Training Report

Faculty Development Training Programme on

Disaster Resilient Healthcare Infrastructure

From 11th to 15th July, 2022

Jointly Organized by

School of Planning and Architecture, New Delhi

&

National Institute for Disaster Management

Ministry of Home Affairs, Govt. of India

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PROGRAMME PATRONS

Prof. Dr. P.S.N Rao, Director School of Planning and Architecture, New Delhi

Shri. Taj Hassan, IPS, Executive Director, National Institute of Disaster Management

PROGRAMME CHAIRS

Prof. Dr. Anil Dewan, HOD of the Department of Architecture, SPA-ND
E-mail: a.dewan@spa.ac.in

Dr. Amir Ali Khan, Associate Professor, NIDM
E-mail: amir.nidm@nic.in

PROGRAMME COORDINATORS

Dr. Khushal Matai, Assistant Professor, SPA-ND
Email: khushal.matai@spa.ac.in

Mr. Thomas Krishna Pegu, Assistant Professor, SPA-ND
Email: thomas.pegu@spa.ac.in

Mrs. Priya Rachel Boby, PhD scholar, SPA-ND
Email: priya.phd.306arch22@spa.ac.in

Ms. Yogita Garbyal, Young Professional, NIDM
Email: yogita.nidm@govcontractor.in

About National Institute Of Disaster Management (NIDM)

The National Institute of Disaster Management (NIDM) was constituted under an Act of Parliament to play the role of a premier institute for capacity development in India with the vision to create a Disaster Resilient India by building the capacity at all levels for disaster prevention and preparedness.

The efforts in this direction began with the formation of the National Centre for Disaster Management (NCDM) in 1995 and gained impetus with its renaming as the National Institute of Disaster Management (NIDM) for training and capacity development. Under the Disaster Management Act 2005, NIDM has been assigned nodal responsibilities for human resource development, capacity building, training, research, documentation, and policy advocacy in the field of disaster management. Both as a national centre and then as the national institute, NIDM has performed a crucial role in bringing disaster risk reduction to the forefront of the national agenda. The Institute believes that disaster risk reduction is possible only through the promotion of a culture of prevention' involving all stakeholders. The Institute works through strategic partnerships with various ministries and departments of the central, state, and local governments, as well as academic, research and technical organizations in India and abroad. It also works with other bilateral and multilateral international agencies.

About SPA, New Delhi

The School of Planning research and consultancy. The university was honoured as "an Institute of National Importance' and Architecture was founded in 1941 as a Department of Architecture in Delhi Polytechnic and was later affiliated to the University of Delhi. It was later integrated with the School of Town and Country Planning, which was established in 1955 by Indian government to provide facilities for rural, urban and regional planning. In 1979, the Ministry of Education and Culture deemed the School of Planning and Architecture as a university. This led to the expansion of the school to include new programmes, while promoting under an Act of Parliament in 2015.

INTRODUCTION

The faculty development training programme on “Disaster Resilient Healthcare Infrastructure” was held on July 11-15, 2022. The five-day programme conducted sessions on various relevant topics relating to disaster management in healthcare design and services, construction and operation management. The target audience were the faculty from architecture and engineering departments across India. The training programme included a site visit to AIIMS Trauma Centre in New Delhi to understand the issues and adaptation strategies in hospitals for disaster resilience.

OBJECTIVES OF THE PROGRAMME

- To define and develop a contextual understanding of the risk and resilience of the healthcare facilities in the wake of disasters.
- Fundamentals of hospital architecture and master planning of healthcare facilities in India.
- Collate information regarding the integration of hospital building and medical services for resilient healthcare infrastructure.

BACKGROUND

India is among the world’s most disaster-prone countries with 27 of its 29 states and seven union territories exposed to recurrent natural hazards such as cyclones, earthquakes, landslides, floods, and droughts (UNICEF, 2022). Hence, the hospital infrastructure must be structurally resilient and able to deal with the patient surge in the event of a disaster. The hospital buildings should not be structurally safe only but also safe for operations with functioning equipment. The Covid-19 pandemic highlighted the drawbacks in the hospital infrastructure and more research is needed to prepare hospitals for any future pandemic.

Addressing the need of hour, National Institute of Disaster Management in collaboration with School of Planning and Architecture, New Delhi had organized a faculty development training programme on Disaster Resilient Healthcare Infrastructure. This was conducted to create awareness among faculty members regarding the design of hospitals in perspective of increasing disaster resilience. The participants throughout the training provided their input on the topic by developing a hospital Disaster Management Plan for Delhi at the end of the programme based on the field visit and group exercise given during the training program.

DETAILED PROGRAMME AGENDA

Day 1: 11th July, 2022		
Disaster Resilient in Healthcare Infrastructure		
Time	**Session theme**	**Resource person**
9:00 am – 10:00 am	Registration	
10:00 am - 10:45 am	Inaugural Session	Director SPA-ND, Director NIDM, Dean Academics (SPA-ND), HoD Architecture, Dr. Amir Ali Khan
10:45 am - 11:00 am	Tea Break	
11:00 am - 12:45 pm	Basic concepts of disaster management; conceptual understanding of disaster resilience and continuity of healthcare services	Dr. Amir Ali Khan
12:45 pm - 2.00 pm	Lunch	
2:00 pm - 3:15 pm	Classification of Hospitals in India and introduction to disaster management codes/standards/guidelines for hospital resilience. Implication of the pandemic on hospital design	Prof. Dr. Anil Dewan
3:15 pm - 3:30 pm	Tea Break	
3:30 pm - 4:30 pm	Safe and Functional Hospital (Resilient Hospital) including structural and non-structural approach of risk mitigation of hospitals	Dr. Hari Kumar

Day 2: 12th July, 2022		
Setting up healthcare Infrastructure (Hospital Design and Services)		
Time	**Session theme**	**Resource person**
10:00 am - 10:30 am	Recapitulation - 1st day	
10:30 am - 11:30 am	Planning principles and master planning of hospital campuses	Prof Manoj Mathur
11:30 am–11:45 am	Tea Break	

11:45 pm - 1:00 pm	Planning of critical areas in hospitals for maintaining continuity of building and medical services	Ar. Sandal Kapoor
01:00 pm - 2.00 pm	Lunch	
2:00 pm - 3:15 pm	Planning and Design of MEP services for ensuring the resilience of critical areas of hospital buildings	Mr. V.K. Jain
3:15 pm - 3:30 pm	Tea Break	
3:30 pm - 4:30 pm	Planning and Design of HVAC Services for ensuring the resilience of critical areas of hospital buildings	Dr. K.B. Sood

Day 3: 13th July, 2022		
Operation and Management / Facility Management		
Time	**Session theme**	**Resource person**
10:00 am - 10:30 am	Recapitulation – 2nd day	
10:30 am - 11:00 am	Indoor Air Quality in hospital buildings	Mr. K.C. Mittal
11:00 am – 11:45 am	Retrofit of hospital buildings for energy efficiency and disaster resilience	Prof. Dr. Bandana Jha
11:45 am–12:00 pm	Tea Break	
12:00 pm - 1:00 pm	Operation and Management of hospital building/ BMS	Dr. Deepti Gupta
01:00 pm - 2.00 pm	Lunch	
2:00 pm - 3:15 pm	Emerging Technologies in Retrofitting of Hospital Buildings	Prof. Dr. B. K. Singh
3:15 pm - 3:30 pm	Tea Break	
3:30 pm - 4:30 pm	National building codes of India -2016. Techno legal provisions for hospital safety	Mr. Arun Kumar
4:30 pm – 5:30 pm	Provision of fire safety in hospitals with case	Prof. Dr. V.K. Paul

Day 4: 14th July, 2022		
Site visit		
Time	**Session theme**	**Resource person**
09:30 am - 10:00 am	Recapitulation – 3rd day	
10:30 am - 06:00 pm	Site visit of AIIMS Trauma Centre	Prof Dr. Tej Prakash, AIIMS

Day 5: 15th July, 2022		
Preparation of Disaster Management Plan for Hospital Buildings in India		
Time	**Session theme**	**Resource person**
10:30 am - 11:30 am	Recapitulation – 4th day	
10:30 am - 11:30 am	Resilient hospital against cyber disaster	Mr. Rajashekar Pullabhatia
11:30 am–11:45 am	Tea Break	
11:45 am - 1:00 pm	HRVC Analysis of hospitals for preparation of hospital disaster management plan & hospital contingency plan (hospital dm plan) - key steps, components, and standards	Dr. Khushal Matai Mr. Thomas Krishna Pegu
01:00 pm - 2.00 pm	Lunch	
2:00 pm - 3:15 pm	Preparation of Hospital Safety Plan – Group Exercise	Dr. Khushal Matai Mr. Thomas Krishna Pegu
3:15 pm - 3:30 pm	Tea Break	
3:30 pm - 5:30 pm	Preparation of Hospital Safety Plan - Group Presentation	Dr. Amir Ali Khan, Prof. Dr. Anil Dewan

PARTICIPANT DETAILS

A total of 34 faculties of Architecture and PhD scholars from Delhi and surrounding states attended the programme, all 34 participants were awarded certificates during the valedictory session.

SUMMARY OF THE SESSIONS

Day 1: 11th July 2022

Inauguration session

The program started with the welcome to all the dignitaries and the participants for the training program and organizing team initiated the inaugural ceremony with the lighting of the lamp by the chief guests and the conveners of the program.

Welcome address was given by Prof Anil Dewan, Head, Dept of Architecture. He welcomed everyone for the training program at SPA Delhi and shared the background of the training as well as the target audience. He further shared the objectives and the scope of the 5 days training program. He spoke on the need of revising the BIS standards for further improvement in building resilience.

Introductory remarks was shared by Dr. Amir Ali Khan, Faculty NIDM. Dr. Khan spoke about the training program agenda specially focusing the architects and engineers teaching in the institutions and organizations and working in field of healthcare infrastructure. He highlighted the necessities of having quality life in which safety of critical infrastructure like hospital is inevitable. He also spoke about the flood scenario of the country especially in the ongoing monsoon season and the impact of earthquakes on medical facilities.

Keynote address was given by Prof. Dr. Aruna Ramani Grover, Dean (Planning and Development) SPA Delhi. Dr. Grover spoke on the civilization in Japan and how the disaster response in Japan showcases the importance of healthcare infrastructure resilience. The response of a nation to a disaster is a sign of how much value the nation places on its citizens.

Special address was shared by Prof. Dr. Sanjay Gupta, Dean (Research), SPA Delhi, highlighting the use of drones in disaster situations. He mentioned a research project conducted on drones being used in emergencies and in monitoring unplanned situations.

Inaugural Speech was given by Prof Dr. Ashok Kumar, Dean (Academics), SPA Delhi where he talked about the ongoing hazardous incidents happening in the country and emphasized on the need of better equipped healthcare facilities. He further talked about the value addition from the FDP and applauded the HOD of Architecture and other faculty for organizing the program.

Session 1: Basic Concept of Disaster Management; Conceptual understanding of disaster resilience and continuity of healthcare services.

Speaker: Dr. Amir Ali Khan, Associate Professor, NIDM, Delhi

Dr. Khan started with discussion with participants about their expectations and their familiarity with disaster management, definition of a safe hospital and NIDM.

The speaker pointed out that safety in hospitals is a great concern in India as the frequency of disasters is increasing and more unpredictable. The basic understanding of hospital safety was discussed with participants. The treatment is the primary function of hospitals, but a safe hospital is one that should be able to continue with treatment during a disaster as well. It should function without any discrepancies/ failures with functioning equipment. The speaker elaborated how the safety of any hospital does not always depend on its location and type. The disaster management and cycle along with the institutional framework was shared and discussed with the participants. He gave examples of ill planned constructions in and around Delhi and the concept of vulnerability in terms of hospital safety. He also elaborated about the Disaster Management Plan of hospitals and why it is of utmost importance.

Session 2: Classification of hospitals in India and introduction to disaster management codes/standards/guidelines for hospital resilience. Implications of the pandemic on hospital design.

Speaker: Prof Dr. Anil Dewan, HoD of Architecture, SPA-ND

The session started with a group discussion on the definition of a hospital. The hospital is an institute that can offer in-patient accommodation and provide active medical and nursing care for more than one category of medical discipline. (e.g., general medicine, general surgery, obstetrics and gynecology and pediatrics). He then spoke about the different classification of disaster resilient healthcare infrastructure in India based on the parameters of the teaching hospital, public hospitals, voluntary hospital, private nursing homes and corporate hospital.

