†. The requirements for the fitments for drainage and sanitation in general hospitals shall be in accordance with Tables 2 and 3.

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*Code of practice for water supply in building (*first revision*).
†Code of practice for building drainage (*first revision*).

TABLE 2 REQUIREMENTS FOR SANITARY FITMENTS IN HOSPITALS FOR PATIENTS

(*Clause* 6.2.4)

Sl No.	Fitments	Requirements	
		In Patient Wards or Nursing Units	
i)	Water-closets	1 for every 8 beds or part thereof (male) 1 for every 6 beds or part thereof (female)	
ii)	Ablution taps	1 for each water-closet plus one water tap with draining arrangements in the vicinity of water-closets	
iii)	Urinals	1 for every 12 beds or part thereof (males only)	
iv)	Wash basins	1 for every 12 beds or part thereof	
v)	Baths	1 bath with shower for every 12 beds or part thereof	
vi)	Bed pan washing sinks	1 for each ward } in dirty utility and sluice room	
vii)	Cleaner's sinks and sink/slab for cleaning mackintosh	1 for each ward }	
viii)	Kitchen sinks and diswashers	1 for each ward in ward pantry	
		Outdoor Patient and Other Departments (Lavatory Block)	
		For Males	*For Females*
i)	Water closets	1 for every 40 persons or part thereof	2 for every 50 persons or part thereof
ii)	Ablution taps	1 in each water-closet Plus 1 water tap with draining arrangements shall be provided in the vicinity of water-closet and urinals per lavatory block	1 in each water-closet
iii)	Urinals	1 for every 25 persons or part thereof	—
iv)	Wash basins	1 for every 50 persons or part thereof	1 for every 50 persons or part thereof

NOTE 1 — Some of the water-closets may be of European style, if desired.

NOTE 2 — Additional and special fitments for specific needs of hospitals may be provided.

TABLE 3 REQUIREMENTS FOR SANITARY FITMENTS IN HOSPITALS (ADMINISTRATIVE AND HOSPITAL SERVICE BUILDINGS, MEDICAL STAFF AND NURSES' HOMES)

(*Clause* 6.2.4)

Sl No.	Fitments	For Administrative and Hospital Services Buildings		For Medical Staff Living (Hostel Type)		For Nurses' Homes (Hostel Type)
		For Male Personnel	For Female Personnel	For Male Staff	For Female Staff	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Water-closets*	1 for every 25 persons or part thereof	1 for every 15 persons or part thereof	1 for 4 persons	1 for 4 persons	1 for 4 persons
ii)	Ablution taps	1 in each water-closet	1 in each water-closet	1 in each water-closet	1 in each water-closet	1 in each water-closet
		Plus 1 water tap with draining arrangements shall be provided per lavatory block in the vicinity of water-closets and urinals				
iii)	Urinals	1 for 25 persons or part thereof but nil up to 10 persons	—	—	—	—
iv)	Wash basins	1 for every 25 persons or part thereof	1 for every 25 persons or part thereof	1 for every 8 persons or part thereof	1 for every 8 persons or part thereof	1 for every 8 persons or part thereof
v)	Baths (with shower)	—	—	1 for 4 persons or part thereof	1 for 4 persons or part thereof	1 for every 4 persons or part thereof
vi)	Drinking water fountains	1 per 50 persons or part thereof with a minimum of 1 on each floor				
vii)	Cleaner's sinks	←——————————Minimum 1 per floor——————————→				

*Some of the water closets may be of European style, if desired.

6.2.4.1 The selection, installation and maintenance of sanitary appliances shall be in accordance with IS : 2064-1973*. The design and installation of soil, waste and ventilating pipes shall be as given in IS : 5329-1969†.