Prof. Dewan explained that hospitals can also be classified based on the system of medicine, bed strength and length of stay. He further explained various codes guidelines for Hospital Management such as NDMA guidelines, FEMA and WHO standards. The speaker also talked about the Ayushman Bharat system, which aims at aiding the poor by providing healthcare for all. The speaker highlighted the importance of location, and specific clientele are paramount in speeding up recovery and creating wellness. For instance, a children's hospital may be placed in a zoo. This location can be more intriguing to the younger generation due to the smells and sound of the site.The session also discussed the National Ayush Mission, clinical establishment act 2010, Master Plan for Delhi, LEED, GRIHA and IGBC and suggested it as future reference. The speaker briefly discussed the BIS standards, especially the need to revise the standards as hospitals are water intensive with high water requirements for each bed, which can be divided into dialysis, treatment, etc.

Session 3: A safe and functional hospital
Speaker: Dr. Hari Kumar, Regional coordinator for South Asia, GeoHazards International

The speaker started the discussion on safe and functional hospitals which shall think and act beyond the limitation of codes and described the various components of functional hospital. The lecture started with example of past earthquake and US and Japan coming out with best practices. Notably, the city of Delhi is in seismic zone 4. A need for a specialized code for hospitals as the current hospitals in Delhi may keep the occupants safe during a disaster but may not be functional during a disaster due to equipment failure.

The speaker mentioned the case studies of Jubilee hospital, Bhuj; North view hospital, and Olive view hospital. The lecture led to a discussion on how the retrofitting of hospitals is important. However, shutting down the hospital is difficult as the services of a hospital are essential to the community. The speaker advised designers to dig deeper early in the design process and conduct a detailed site analysis of the site that includes the contours, flood zones, seismic zones, etc.

The speaker suggested that the designs should be symmetrical, while inverted pendulum designs are not recommended as a pendulum effect on the heavy mass above. Also, the buildings with varied heights may be at risk of collision during an earthquake. The L form for a hospital should also be avoided as there is a risk of cracks and breakage at the corners. In terms of structure, the stirrups in the columns should be at an angle of 135 degrees to create disaster resilience. The lecture included an example of how in the scenario an earthquake, the piping and false ceiling will vibrate differently leading to ceiling failure. Therefore, a flexible pipe can be placed between the ceiling and the sprinklers.

Day 2: 12th July 2022

The participants were welcomed on the 2nd day of the faculty development programme by Prof Dr Anil Dewan who gave an overview of the day's activities.

Session 1: Planning and Master Planning of healthcare campuses
Speaker: Prof. Manoj Mathur, Professor of SPA-ND.

The discussion started with the meaning of hospital resilience. Prof. Mathur defined it as “resist, mitigate, recover and adapt together create resilience” and hospital resilience can include facility management, logistics, operation, and maintenance. The design process ensures the hospital is prepared for unplanned events. The concept was linked to the everyday activity of preparing for extreme weather conditions. The fundamental aspects of hospital design and planning involve the site, requirements, and budget.

Prof Manoj explained how the standard corridor width in hospitals was insufficient during the pandemic the use of sanitizers reduced the usable width. In terms of ventilation, the hospitals should have separate air handling units to ensure that in the event of equipment failure the hospital keeps running. The speaker provoked the audience to think about the building's interior and exterior. For instance, the piping in the structure is often considered late in the design process and may have to be placed on the facade of the building.. For example, the cable connector outlets are now redundant as the technology has been replaced by Wi-Fi. The speaker commented that it is the responsibility of the designer to create resilient designs.

The discussion on the fundamental aspects of hospital design and planning included how to locate a hospital site location for redundancy. Prof. Mathur explained that hospital should have at least two entry points with a periphery road around the site. The current standard width of a corridor in India is 3m but Prof Mathur recommends 3.1m and justified that the increase in the cost of the hospital can be compensated in the rest of the design. Ideally, the hospital should have a day room for recreation for patients for exercise and socialization. Prof Mathur suggested that the open green spaces in a hospital should be modular i.e., expandable, connected and ideally not in nonlinear forms. The presenter referred to Apollo hospital which has issues with access as only one road next to the site while AIIMS Jodhpur has multiple access points and a ring road around the hospital.

The speaker commented that the cluster of hospitals should have a simple shape and in case the shape needs a perforation then the sections of the hospital should be treated as separate structures. The speaker suggested that if the land is insufficient then the services should be below ground. However, the outer skin of the hospital should not have perforations as it creates irregularities. In the same way, the elevation materials should have a similar weight to avoid failure during disasters. The lecture ended with an emphasis on the role of architecture to accommodate the patient surge.

Session 2: The planning of critical areas in hospitals for maintaining continuity of building and medical services.
Speaker: Ar. Sandal Kapoor, Visiting Faculty, SPA-ND.

The speaker talked about the management and functionality of critical areas of hospital. The planning principles of hospitals should use integrated planning: service + life cycle costing of building. Considering the issue of climate change, energy consumption should be reduced by designing lighting and AHU units accordingly. Microclimate should be harnessed to reduce the heat on site with segregation between pedestrians and vehicles. The carbon-neutral design can be achieved using alternative energy and utilizing the site efficiently.

Ar Kapoor told that the important adjacencies in a hospital are emergency, OPD and diagnostic which must be on the ground floor as they experience most footfall while the birthing, NICU and gynecology department should be grouped to allow for easy movement of patients. The radiotherapy and nuclear sections are placed in the basement to reduce radiation emissions. The OPD should be stacked in one zone vertically to control the traffic and the IPD are stacked to control traffic.The beds should be placed parallel to the façade to allow views of the outdoors and create a headboard for oxygen supply. Infection control in the hospital can be achieved by creating a positive pressure room for patients with compromised immunity and negative pressure for patients with infectious diseases.

The future hospital should be a smart building with service integration and building management systems. The building typologies discussed were AIIMS Bhubaneswar with a finger plan layout, low rise multi courtyard and monoblock with multiple perforations for courtyards, podiums and towers. The speaker pointed out that the lift's location and size should be considered after comprehending the dimensions of the beds. The planning of operation theatre departments should promote high standards of disinfection and workflow criteria. The operation theatre should be near CSSD, lab, blood bank, emergency department, surgical work and ICUs for easy movement. The design considerations for operation theatres include split AC, anti-bacterial paint finish and joints for easy maintenance. Ar. Kapoor suggested that electrical points should be available in parking areas in case they need to be converted to treatment areas during patient surges. The speaker also spoke of the triage approach is used to assess the condition of the patient and then he is treated in the critical care area but there should be a separate exit for staff.

Session 3: Planning and design of MEP services for ensuring the resilience of critical areas of hospital buildings
Speaker: Mr. V.K Jain, retired CPWD engineer, hospital design consultant

The speaker in his talk pointed out that a designer should revisit the hospital after its construction to understand its functionality and conduct a post-occupancy evaluation. The speaker suggested that the cost of engineering is more than the structure of a hospital. Mr Jain quoted that even though the NBC codes are in place they are rarely followed. Building classification as per ECBC 2017 is important for buildings of more than 1000 sqm. The MEP services should have fire safety factors considered.

Speaker explained why fires from short circuits are common, he told audience that the screw clamps on aluminium wires cause pressure which may cause a fire. This material has been replaced by copper which does not pose this challenge. The speaker suggested that priorities

during the design of healthcare facilities should include the location of central control rooms, proper means of evacuation, emergency evacuation and annunciation, Proper sealing of vertical service ducts and shafts, Principle of progression horizontal evacuation. False ceilings should be used sparingly in hospitals except in OTs (CPWD guidelines) as it can be an area for infestation.

Session 4: The planning and design of HVAC services for ensuring the resilience of critical areas in hospitals.
Speaker: Dr. K. B. Sood, (MBBS), NOUS Hospital Consultant

Dr. K. B. Sood through his presentation recommended that the hospital design must be prepared for the disaster through services optimization. Air Conditioning system can reduce cross contamination. The speaker spoke of the management of the SARS pandemic in South Korea can be referred to for pandemic resilient design. The speaker also promoted the idea of air flow achieved by AC systems by taking in outdoor air. The speaker discouraged implementation of air filtration as it uses 3 to 4 times more energy to propel air through the filter. He recommended that the HVAC zone ventilation should move from clean to contaminated zone i.e., from the center to the patient with the inlet above the patient's bed while the opposite is recommended in the OT. Dr. Sood pointed out that during the design of HVAC, the HVAC zones should be identified and an emergency inlet for generator, and oxygen should be made.

Further speaker spoke about the design of the basement which must be done with care as the rainwater ingress becomes an issue. Instead, the courtyard design is recommended for locating services, natural ventilation and lighting. The speaker also warned that oxygen tanks in a hospital must be designed with care as they can cause damage within a radius of 5m distance in case of leakage, while a massive leak may spread up to half a kilometer as the concentration of oxygen is 52%. The NABH guidelines mandate that PSA plants should be monitored to ensure oxygen concentration does not fall below 90% to reduce accidents. Also, an oxygen supply should have a water supply to be administered safely.

The speaker further suggested to have air flow be controlled in temporary medical care facility with air intake having 2 ACH and 30-60% humidity. The air intake is sometimes polluted and has to be filtered using filters (carbon filters) but this increases energy consumption. The airflow should move from the doctors to the patient to avoid the spread of infections. The air inlet in a dentist's office should be in front and the air outlet should be behind the dentist's chair. The distance between areas should be maintained at 2.6 meters minimum or ideally 3.2m between beds while 3.6m is the international standard. The speaker suggested that the passage for the hospital evacuation should be 2400 mm to allow movement of 2 trolleys while 3200 mm can be

the width of passage in the waiting areas. The air can be flushed through the spaces to remove contamination. A physical barrier can be used instead of an air barrier. Laminar flow is encouraged in passages instead of turbulent flow to ensure that cross-contamination is reduced.

Day 3: 13th July, 2022

Session 1: Indoor air quality in hospital buildings
Speaker: Advocate K. C. Mittal, President of the Delhi High Court

Shri Mittal shared his experiences of revision of the CPWD guidelines for the air conditioning by Delhi High Court. The speaker encouraged further research on indoor air quality as the post pandemic scenario requires changes in the guidelines. The presenter spoke about horrors of the Covid-19 lockdown in India that disrupted human lives and called for action by architects and policy makers for tackling ventilation issues in buildings.

The speaker further suggested that focus for all architects should be for improving air quality and encourage the admittance of natural daylight. The advocate revealed that numerous litigations are being raised in the courts to change air quality standards for public buildings to reduce the spread of infectious diseases. The speaker closed the session by calling for architects in providing more initiative in changing the guidelines for design.

Session 2: Retrofit of hospital buildings for energy efficiency and disaster resilience
Speaker: Dr. Bandana Jha, Professor, Department of Architecture, SPA-ND

The speaker brought out new technologies such as: agro-voltaic roof which combines plants and P.V. panels, an investigation of thermal insulation to check for fire insulation. Dr Jha recommended SIP can be used for temporary structures: ventilated or double skin walls and the green living walls can be used inside and outside to create microclimate in hospitals. Also, innovative technologies such as the Trombe wall can be used for energy efficiency in cold climates due to its high insulation. Integrating natural ventilation and incorporating micro grid in large hospitals will help in achieving energy efficiency and disaster resilience. The speaker also pointed out that natural daylight creates speedy recovery and improves mental health. Prof Jha called for priority research on the energy retrofit of hospitals to meet the COP 26 requirements. The discussion further included the retrofit of buildings which is possible as the envelope is redesigned, and lights can be changed without disturbing hospitals. The costof such retrofit measures can be 3% of the building cost for building a new hospital.

Session 3: Operation and management of building services in hospitals: BMS - Building Management System
Speaker: Dr. Deepti Gupta, Visiting Faculty, SPA-ND

Dr. Gupta through her session talked about the access and safety as two important factors in hospitals in terms of operation and management as buildings require comfort, air quality, structural safety, and universal accessibility. Numerous departments and services in the hospital make it difficult to manage and require interventions such as building management systems. The speaker gave an overview of the services in a hospital and how they can be added to the layout of a hospital. She also emphasized on the importance of the building management system for the sustainable management of hospitals and the creation of intelligent buildings. It can be used for energy efficiency, disaster resilience and fire safety protocols. Speaker concluded by saying that the automation systems, energy analytics and fire monitoring systems make the management of hospitals easier and resilient.

Session 4: Structural retrofitting in hospitals
Speaker: Dr. B. K. Singh, Professor of Structural Engineering at SPA-ND

The speaker to discuss about the structural retrofit firstly discussed the earthquake zones in India. The speaker explained the bracing systems for earthquake resilient design and recommended the use of cross bracing. He also explained the importance of structural design to avoid structural failure of the building. A discussion on the grade of the concrete needed for different scenarios in construction was discussed. Also, the different procedures for carrying out the testing for concrete on site. The final remarks of the speaker were to consider the design of the structure and services early in the design process to avoid making errors such as passing pipes through the column that reduces the buildings structural integrity.

Session 5: National building code of India 2016- Techno-legal provisions for hospital safety.
Speaker: Mr. Arun Kumar, Scientist 'E'/Director (Civil Engg.), Scientist-E, Head Civil Engineering, Bureau of Indian Standards

Mr Arub Kumar spoke about the need for building regulation and constitutional position, the authorities that have delegation for this task and the instruments for the building regulation. The speaker talked about the authorities concerned with the planning approval, the salient features of the NBC code, the contents of NBC (2016), and the team approach for stages of design and construction. A multidisciplinary team of building professionals is needed for all the stages of

design and construction. Structured approach for ensuring compliance with provisions of NBC 2016 is in the code.

The lecture also included modifications being made to the NBC code. The session ended with a discussion on the defects in current designs and the changes being made in hospital design guidelines. The audience raised a question on the need for change in ventilation codes post-pandemic. The speaker responded that the comfort standards from NBC and other standards must be combined, and the codes should not be prescriptive but just guidance as the designer has to consider the site conditions as well.

Session 6: Fire safety in hospitals
Speaker: Prof Dr V K Paul HoD of Building Engineering and Management, SPA-ND

The lecture started with a briefing on how a fire starts and spreads. The different stages of the spread of fire through the building and the apt fire responses were highlighted. The hospitals possess a fire risk due to the flammable supplies such as oxygen supply in the hospitals and in homes the split air conditioning may increase the chances of fire.

The talk highlighted the importance of creating awareness of architects and inhabitants to fire safety protocols. Also, the design and construction team should pay attention during the installation of the electrical equipment to be used in the building to reduce fire hazards and design the layout for fire evacuation. The speaker gave the example of the external metal fire escape used in European countries to evacuate occupants in the event of a fire. This is a better solution as it is an escape from the exterior of the building. The solution suggested by the speaker was the careful design of circulation for fire evacuation, installing quality equipment and maintenance of the equipment**.**

Day 4: 14th July 2022.

Field Visit to AIIMS Trauma Centre, Delhi

Full day field visit with learning sessions was organized for the participants. The participants gathered at the AIIMS trauma centre entry to be greeted by Dr Tej Prakash Sinha, Associate Professor Dept of emergency medicine, JPNATC, AIIMS ND. The participants were seated in the conference room as the video on the Arpit Swayam programme on hospital design by Prof. Anil Dewan sir was displayed.

Topic 1: Triage in hospitals & integrating emergency care into the buildings
Speaker: Dr Tej Prakash Sinha, Associate Professor Dept of emergency medicine, JPNATC, AIIMS ND.

The speaker highlighted issues in the trauma center such as the design of the ramp in the conference area; which had untampered edges making it less accessible. The evolution of structure, the flexibility of the AIIMS Trauma Centre's structure, and the cost of hospital modifications were discussed in the lecture. The AIIMS hospital was built in 1970 while the trauma block was constructed 13 years ago. He expressed concern over the disconnect between doctors and architects leading to issues such as lack of storage for supplies, and insufficient dimensions for movement through passages and doorways. The poor circulation and space planning in an emergency department may lead to increased morbidities due to lag in the treatment. Instead, Dr Tej suggested the designers should design for "life, care, and organ'. The speaker pointed out that the footfall at AIIMS trauma goes to 250 people per day and life-saving care must be integrated into the structure.

The speaker further explained the healthcare model followed which is patient-healthcare provider-administrator in descending order of priority. The healthcare workers' mental health must be addressed by designers for the provision of proper services. Dr Prakash responded that there should be a clear discussion with the user so that the structures last for 50 years and leaves flexibility for future expansion. The audience raised points on how the planning of urban areas must integrate the hospital to ensure shorter distances for the movement of patients and the hospitals must avoid fixed glazing and have operable windows for natural ventilation. The doctor mentioned that currently there are 2 faculty members, 2 senior residents, and 67 nurses at the AIIMS trauma centre, Delhi.

Topic 2: Triage in emergency
Speaker: Dr Tej Prakash Sinha, Associate Professor Dept of emergency medicine, JPNATC, AIIMS ND.

The triage effect was explained in detail in this session. Triage is the sorting of patients into unstable (red), and stable (yellow/green) to make treatment more efficient. The doctor called for simple measures such as the use of signage in the emergency area to reduce waiting times, and the use of a granite layer to demarcate spaces instead of signage.

The red zone of the triage requires more healthcare staff and equipment for treating the critical patients. Also, the beds in this zone require more equipment and service points than an ICU bed because the bed will be used by patients with various ailments. A 12 ft distance between 1st bed and the wall is needed as there is a 4 x 2 ft cart for supplies, biomedical waste storage space and right-side defibrillator. A distance of 3 feet from the wall to the head of the bed was recommended by the doctor while 6 feet should be maintained between the 2nd and 3rd beds. The recommended width of the passage in the red zone of emergency is 20 - 30 feet. The speaker pointed out that 3 - 5% of beds are emergency beds, but IPHS standards require 10% of emergency beds. The doctor emphasized that circulation must be designed to ensure 7 minutes of movement time from emergency to OT. The design should incorporate a point of care lab that is needed in an emergency

The doctor called for more training areas, and research activity areas, which are cost-effective and increase the hospital's resilience. Also, these should be prepared for future pandemics or bio wars. A decontamination area near the entrance of the hospital and separate corridors is needed for reducing cross contamination. The presenter also cited that according to IPHS (2022), there is an emergency/ isolation room which also needs to be incorporated.

Case Study: AIIMS Trauma Centre as per the Field Observation

Following points were observed by the participants while inspecting the AIIIMS trauma centre infrastructure:

- The typology for the hospital is as following: the ground floor has OT, 1st-floor disaster wards, 2nd and 3rd ICU and 4th-6th IPD wards.
- There are 4 entry gates in the AIIMS trauma centre.
- The emergency department has multiple entries to reduce congestion at one entry.

- During the Covid-19 pandemic, the ground floor was converted to the Covid-19 ward with a separate back entry point.
- Notably, the entry to the emergency gate has a low slope to allow the easy movement of patients and staff while stopping the entry of the ambulance beyond a certain level.
- There are multiple level entries to the floors of the hospitals allowing quick entry to departments of the ED. The space under the ramp leading to the first floor is utilized as offices and PPE donning areas.
- There are multiple doorways at the emergency department but only 2 have been left open and Dr. Prakash explained that the doors have safety grills to avoid violent entry during mobs or riots.
- The entry leads to the triage area where the patients are sorted into the red for the most urgent cases while the patients sorted in the yellow/green section are asked to fill out a form for further clarity on the mode of treatment. However, the patients in the red zone are taken to the critical area for resuscitation and other emergency protocols.

Recommendations/Suggestions noted during field inspection:

- The doctor recommended that counselling rooms should be incorporated to deal with the mental health issues of the patients and their families. He mentioned that initially the mobile tables were used during disaster management to allow conversion of space to treatment areas but this has been replaced by fixed furniture.
- Notably, the beds, in the end, should have enough electrical points for the lifesaving procedure. The Minor OT has an infection control zone, change area, wash area and space for equipment.
- The trauma centre has a hall covered by a polycarbonate vaulted ceiling which admits daylight and can be converted to a treatment area during a patient surge.
- The designer must provide oxygen points, medical air outlets and 10 equipment electrical points.
- The finishing for the wall behind the ED bed should be robust to hold the equipment.
- There should be provision for 2 monitors in the ED for easy view by the doctors.
- The flooring in the minor OT must be anti-static. The creases and wiring should be minimized for easy maintenance.
- In the anticipation of terrorist attacks, the hospital had restricted access to the helipad and preferably the top floors would be empty for people to move safely. Lessons can be derived from hospitals in Israel where the main wards are underground, and the temporary facilities are on the upper floors.

- The medicine and samples were often moved between floors using suction tubes to reduce the hassle in place of moving them physically. However, in some areas of the hospital, this provision was not incorporated early in the design and was left unutilized.
- The Covid-19 ward is currently empty, but it was unfortunate to see the fire exit was blocked to create seclusion between wards.
- The participants were not granted access to the burns ward and the occupied OTs to avoid contamination of the spaces.

The visit ended with the participants expressing gratitude to Dr Tej Prakash for the lectures and site visit.

Day 5: 15th July 2022

Session 1: Hospitals resilience against cyber-attack.
Speaker: Mr Rajshekhar Pullabhatla, Director of Information Sharing and Analysis Centre, India

Mr Rajshekhar Pullabhatla spoke about the seriousness of cyber-attack on hospitals. A hospital is a target for cyber-attack as it allows forging of doctors' identities, private health information (PHI) is sold underground, stolen health insurance login details, fake health insurance cards, fake drug labels, prescriptions for smuggling, and patient details are used for blackmail (in case of STDs etc.), information on VIP Patients, survivors' details injury details, army personnel family tracking, insurance frauds etc. He suggested that firewalls can be used for protection against hacks such as Bounty bugs. Cyber insurance is also a necessity for hospitals, and an IT professional should be part of the hospital workforce. The speaker further pointed out that designers must design the wiring in a way to reduce the chance of cyber-attacks in hospitals while giving provisions for building management systems rooms which can monitor the hospital.

The takeaways from the lecture were that cyber security is important in hospitals as the confidential patient records are liable to hacking. The speaker pointed out that India has many terrorist attacks and almost 358 terrorist groups registered in India.

Session 2: Hospital Disaster Management Plan and group activity
Speakers: Dr Khushal Matai, and Mr. Thomas Pegu Assistant Professor, SPA-ND

The speakers Mr. Thomas Krishna Pegu and Dr Khushal Matai introduced the group exercise on Disaster Management Plan as the last session.

Mr. Thomas Krishna Pegu spoke about Mising community in Assam who dwells in the flood plains of the mighty Brahmaputra. He also talked about how they have become resilient towards perennial floods and climate change by adopting their Indigenous based knowledge systems. The speaker explained the definitions of safe hospital, hospital preparedness and preparation plan were also shared during the presentation. They also recommended that to enable effective preparedness and response during disasters, an efficiently functioning HIRS (Hospital Incident Response System) need to be established. The case study of AMRI Hospital, Dhakuria Branch, Kolkata, was taken by the presenters for the hospital disasters. The speakers concluded with the checklist for the hospital disaster management plan.

Introduction to Group Exercise: The AIIMS Jai Prakash Narayan Apex Trauma Center and Government Hospital, Yamunanagar 'Mukand Lal Civil Hospital' Hospital Disaster Management Plan was shared with the participants to help in the group exercise. The participants were divided into five groups and asked to prepare 1 or 2 A1 sheets for a hospital disaster resilient plan specifically for AIIMS trauma center, Delhi. The tasks divided were divided to cover:

Group 1: Hazards and the institutional plan
Group 2: Resource mapping and preparedness
Group 3: Prevention and mitigation measures and capacity building measures
Group 4: Response plan and mass casualty plan
Group 5: Evacuation Plan & Mock drill

GROUP WORK

Group 1

Topic: Hazards and the institutional plan
Participants: Amisha Jangra, Ankit Kumar, Avitesh, Vaishnavi Nayak, Aftab Alam

Learnings Outcomes:

Disaster - A disaster is a serious issue that occurs over a short or long period of time and results in widespread losses of people, property, or the environment that are greater than what the affected community or society can reasonably expect to be able to recover from using its own resources.

Hospital – A place where we can go for treatment, consultation about health, health care facilities by trained medical professionals.

Definition by WHO - Hospitals complement and amplify the effectiveness of many other parts of the health system, providing continuous availability of services for acute and complex conditions. They concentrate scarce resources within well-planned referral networks to respond efficiently to population health needs. They are an essential element of Universal Health Coverage (UHC) and will be critical to meeting the Sustainable Development Goals (SDG).