6.2.5 *Air-conditioning* — Air-conditioning and environmental control in hospitals is essential to ensure the comfort of patients, sterile and comfortable conditions in operation theatres, maintenance of essential sophisticated instruments and equipment and to help in the speedy recovery and treatment of seriously ill patients. Whereas it is advisable that the entire hospital be air-conditioned, this may not be possible due to economic considerations. The following department/ wards are considered essential and recommended for air-conditioning:

a) Blood laboratory in blood bank of out-patient department;

b) Operation theatre complex in emergency and casualty department;

c) Certain laboratories in pathology department;

d) Radiography and radio therapy rooms in radiology department;

e) Fracture-cum-casualty theatre, recovery, frozen section of clear zone and all rooms in sterile zone of operation theatre department;

f) Certain number of beds in ward units of particular specialities;

g) All rooms in sterile zone of delivery suite;

h) Intensive care unit; and

j) Autopsy room in mortuary.

6.2.5.1 The air-conditioning may also be achieved with room air conditioners (*see* IS : 1391-1971‡), desert coolers (*see* IS : 3315-1974§), packaged air-conditioners (*see* IS : 8148-1976‖).

6.2.6 *Refrigeration* — Hospitals shall be provided with water cooler and referigerators (*see* IS : 1474-1959¶) in wards and departments, freezers (IS : 7872-1975**) in pathology, and cold storage plants for pathology, mortuary, medical stores and dietary department. All these, power consuming units shall be provided with voltage stabilizers.

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*Code of practice for selection, installation, and maintenance of sanitary appliances (*first revision*).

†Code of practice for sanitary pipe work above ground for buildings.

‡Specification for room air-conditioners (*first revision*).

§Specification for evaporative air coolers, desert coolers (*first revision*).

‖Specification for packaged air-conditioners.

¶Specification for commercial refrigerators.

**Specification for freezers.

6.2.7 *Illumination*

6.2.7.1 *General* — For requirements and method of daylighting in hospital buildings reference may be made to IS : 2440-1975*. The level of illumination for various visual tasks shall be provided in accordance with IS : 4347-1967†. General lighting of all hospital areas except stores and lavatory block shall be fluorescent. In other areas it is recommended to be of incandescent lamps. Electrical installation except for artificial illumination, shall be in accordance with IS : 732-1963‡, IS : 2032 (Part 11)-1969§ and IS : 2274-1963‖.

6.2.7.2 *Shadowless light* — Shadowless light (mountable type) shall be provided in operation theatres and operating delivery rooms whereas in other areas, where operations of minor nature are carried out shadowless lamps (portable type) shall be provided.

6.2.7.3 *Call bells* — Call bells (*see* IS : 2268-1966¶) switches should be provided for all beds in all types of wards with indicator lights and location indicator situated in the nurses duty room of the wards.

6.2.7.4 *Emergency lighting* — Emergency portable light units should also be provided in the wards and departments to serve as alternative source of light in case of power failure.

6.2.7.5 *Standby generators* — Standby generators should be provided to generate electric and power supply to water supply, air-conditioning units, and plants, cold storage units, and radiography units.

6.2.7.6 *Lighting protection* — The lighting protective system of hospital buildings shall be in accordance with IS : 2309-1969**.

6.2.8 *Ventilation* — Ventilation of hospital buildings may be achieved by either natural supply and natural exhaust of air, or natural supply and mechanical exhaust of air, or mechanical supply and natural exhaust of air, or mechanical supply and mechanical exhaust of air. The following standards of general ventilation are recommended for various

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*Guide for daylighting of buildings (*second revision*).

†Code of practice for hospital lighting.

‡Code of practice for electrical wiring installations (system voltage not exceeding 650 volts) (*revised*).

§Graphical symbols used in electrotechnology: Part 11 Electrical installations in buildings.

‖Code of practice for electrical wiring installations (system voltage exceeding 650 volts).

¶Specification for electric call bells and buzzers for indoor use (*revised*).