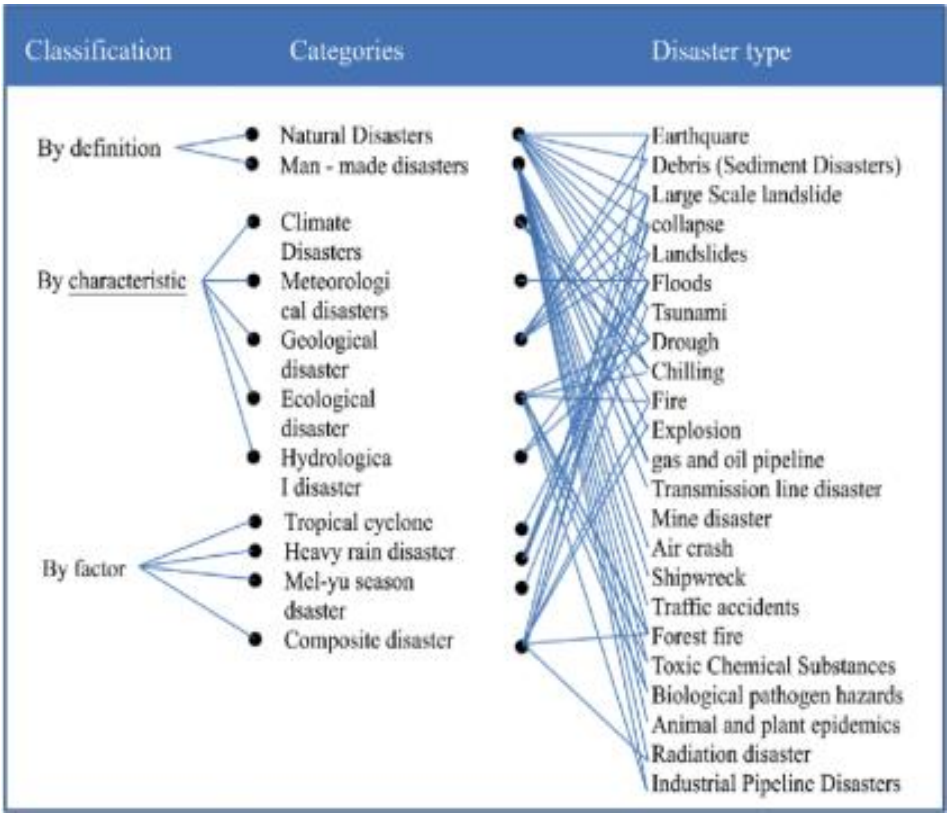


FIGURE 1: THE CATEGORIES AND TYPES OF DISASTER

FIGURE 2: THE DISASTER CYCLE OR DISASTER MANAGEMENT CONTINUUM.

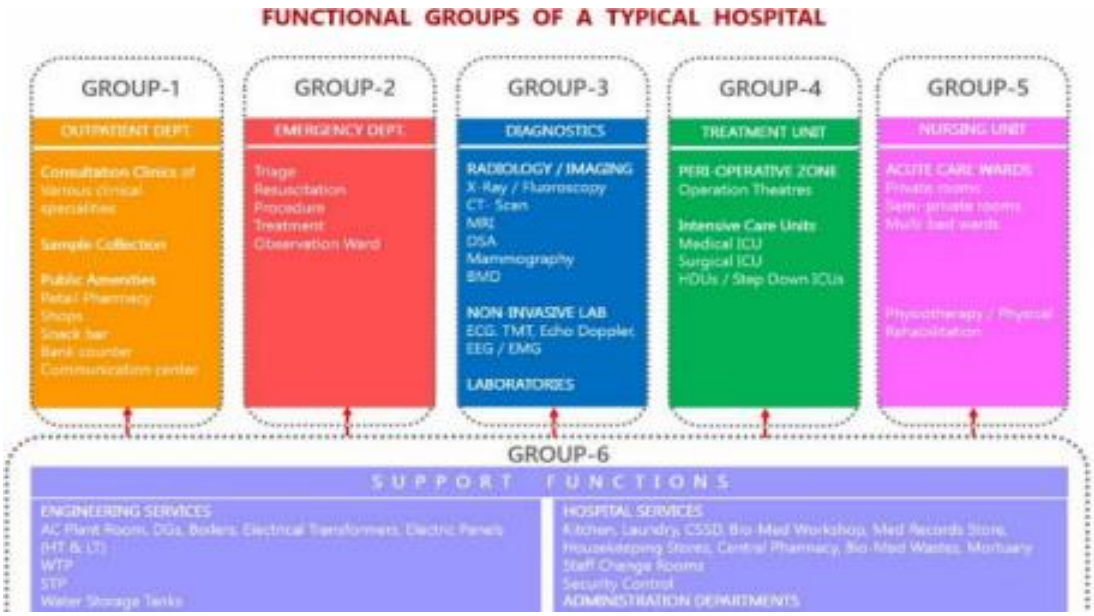


FIGURE 3: FUNCTIONAL GROUP OF HOSPITAL

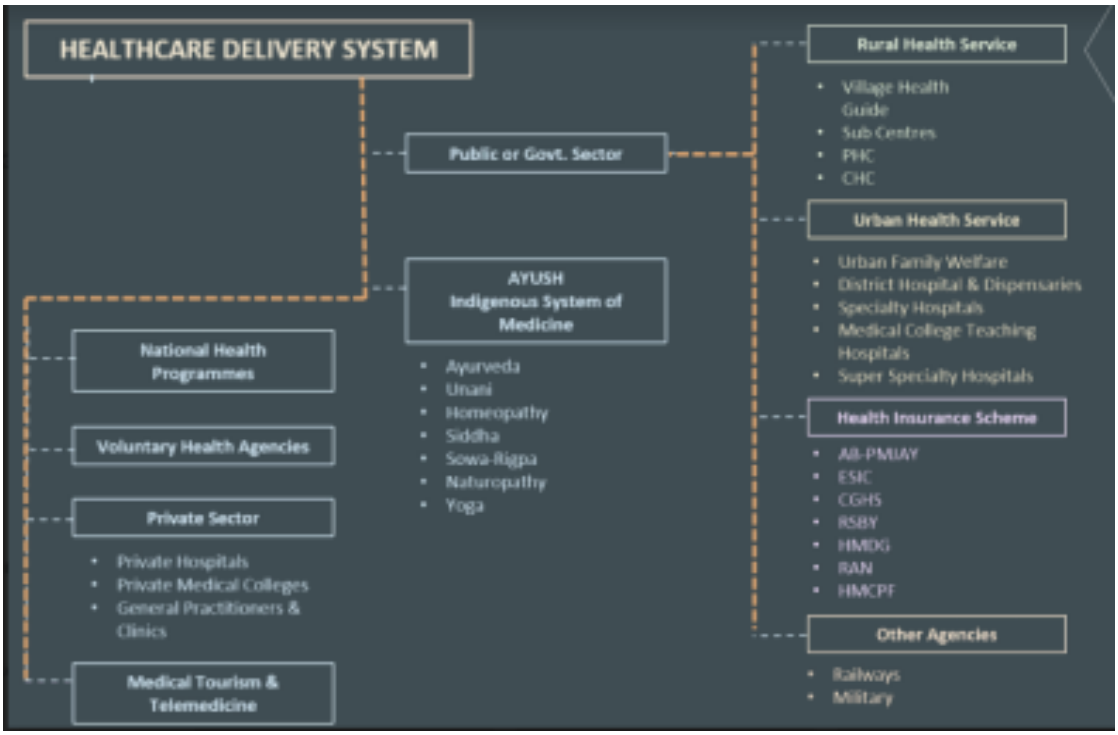


FIGURE 4: HEALTHCARE SYSTEM IN INDIA

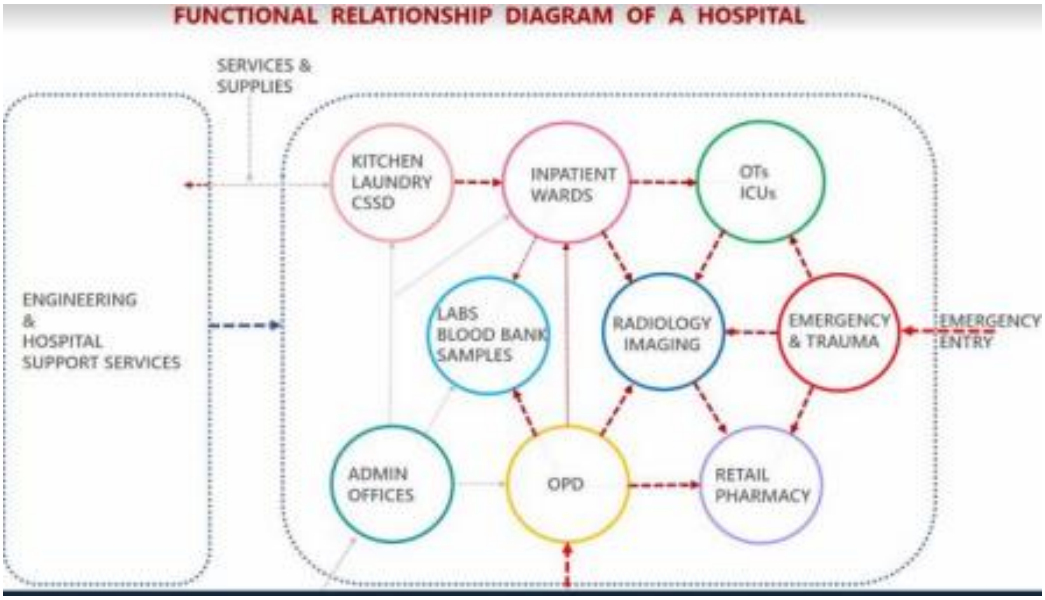


FIGURE 5: FUNCTIONAL RELATIONSHIP DIAGRAM OF HOSPITAL

Classification of Hospital

1. Basing on Objective
   a. General hospitals
   b. Special hospitals
   c. Teaching cum Research Hospital
2. Basing on Administration, ownership, control or financial income
   a. Governmental or public
   b. Non-governmental or private
   c. Semi Govt Hospital
   d. Voluntary Agency Hospitals
3. Basing on Length of Stay
   a. Short-term or short-stay hospitals (Stay less than 30 days)
   b. Long-term or long-stay hospitals: (Stay more than 30 days)
4. Depending on Type of Medical Staff
   a. Closed-staff hospital:
   b. Open-staff hospital:

FIGURE 6: FUNCTIONAL GROUPS OF A HOSPITAL

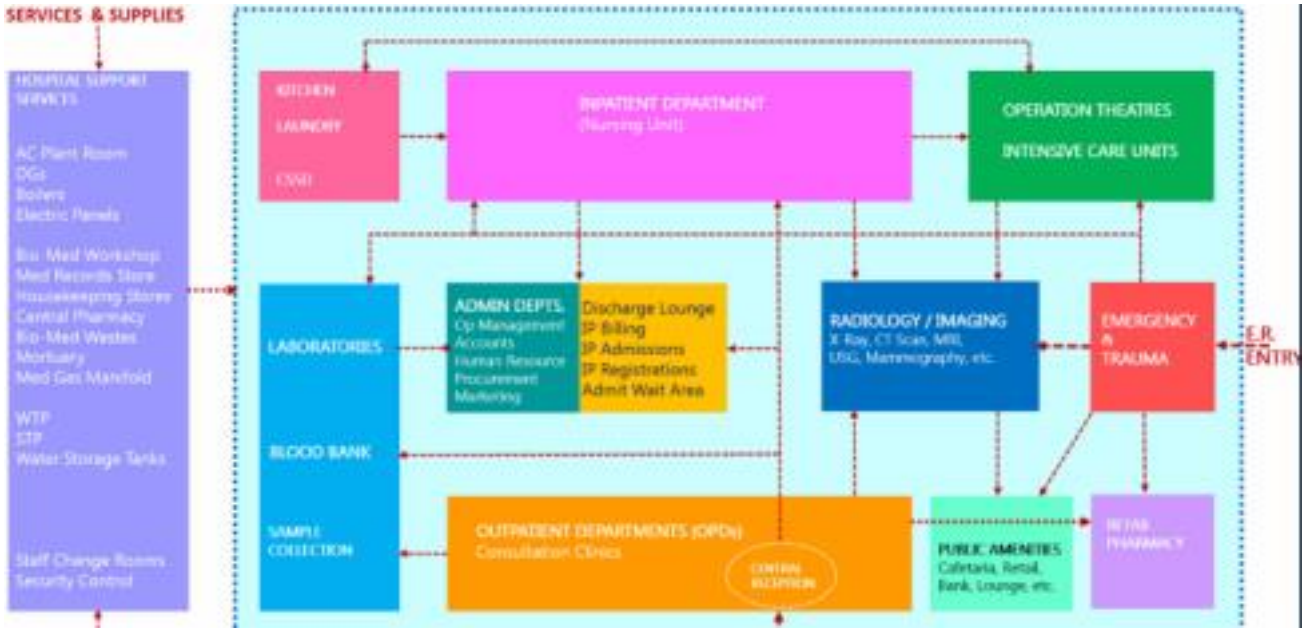


FIGURE 7: FUNCTIONAL RELATIONSHIP DIAGRAM OF A HOSPITAL

FIGURE 8: STANDARDS FOR DESIGNING A HOSPITAL

Other Standards -

- IS: 4326 Earthquake Resistant Design and Construction of Buildings – Code of Practice • IS: 1893 Criteria for Earthquake Resistant Design of Structures
- National Disaster Management Guidelines – Hospital Safety
- Guidelines for Hospital Emergency Preparedness Planning – UNDP
- Design Guide for improving Hospital Safety in Earthquakes, Floods, and High Winds – FEMA • Safe Hospitals in Emergencies and Disasters - WHO Guidelines

Site visit and Group Excercise: -

Click on the link for details of Site Visit – AIIMS Trauma Centre.
https://vaishnavinayak.wordpress.com/2022/07/14/hospital-architecture-the-voidbetween-standards-and-reality/

Outcome: Development of Hospital Disaster Management Plan and understanding different type of disasters. The participants used the practical knowledge from the site visit and various

lectures. During the presentation, Dr. Amir Ali (NIDM) and Dr. Anil Dewan (SPA – ND) shared their comments for improvement.

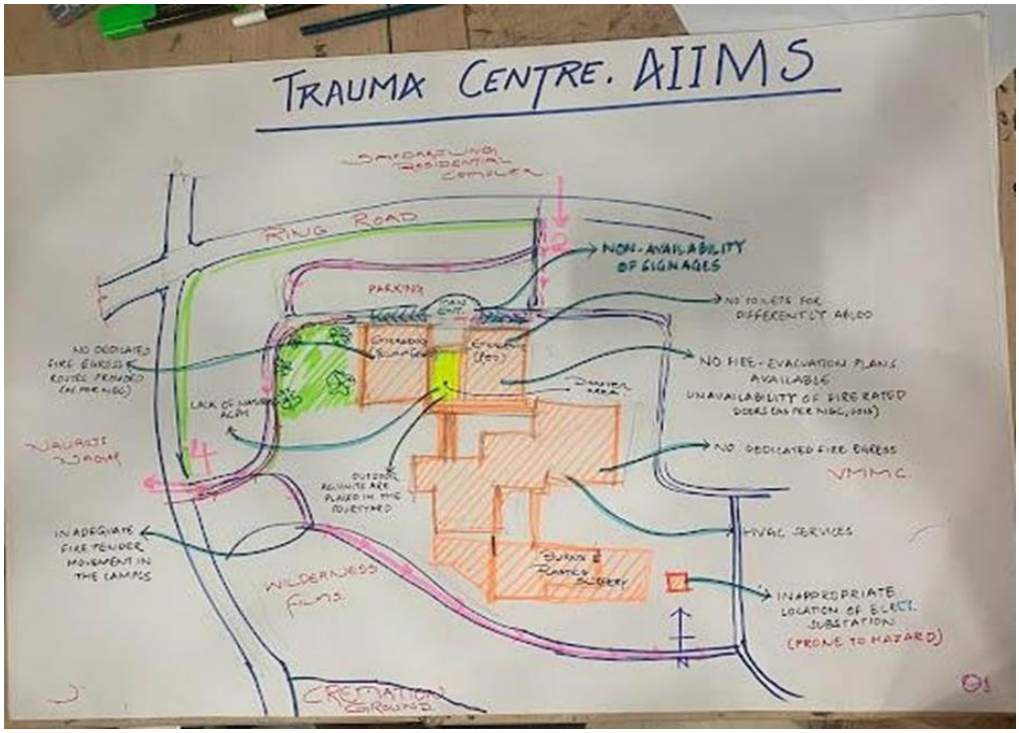


FIGURE 9: GROUP WORK: HAZARDS AT AIIMS TRAUMA CENTRE

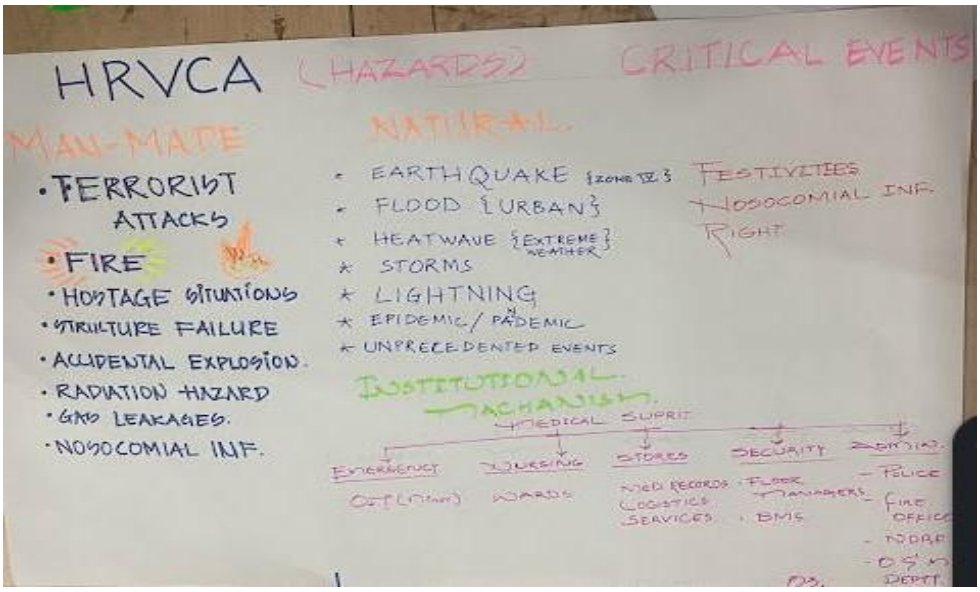


FIGURE 10: HAZARDS TO HOSPITAL

Group 2

Topic: Resource mapping and preparedness
Participants: Arathy Gopal, Krishna Prakash, Dr. K. Bangkim Singh, Mohd. Rashideen, Dr. Sandesh

The group was assigned the task of preparation of resource mapping and measures of preparedness. The resources were segregated into on-site, emergency response and offsite. For the aspect of preparedness, the possible list of disasters was listed out as-

A. Fire, earthquake, flood
B. Cyber security issues
C. Terrorist attack, mob attack, locust attack
D. Biomedical weapon/Chemical explosion/ radiation leak

The preparedness plan was prepared in a matrix considering the five aspects of-

1. Safety and security
2. Mass casualty
3. Continuity of essential services
4. Communication
5. Evacuation Plan & Mock drill

The preparedness strategies are presented in the matrix below-

	A	B	C	D
1	● Evacuation plan needs to be checked and enforced- periodic checking drill	● Separate space and officer responsible need to be assigned for cyber security	● Offsite resource mobilization needed ● Separate spaces identified in	● A separate room to be provided for unidentified corpse in emergency ● Offsite backup with biologists to tackle

	● Specially in ground floor in Trauma center ● To avoid death/injury by stampede, the corridors in critical areas in core should be bigger in new blocks in Trauma center ● Location of local language signage needed- totally absent in Trauma center now	● Virtual backup- cloud storage needed- a big records room is no longer needed- record room could be converted to computer rooms for digital MIS ● Back up with manpower in case of power failure	nearby schools of Father Agnel school/ Atal Adarsh Vidyalaya – offsite resources in case of mass casualty, Crematorium-Green Park	issues of biomedical weapons ● Isolation rooms are needed
2	● The possibility of opening the waiting area from the other side needs to be explored, to maximize accessibility and increase redundancy ● Ramp is needed so that patient get evacuated even if there is a block in lift ● Portable toilets to be provided, so that tents maybe put up in case of emergency situations	● Offsite space to be provided for storage of essentials (IV fluids, etc.) in times of mass casualty	● Multiple access for doctors and relatives needed	● More space for storing masks, PPE kits and sanitiser needed ● Screens for radiation protection

<table>
<tr><td>3</td><td>Drone delivery of essential services in case of emergency</td><td>Virtual backup- cloud storage needed</td><td rowspan="3">Low-cost materials and unbreakable grills, instead of glazing</td><td rowspan="3">Flexibility of spaces needed in screens for radiation protection, changing spaces</td></tr>
<tr><td>4</td><td>Helipad- to be made functional</td><td rowspan="2">Separate uninterrupted supply of power to be ensured
Separate uninterrupted supply of power to public address systems for the announcement in times of mass casualty</td></tr>
<tr><td>5</td><td>Mockups of built up with cardboard to be tried initially before construction</td></tr>
</table>

Group 3

Topic: Prevention and mitigation measures and capacity building measures
Participants: Ar. Nagendra Narayan, Ar. Radhika Gopinath, Ar. Pushkar, Ar. Priyanka & Ar. Vidushi.

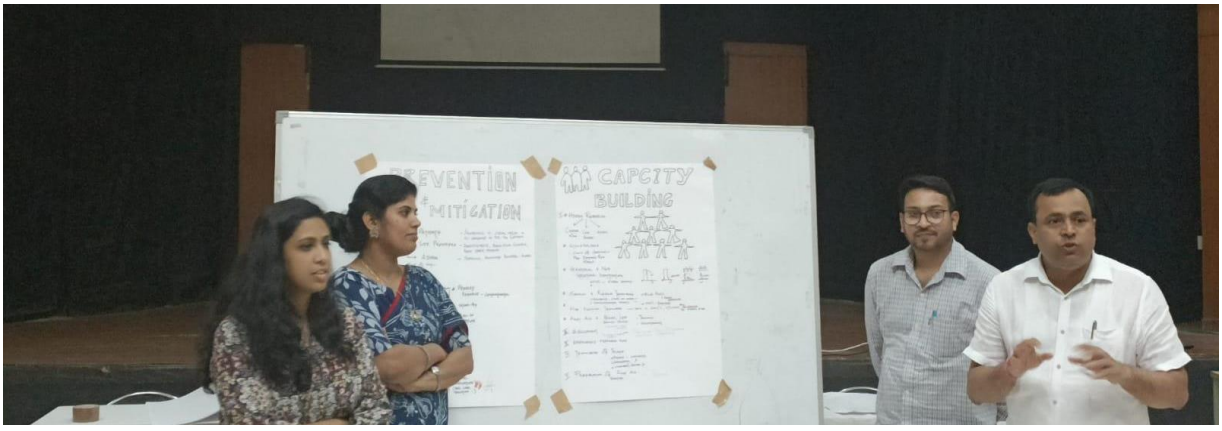


FIGURE 11: GROUP PHOTO

Importance of Disaster Management in Hospital Sector

A building may remain standing after a disaster yet be rendered incapable of providing medical care due to nonstructural damage. In most buildings the cost of nonstructural components is considerably higher than that of structural components. This is particularly true of hospitals, where between 85% and 90% of the value of the facilities lies in the architectural elements, the mechanical and electrical systems, and the medical equipment. A seismic event of lesser magnitude, which is far more common than a major earthquake, can damage nonstructural elements. These key components of a hospital, those most directly linked to its purpose and function, are the ones most likely to be affected or destroyed by earthquakes.

On the other hand, it is easier and less costly to retrofit them and prevent their destruction or severe degradation. Many of the problems mentioned above originate in structural and nonstructural safety of the building. The structural components should be considered during the design and construction phase of a new building or during the repair, remodeling, or maintenance of existing buildings. Good structural design is key to a building's survival in an earthquake.

Damage may occur, but collapse is unlikely. Unfortunately, most of the hospital's buildings have not been followed or have not taken into account the special specifications required by health facilities. Little wonder, then, that every time a major earthquake shakes the region, the most severely damaged buildings will include some hospitals. Hospital vulnerability is high and this must be corrected in order to prevent economic, social and human losses, particularly Emergency / Trauma centres in India where that can ill afford such losses.

Disaster mitigation through the adoption of preventive measures makes economic sense in areas prone to recurring events. For the funds invested in mitigation before a disaster strikes, enormous savings will be made in losses prevented. Mitigation is ultimately cost-free, since it pays for itself in lives and money saved. The various mitigation measures have different implementation methods and costs. The simplest and most economical have to do with nonstructural and administrative and organisational aspects; the most complex and costly are the structural measures. If an integrated hospital mitigation plan is carried out in stages, the use of resources can be spaced out over time, making it easier to keep the additional expenses within a reasonable margin of ongoing maintenance costs.

A vulnerability analysis begins with a visual inspection of the facilities and the preparation of a preliminary report. This inspection makes it possible to identify the areas that require attention. The report will be discussed with consultants and hospital authorities in order to set priorities and a timetable for undertaking the work.

In every documented case, cost/benefit analysis has shown the economic and social sense of upgrading the structural and nonstructural behaviour of vulnerable hospital buildings. The cost may seem high, but it is always significantly lower than that of repairing or replacing damaged facilities. It is useful to ask questions such as this: how many CT scanners could be bought with the cost of retrofitting the building?

And how many of them does the hospital now have? The answer can be surprising, without even considering the other equipment and assets currently.