**Code of practice for the protection of buildings and allied structures against lighting (*first revision*).

area of the hospital building based on maintenance of required oxygen, carbon dioxide and other air quality levels and for the control of body odours when no products of combustion or other contaminants are present in the air or anaesthesia gases which are highly explosive are present:

Space to be Ventilated	*Air Changes per Hour*
Bathrooms/toilets	6-12
Wards	8-12
Kitchens	6-9
Operation theatres	15-20
Other air-conditioned spaces	8-10

The general principles of natural ventilation shall be in accordance with IS : 3362-1977*. Where adequate air changes cannot be obtained by natural ventilation, mechanical ventilation either by exhaust of air or by positive ventilation (like fans and other equipment) or combination of two shall be provided. Fans and other equipments for mechanical ventilation may be located in convenient positions having regard to the intake of fresh air, accessibility for maintenance and noise control. Exhaust fans shall be provided in walls on one side or in the attic or roof. The exhausted air shall not find entry back into hospital.

6.2.9 *Gas Supply*

6.2.9.1 *Medical gas* — Medical gases comprise of oxygen and nitrous oxide. Necessary pipe line network should be laid in departments and wards to connect them to the manifold room (where gas cylinder of bulk supply will be mounted on wall). A compressor should also be provided in separate room adjoining to the manifold room to provide suction along with medical gas supply pipe. All these three pipes should be of different colour conforming to a laid down standard and mounted on wall or ceiling surface.

6.2.9.2 *Cooking gas* — For better hygienic conditions use of cooking gas LPG (liquefied petroleum gas) is recommended. These should also be kept in a room from where necessary pipe line with gas outlets as required may be provided to hospital kitchen and ward pantries.

6.2.9.3 *Laboratory gas* — Pipe line network should be laid in pathology laboratories and other laboratories of sub-speciality clinics where extensive laboratory benches are provided. This network should be connected to gas plant room or gas storage room wherein either LPG (liquefied petroleum gas) cylinders are stored or gas plant is installed to manufacture lab-gas from kerosene oil medium.

*Code of practice for natural ventilation of residential buildings (*first revision*).

6.2.10 *Transport and Communication*

6.2.10.1 *Lifts* — Electrically operated automatic control lifts (*see* IS : 4666-1980*) shall be provided in all category of hospitals having more than one storey. The installation, operation and maintenance of lifts shall be as given in IS : 1860-1980†. The outline dimensions of machine room, pit depth and total headroom, shall be in accordance with IS : 3534-1976‡. The recommended car speed for hospital bed lifts are given below:

Occupancy	*Number of Storeys*	*Car Speed, m/s*
a) Short travel lifts	2 or 3	0·25
b) Medium travel lifts	4 or 5	0·50
c) Long travel lifts	6 and above	1·00

The passenger lifts should be so arranged that they are easily accessible from all entrances of the hospital. It is convenient to place the lifts near the staircases. Hospital lifts should be situated conveniently near the ward and operation theatre department entrances. There shall be sufficient space near the landing door for easy movement of stetcher/ trolly. Service lifts (*see* IS : 6383-1975§) should be situated so as to secure convenient and easy access at each floor and shall be installed in accordance with IS : 6620-1972‖. Escalators, if provided, shall be in accordance with IS : 4591-1968¶.

6.2.10.2 *Ramp* — A ramp leading to the topmost floor of hospital of two or more storeys may be provided in addition to the stairs needed at places.

6.2.10.3 *Telephone and intercom* — Wiring in conduits shall be provided to give telephone outlet points in rooms, wards and departments as desired by the authority. An intercom system may also be provided in addition to the telephones. The communication system should be adequately designed in hospitals for alerting all persons charged with duties for patient care and all employees of the hospital who are within the building in the event of emergency. The alerting system shall be capable of being operated from the telephone switch boards and the administrative office.

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*Specification for electric passenger and goods lifts (*first revision*).

†Code of practice for installation, operation and maintenance of electric passenger and goods lifts (*second revision*).