Recommendations with respect to Prevention and Mitigation measures:

<u>Prevention measures:</u>

Design Parameters:

FIGURE 12: UNIVERSAL DESIGN

- Universal design international standards should be followed with respect to accessibility, built environment and the product design. Structural stability as per the code provisions to be followed. Signages in regional language in addition to English to be provided for common man to understand the exit routes and evacuation plans easily.
- Colour coding for evacuation indications like footsteps marks could be marked on floor to easily locate the exits in addition to the signages.
- To create visibility during the failure of electricity or artificial lighting, the signages on ground or wall or ceiling should be reflected by incorporating neon lights/radium which doesn't require regular supply of electricity.

Services:

Critical supplies should be located in the safe zone, so that those areas can be safeguarded at the time of any disaster. For eg. floods or earthquakes.

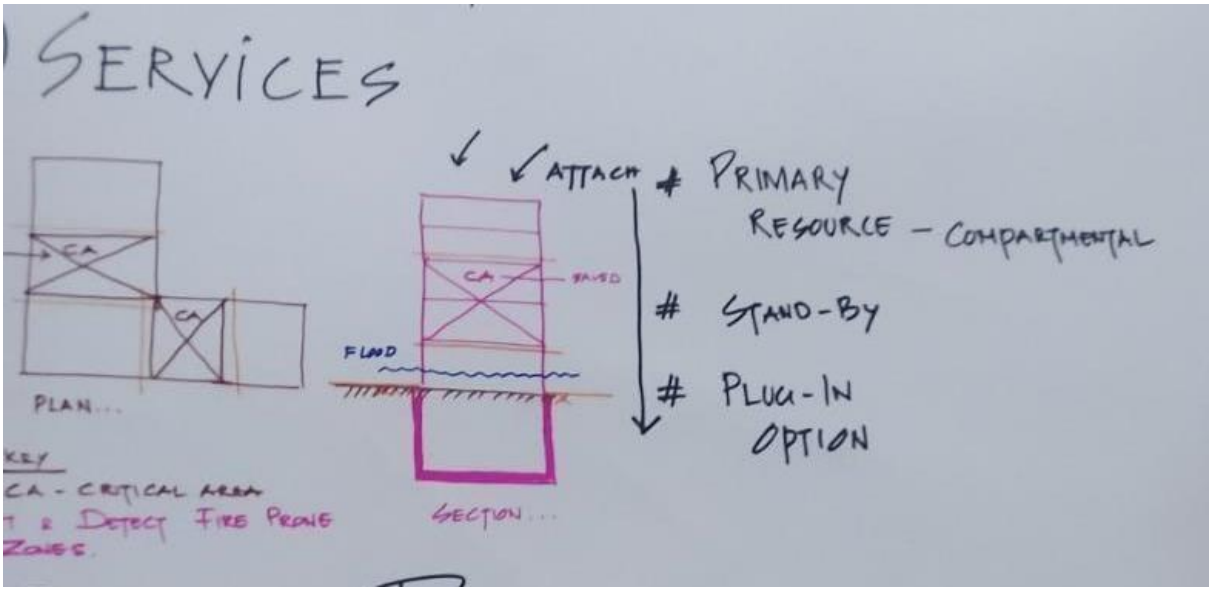


FIGURE 13: GROUP PRESENTATION

Option 1: If the layout of the hospital is linearly covered in the ground level, we need to bring the core zone to the centre or middle of the plan.

Option 2: if the building is vertical with more no. of floors, then the location of the core zone should be in the middle floors to safeguard from floods or any air attacks from top of the building.

With respect to drive way, as per norms fire engine should be able to use the driveway in case of any emergency, parking of cars and other vehicles should not be a hindrance in the 5 m driveway. There should be more no. of exits and specially in the emergency ward, entry of patients from the ambulance and boarding of treated patients into the ambulance should be segregated to have a smooth transition process.

Human Resources:

Currently in most of the hospitals, Administration is given first priority, secondly to life savers and thirds to Users/ patients. Instead, we should focus on users / patients as first target, then life savers and at last on administrators to streamline the circulation, provision of facilities and evacuation plan etc.

Common issues to be addressed:

- Awareness to common people through social media and televisions in the hospital building.
- Advertisements through audio sensors and fire alarms

Mitigation measures: Zone wise planning, layout should be made based on critical and non-critical areas and work towards. Do’s and Don'ts list to be well planned and latest plans and evacuation plan should be ready in place with the hospital administration. For example: Medicine and supplies

Capacity Building Measures

Based on the references and inputs collated, the capacity building training could be arranged on the following agenda from time to time for not only the staff of healthcare or trauma centres regularly but it is essential to bring awareness to the common man or users. Based on the site visit on the fourth day of Faculty development program to Jai Prakash Narayan Apex Trauma Centre (AIIMS) our group analysed the existing scenario and presented the recommendations to be followed in any hospital sector.

FIGURE 14: GROUP PHOTO AT AIIMS TRAUMA CENTRE

Techniques for Disaster Planning and Response

Existing Scenario:

As the infrastructure and human resources in the AIIMS Trauma centre keeps on changing, it is noted that they have taken necessary actions for establishing the institutions for planning and response. Also, regular training planned to the staff and service providers by issuing SOP (standard of procedures) and protocols were given to enable decision makers to plan for measures to tackle the disaster situation and to take appropriate decisions for management during any disasters in future. But for the users or patients, there is no awareness created or initiated how to react during any disaster.

Recommendations:

Right of way is mandatory in and out of the site. For example, the design of the spaces should be in such a way which will reduce the distance and ease the work of the life savers by providing facilities by addressing and observing their daily routine and activities. Similarly, vehicle movement outside should be segregated from the pedestrian path. A 5 m width driveway for fire

engine movement even on regular days must be available without any hurdles, thus during an emergency we can save golden hours in saving lives.

Most of the time, when the source of fire is not detected and suppressed at an early stage leads to a big fire accident and finally to a disaster. Instead, if stakeholders prepare more people by training and improving the Skill set of using fire extinguishers and how to respond and address different types of issues which could become a danger by analyzing prior to the incident. It will lead to a saving of property, lives and fast recovery, and resume the functioning of hospitals in less time.

- Advertisements of usage of fire extinguishers in the waiting rooms to be telecasted on a routine basis.
- Legible Location plan in the main lobby areas for the users to locate where they are standing and how to identify escape routes.
- Latest blueprints of trauma centre plans marked with critical areas, core and non-core areas must be available to be produced to the rescue team or even to the management.

HRVC (Structural and Non-Structural Identification)

Existing Scenario:

It is noticed that Renovation work is going on in the visited trauma centre and also changes have been made in the functional usage of core and non-core spaces due to pandemic and post pandemic situation of COVID crisis. Though the disaster zone is well planned, and sufficient space allocated to handle and protocols and SOP prepared for the staff of the health centres, anticipating any emergency or pandemic in future is managed, but availability of latest blueprints based on the final changes of planning or changes with respect to functional requirements is in place to hand over to fire squad or rescue team at the time is doubtful and challenging.

Few years back, one fire incident broke out in the disaster-marked zone due to malfunction of the HVAC system and the institution realised that the precaution measures have to be taken and worked out feasible solutions with respect to the responsibilities and actions to be taken in the way of handling patients, equipment etc. But when the fire engine was called during a fire accident, they found vehicles obstructing the drive ways which took time to clear out the vehicles by the help of security in charges.

Recommendations:

Assessment of hazards and vulnerability is one of the tools for response, prevention, mitigation and planning for disaster. Therefore, the staff should be sensitised for identification of structural and non- structural hazards and its behavior during disasters so that they can be made aware and trained for various do-s and don't-s during emergency situations. The medicine stock is arranged in the freestanding racks which could fall and block the way at the time of any disaster. So, it needs to be fastened and braced in a proper way. Existing false ceiling is fixed and various materials are used, it is advisable to cross check the combustibility of the material or fire retardant and the fixing of false ceiling with the ceiling should be made flexible to stop failing during disasters like earthquakes.

FIGURE 15: COLLAPSE OF FALSE CEILING

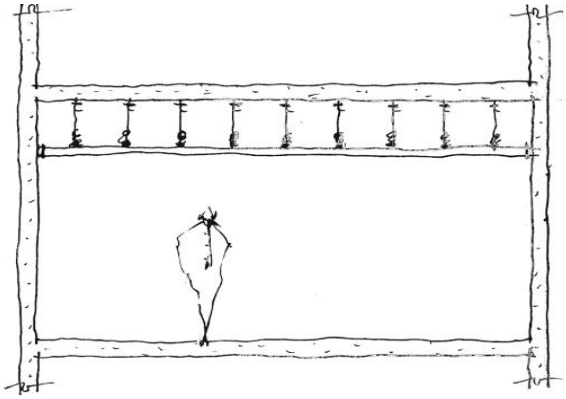


FIGURE 16: FLEXIBLE CEILING DESIGN FOR EARTHQUAKE RESILIENCE DHAKA'S R (2020)

Collapse of false ceiling if it fixed with ceiling: Use of a flexible system connecting the structural member is recommended.

http://www.seismicresilience.org.nz/topics/non-structural-systems/special-considerations-for-suspended-ceilings/restraining-suspended-ceilings/

Search and Rescue Techniques (SAR)

Existing Situation:

During an emergency there is a need to rescue persons trapped in a hazard zone. As disaster situations are associated with resource crunch and destruction of physical infrastructure, there is a need of learning and practicing the search and rescue techniques by selected members of the staff. But for this the count of every person entering the hospital sector along with the patients need to be considered, but currently we have a system of tracking the data of patients only but not the family members or friends or people who visit the trauma centre along with the patients. Most of the time it will be difficult to know how many are trapped inside the building during any disaster because of the missed data.

Recommendations:

- Every person entering the hospital premises other than the patient should be considered for data with the help of any device or screen test. So that indirectly it helps to calculate the exact number of victims to be rescued by assessing the people who have also evacuated.
- Stakeholders should assign existing staff to hold responsibilities by allotting who and how they will protect and safeguard patients, equipment etc. in a planned manner. And provide sufficient training beforehand to tackle during any emergency.
- Safe zones should be marked and kept ready where important and lifesaving equipment, critical patients and life savers could be kept safe till the rescue team comes and takes over.

Fire Fighting Techniques

Existing Conditions:

- It is observed that existing buildings are enforced with fire extinguishers installed still there is very low awareness regarding its usage in case of fire.
- Also, regular checks on working of fire tanks, hose pipes and sprinkler systems should be made.
- Do’s and don'ts of suppressing fire is not expressed clearly.
- Due to renovation, junk items are kept on the corridor which restricts the movement during any emergency.

Recommendations:

FIGURE 17: FIRE EXTINGUISHING TECHNIQUES SOURCE: I STOCK (2020)

- To make the staff aware of the techniques of using fire extinguishers regular training for firefighting should be conducted.
- Also, virtual advertisements about the usage of fire extinguishers should be popularized in the daily routine to reach out to the public as well.

- There should be an alternate power supply or plug in model to function when the main supply cuts off. If the stand by power also doesn't function then a plug-in model needs to be introduced.
- Provision of more no. exits to evacuate equipment’s and people is also important.

First Aid and Basic Life Saving Skills

Existing Scenario:

Life savers and administration are busy with the day-to-day activities and concentrating on patients. So, they may not be able to focus their time and energy to assess or be prepared with solutions all the time.

Recommendations:

Disaster requires prompt response to save life. Therefore, there is a need for first aid providers in the complex other than regular staff who will inspect the site and indoors and detect the upcoming problems and make sure how they can reduce the loss of life or completely avoid losing any life in case of any disaster. so that they could respond within the golden hour. Therefore, there is a need for training staff for first aid and basic lifesaving skills regularly.

Equipment for appropriate disaster response

Along with trained human resources there is a need for disaster response equipment. The equipment can be categorized for use by different responding teams. For example, Search and Rescue teams shall have ropes, stretchers, blankets, ladders, etc for conducting activities. Similarly, firefighting teams should have fire extinguishers, fire hose reel, sand buckets, etc. First Aid teams should have bandages, first aid kits etc. Therefore, the equipment should be made available under capacity building funds. Due care for maintenance and safety of these equipment should also be taken.

Emergency Preparedness Plan

To deliver proper response to the disaster situation there is a need for a comprehensive disaster management plan. This plan contains the detailed HRVC, prevention, mitigation and response

plan. It should also have updated resource inventory and updated list of trained staff. This plan should be annually updated and discussed with all the stakeholders regularly.