‡Outline dimensions for electric lifts.

§Specification for electric service lifts.

‖Code of practice for installation, operation and maintenance of electric service lifts.

¶Code of practice for installation and maintenance of escalators.

6.2.10.4 *Public address system* — The public address system shall be provided in hospitals of category C, D and E to facilitate calling nurses/ doctors in emergency and to play music for entertainment of patients. Wiring for the system shall be in conduits and shall be installed in accordance with IS : 1882-1961*. The amplifiers shall conform to IS : 1819-1961†. The public address system shall also have control in telephone exchange room.

6.2.11 *Fire Protection*

6.2.11.1 *First-aid fire-fighting equipment* — Adequate first-aid, fire-fighting equipment shall be provided and installed in accordance with IS : 2217-1982‡, and IS : 2190-1979§.

6.2.11.2 *Fire alarm* — Manually-operated fire alarm facilities shall be provided in hospital buildings which sound an audible alarm in administrative department, engineering service, offices, fire office and such other locations where gongs, sirens, whistles or bells do not disturb the patients. Distinctive visual or audible alarm shall be installed at each nurses duty room, duty station and used for fire alarm purpose only. Hospitals may also be equipped with automatic fire alarm system conforming to IS : 2189-1976‖ in hospital of category D and E. An approved type of automatic explosive venting device providing the required amount of venting area may also be provided in hospitals of category D and E, specially in rooms where medical gases, compressed air and electrical equipments are stored and used.

6.2.11.3 *Fire detection* — In hospitals of category D and E, an automatic fire detection system will be an added advantage.

6.2.12 *Waste Disposal System* — All hospitals up to category C shall be provided with one incinerator consisting of a burning chamber and chimney. Hospitals of category D and E should, in addition have an electrically operated incinerator of capacity to burn 1 kg/bed/day of refuge.

7. CONSTRUCTIONAL REQUIREMENTS

7.1 Circulation Areas — Circulation areas such as corridors, entrance halls, staircases, etc, in the hospital buildings should not be less than 30 percent of the total floor area of the building.

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*Code of practice for outdoor installation of public address systems.

†Recommendations for general requirements of public address amplifiers.

‡Recommendations for providing first-aid fire-fighting arrangements in public buildings (*first revision*).

§Code of practice for selection, installation and maintenance of portable first-aid fire extinguishers (*second revision*).

‖Code of practice for installation of automatic fire alarm system using heat sensitive type fire detectors (*first revision*).

7.2 Floor Height — The height of all the rooms in the hospital should not be less than 3·00 m and not more than 3·65 m, measured at any point from the surface of the floor to the lowest point of the ceiling. The minimum head-room such as under the bottom of beams, fans and lights shall be 2·5 m measured vertical under such beam, fan or light.

7.2.1 The height of the operation theatres may be suitably increased if viewing galleries are provided.

7.3 Room shall have for the admission of light and air, one or more apertures, such as windows and fan lights, opening directly to the external air or into an open verandah. The minimum aggregate areas (*see* Note) of such opening, excluding doors but inclusive of frames, shall be not less than 20 percent of the floor area in case such apertures are located in one wall and not less than 15 percent of the floor area in case such apertures are located in two opposite walls at the same sill level.

NOTE — If a window is partly fixed, the openable area shall be counted.

7.4 The architectural finishes in hospitals shall be of high quality in view of maintenance of better hygienic conditions specially in sanitary blocks. Flooring in sanitary blocks should be done with marble or polished stone; and dado or glazed/ceramic tile finish given on wall.

7.5 The design of building shall ensure control of noise due to walking, movement of trollies and banging of doors, etc. Expansion joint should have a non-metallic beading finish.

(*Continued from page* 2)

Ad-hoc Panel for Hospital Buildings, BDC 12 : P1 : 1

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INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	Unit	Symbol
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	Unit	Symbol	Definition
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2