FIGURE 18: DISASTER PREPAREDNESS (LAEDC, 2021)

Priority Group			Description
Number	Name	Color	
P1	Emergency/Immediate	Red	Patients who have life-threatening injuries that are treatable with a minimum amount of time, personnel, and supplies. These patients also have a good chance of recovery.
P2	Urgent	Yellow	Indicates that treatment may be delayed for a limited period of time without significant mortality or in the ICU setting patients for whom life support may or may not change their outcome given the severity of their illness.
P3	Delayed	Green	Patients with minor injuries whose treatment may be delayed until the patients in the other categories have been dealt with or patients who do not require ICU admission for the provision of life support.
P4	Expectant	Blue	Patients who have injuries requiring extensive treatment that exceeds the medical resources available in the situation or for whom life support is considered futile.
--	Dead	Black	Patients who are in cardiac arrest and for which resuscitation efforts are not going to be provided.

FIGURE 19: STAGES OF TRIAGE SOURCE: CHRISTIAN (2018)

Currently there is a system to be followed for life savers and administration staff to deliver proper response to the Mass Casualty event the committee should arrange regular training for Doctors/ MOs for emergency triaging / colour coding. This training would help in prioritisation of patients and help in provision of health care within the golden hour. It is very critical for the staff and life savers to protect critical patients and it needs a sensitive approach.

So, it is necessary for the hospital disaster management committee to take responsibility to provide more manpower to safeguard equipment and how they can resume the hospital within a shorter period of time after any type of disaster.

Conclusion:

For providing effective medical response on the site of disasters, stakeholders collaborating with disaster management agencies should conduct regular training of first-aid for ambulance staff, so that during mass casualty incidents, these parties can respond effectively. Plug in model to be introduced with respect to services and conversation of parking lots or any other open areas to the emergency ward module. there should be additional supplies kept in the safe zone, which could be used at the time of any disaster. If the main medicine or food supply is cut off or damaged.

Overall, it's the collaboration of common man to the life savers to the stakeholders who needs to be prepared and to know how to respond and recover soon to save more lives with their trained action.

Group 4

Topic: Response plan and mass casualty plan
Participants: Mr. Ram, Ar. Renuka Awatramani, Ar. Renuka Singh, Ar. Sajida Shahnum, Ar. Priya Boby

RESPONSE PLAN: AIIMS TRAUMA CENTRE
Response plan has been worked out in two segments: On-site Response Plan and Off-site Response Plan.

On Site Response Plan includes all the actions to be taken in the event of a disaster within the premises of AIIMS Trauma Centre, whereas Off-site Response Plan involves all other co-ordination required between the site and different associated healthcare organisations.

On-Site Response Plan: First and foremost, step of the proposed response plan is to formulate different teams within the hospital and train them to work effectively in the event. The pandemic response team has been added on to the response plan to implement sanitization, isolation and

treatment. The teams can be given different responsibilities for example Evacuation, Logistics etc. and the proposed communication between different types is as per following flow chart:

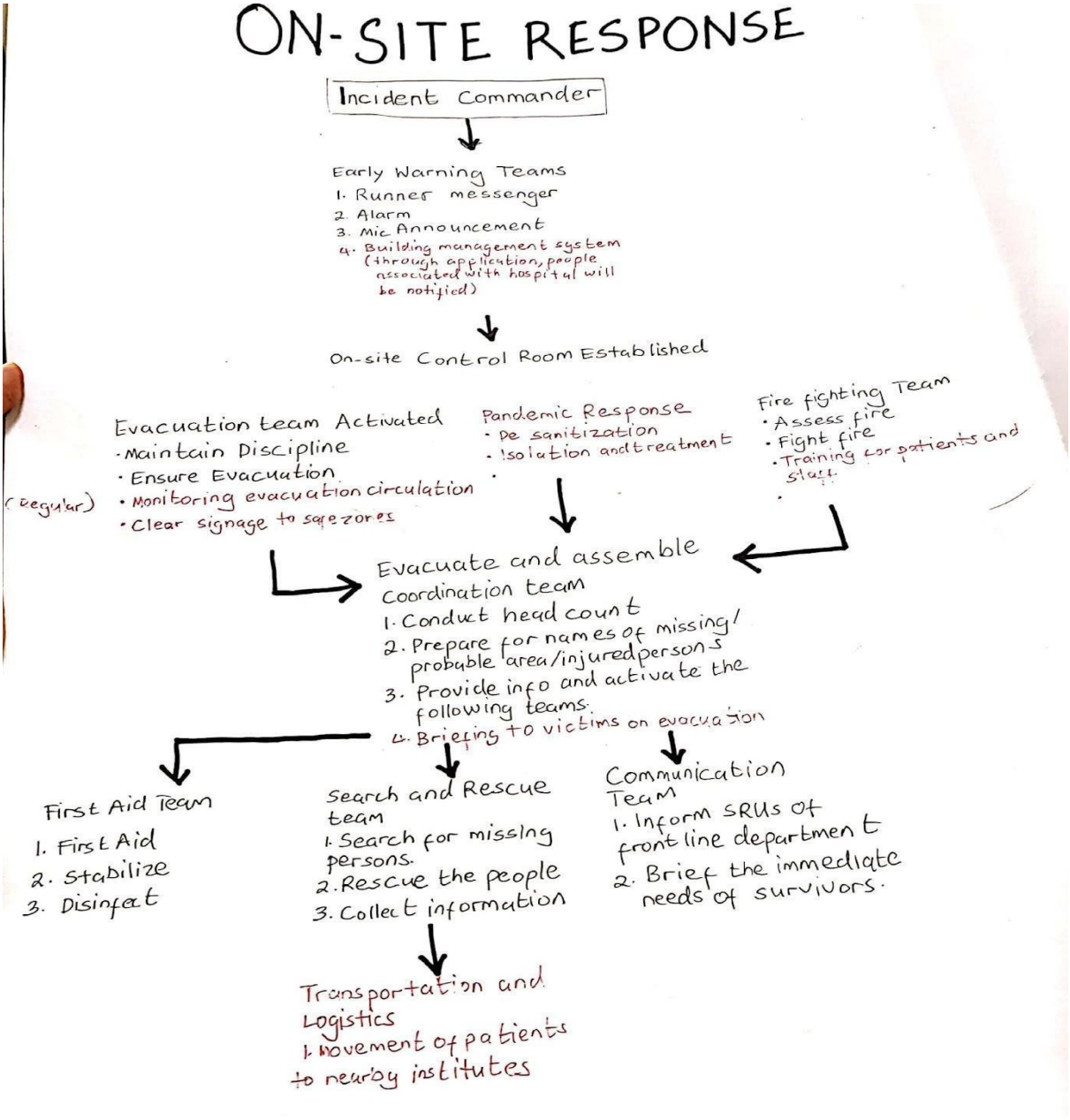


FIGURE 20: ON SITE RESPONSE PLAN

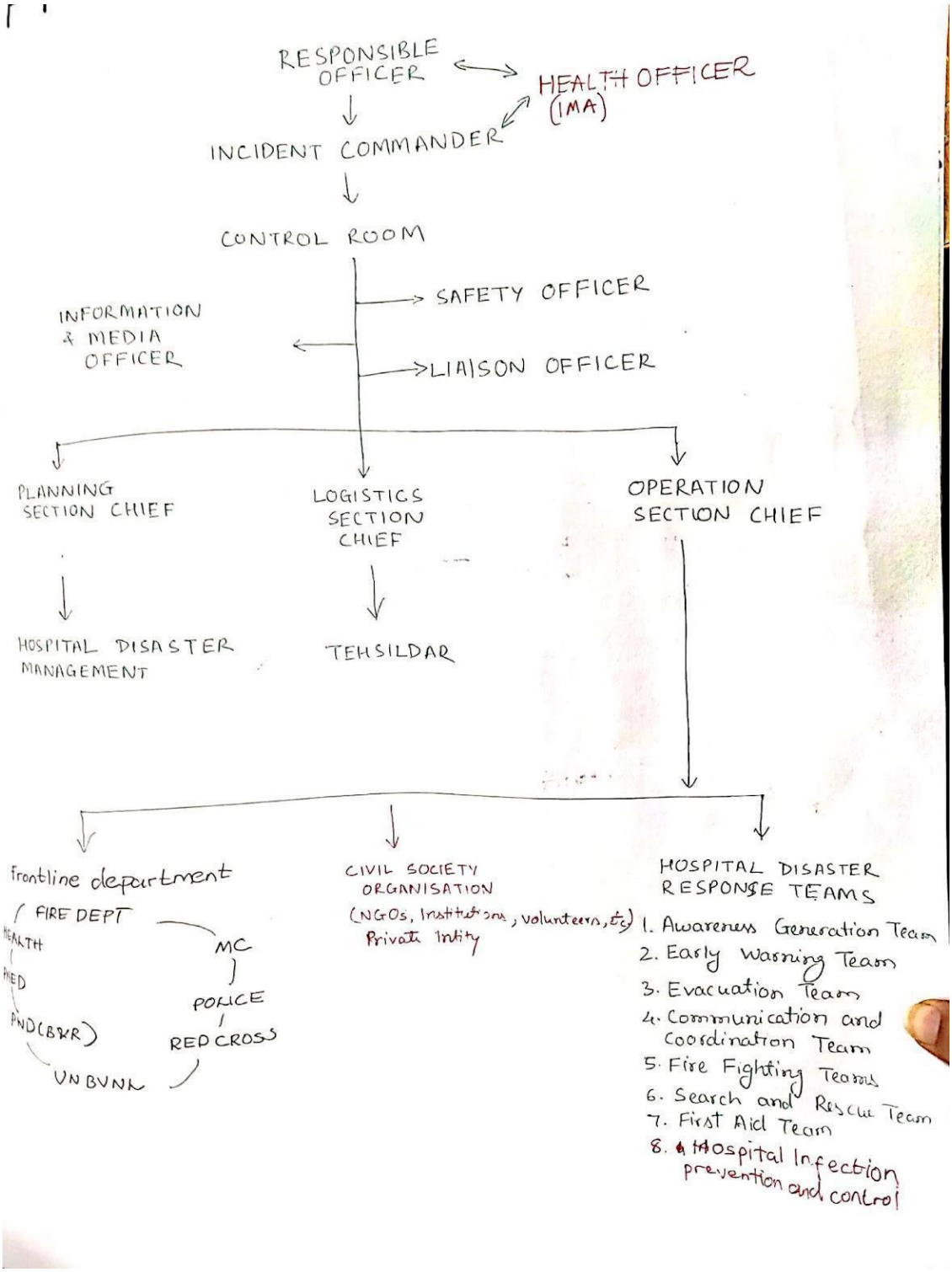


FIGURE 21: OFFSITE RESPONSE

The team referred to the document by Haryana Institute of Public Administration and built upon it by adding components highlighted in red. The hospital infection prevention and control and civil society needs to be in the loop for offsite response.

MASS CASUALTY PLAN: AIIMS TRAUMA CENTRE

Based on the primary visit of the trauma centre, following observations has been taken care while formulating mass casualty plan.

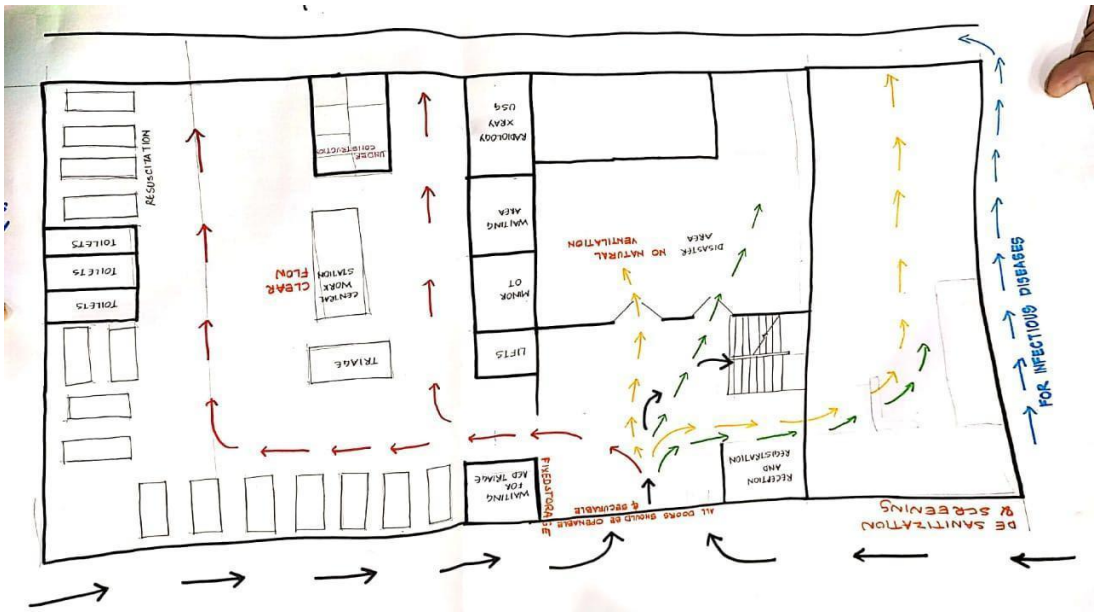


FIGURE 22: TRIAGE AT AIIMS DURING MASS CASUALTY

Proposed Interventions:

- Series of entrance doors should be openable.
- There was absence of fire signage, which won't guide the victims for an effective evacuation in the event of disaster.
- The automated doors won't work during flooding and power failure, so they can be avoided
- A buffer area should be provided between the minor OT and the circulation area in red triage.
- Clear flow to be maintained in yellow and green triage.
- Natural ventilation to be considered in the Disaster Area.

- Roofing to be not of polycarbonate sheet.
- Separate entrance to be provided for Infectious diseases like Covid-19, including desensitization and screening process.
- Dedicated areas in parking should be left for gathering purposes during disasters
- Proper information flow to be maintained in the event of the disaster.

Group-5

Topic: Evacuation Plan & Mock drill

Participants: Prof Dr Bandana Jha Shalini Vig Sushil Chokhani Pankaj Dhayal Tabassum Yasmeen

Floods Scenarios of risk

- The basement & ground floor will be affected primarily.
- Time line preparation (30 minutes in case of cloud burst and 2-3 hours in the case of flash flood)
- Toilets will be choked.
- Drinking water will be a problem.
- Electrical network including the Generator facility will be disrupted in the basement.

FIGURE 23: BIRDS EYE VIEW OF AIIMS TRAUMA CENTRE

Mitigation plan

- Electrical network should be connected with photovoltaics and batteries as a backup to supply electricity to critical areas during power shutdown.
- Generators and other battery backups need to be shifted from basement to upper floors.
- Water purifier must be planned on each floor.
- Deep Retrofitting should be done to reduce energyloads and increase day-lighting and natural ventilation.

Evacuation & Operation

- Back up of medicine should be available on each floor
- Medicines should be sealed with plastic or otherwaterproof material.
- Patient to be moved to upper floors through ramps and staircases.
- Every upper floor should have OT for emergencies.

There is use of non combustible materials and fire rated doors.

Fire escape staircase not accessible due to covid partitions.

FIGURE 24: INTERIORS OF AIIMS TRAUMA CENTRE, DELHI

FIGURE 25: FIRE HAZARDS AT AIIMS TAUMA CENTRE

Evacuation in case of fire

- Paramedical staff and security staff to practice drills to move patients to identified locations.
- If fire on ground floor than patients are to be moved outside.
- In the event of fire on the upper floor, patients are moved down through the ramps.
- Patients near adjoining blocks can be moved to other connected blocks.

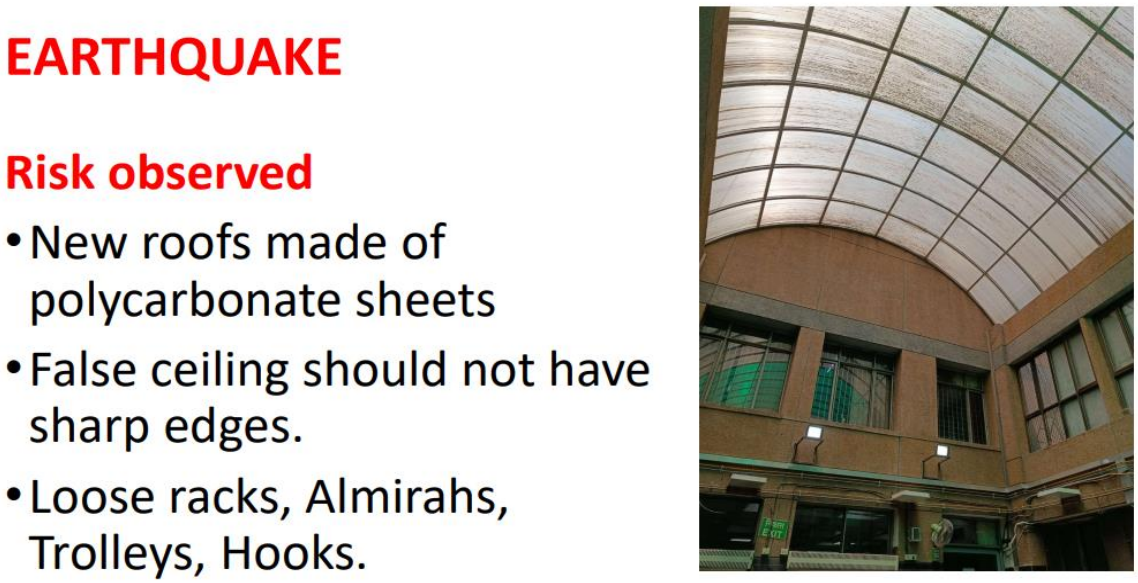


FIGURE 26: EARTHQUAKE HAZARDS AT AIIMS TRAUMA CENTRE

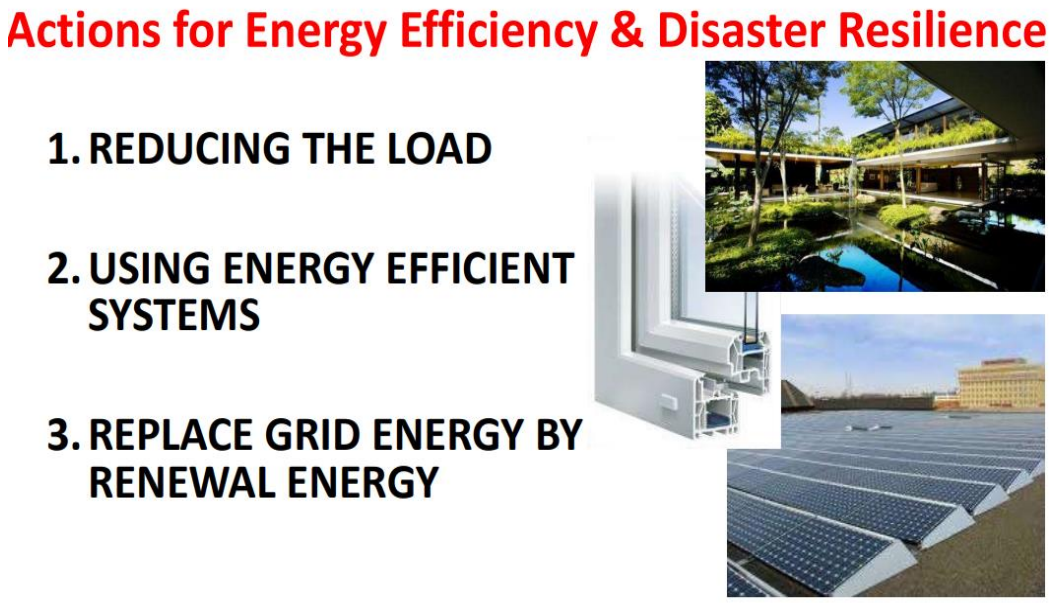


FIGURE 27: ACTIONS FOR ENERGY EFFICIENCY

KEY TAKEAWAYS OF THE TRAINING PROGRAMME

1. A safe and resilient hospital should remain functional during any disaster to aid the sick; hence the equipment and infrastructure should be accordingly designed and planned.
2. The hospital should be self-reliant to remain functional during a disaster with its backup electricity and medical gas supply.
3. The design team should carry out a thorough site survey to determine the flood and earthquake or other relevant zones of the site. This will help in site selection, design, and construction.
4. The earthquake resistant design should be implemented early in the design, particularly the columns, façade, and layout. The grade of concrete and column sections is paramount in hospital resilience to earthquakes.
5. The design of HVAC system post pandemic must be modified to have filtration systems, increased air flows and more operable windows to reduce infections.
6. The hospital corridors should be round instead of linear to allow multiple exits in the event of a fire or an unplanned event.
7. The designers should take a modular approach to allow for flexibility and adaptability of the plan to allow for expansion.
8. The post pandemic changes in the functionality of hospitals such as AIIMS include creation of isolation wards for infectious diseases, and changes in the triage process. The designers must provide electrical and medical gases connection lines in various forms for usage during a surge.
9. The building management systems in hospitals should integrate pandemic resilience and warning systems. This can help issue warnings to patients, staff and government bodies during a disaster or infection outbreak.
10. Daylight and natural ventilation are critical in pandemic resilience and wellbeing of patients. Hence, operable windows are encouraged in wards.
11. The cyber security of a hospital must be considered by the designers while preparing the services of the hospital.
12. Fire safety in hospitals should be prioritized to create safe hospitals; the evacuation plan and materials used should be given more attention.

13. The BIS standards, NBC standard etc. should not be prescriptive but flexible to incorporate guidance as per the site conditions.
14. The services in the hospital are dynamic and require constant updating to keep up with the new technology.
15. Space planning and facade design for resilience is important as the shape can determine the energy use and functionality.
16. In terms of space planning, the inter-bed distance is standard 2.9m but a 3.2m distance is recommended to allow the addition of beds during the surge.
17. Flexible, and adaptable hospital design is important to be prepared for any disaster or unplanned event. The convertible spaces can be used in the event of a patient surge.
18. The planning matrix of the hospital should be designed to allow minimum movement between departments to reduce lag in treatment.
19. The hospitals of the future should be energy efficient while able to maintain its functions. The biophilic design in hospitals can reduce heat island effect while speeding up the recovery process.
20. The high mortality during the pandemic was due to a lack of medical services and insufficient infrastructure and that there is a need for time-saving standards instead of life-saving standards.
21. Infection control in the hospital can be achieved by creating a positive pressure room for patients with compromised immunity and negative pressure for patients with infectious diseases.
22. The way finding in a hospital is also important as fluorescent signage can speed up evacuation.
23. The furniture used in a hospital must be modular to create flexible spaces. Furniture fixed to the ground should be avoided.
24. The future hospital should be a smart building with service integration and building management systems.
25. The disaster management plans in hospitals should be updated for the event of a pandemic.

PHOTO GALLERY

FIGURE 28: INAUGURATION CEREMONY

FIGURE 29: DAY 1 GROUP PHOTO

FIGURE 30: FDP PARTICIPANTS

FIGURE 31: PRESENTATION BY AMIR ALI KHAN

FIGURE 32: DAY 1 PRESENTATION BY PROF ANIL DEWAN

FIGURE 33: DAY 1 PHOTOS OF THE AUDIENCE

FIGURE 34: SPEAKER DR. HARI KUMAR, REGIONAL COORDINATOR FOR SOUTH ASIA, GEOHAZARDS INTERNATIONAL

FIGURE 35: SPEAKER PROF. MANOJ MATHUR, SPA-D

FIGURE 36: SPEAKER PROF BANDANA JHA, SPA-D

FIGURE 37: SPEAKER DR. TEJ PRAKASH AT AIIMS TRAUMA CENTRE, DELHI

FIGURE 38: DR. TEJ PRAKASH LEADING THE FIELD SURVEY AT AIIMS TRAUMA CENTRE, DELHI

FIGURE39: AIIMS TRAUMA CENTRE VISIT

PARTICIPATION LIST

Sl. No	Salutation	Name	Email Id	Department/ Organisation	Designation
1	Dr.	Aaditya Pratap Sanyal	apsanyal.apd@iitbhu.ac.in	Architecture	Assistant Professor
2	Mr.	Aftab Alam	arch.aftab@gmail.com	Jamia Millia Islamia	Visiting Faculty
3	Mr.	Ankit Kumar Singh	ankit.kumar@spa.ac.in	SPA-D	Assistant professor
4	Ms.	Arathy Gopal	arathy.gopal@spa.ac.in	SPA-D	Assistant Professor
5	Ar.	Avitesh	aravitesh13@gmail.com	Sushant School of Art and Architecture	Assistant Professor
6	Dr.	Sandesh Yadav	sandesh_official@yahoo.in	Guest lecturer, Department of Geography	Jamia Millia Islamia
7	Mr.	Krishna Prakash	krishna2007prakash@gmail.com	IIT ROORKEE	Ph.D. Scholar
8	Mr.	Mohd Rashideen Saifi	rashideens@spa.ac.in	SPA-D	Assistant Professor
9	Prof.	Mohd ShoebAlam	shoebalam.vaka@gmail.com	Vastu Kala Academy College of Architecture, New Delhi	Associate Professor
10	Prof.	Nagendra Narayan	nagendra.19799@lpu.co.in	Lovely Professional University, Punjab	HOD Architecture
11	Ms.	Priyanka Kochhar	priyanka.usap@gmail.com	University School of Architecture and Planning, GGSIPU	Associate Professor

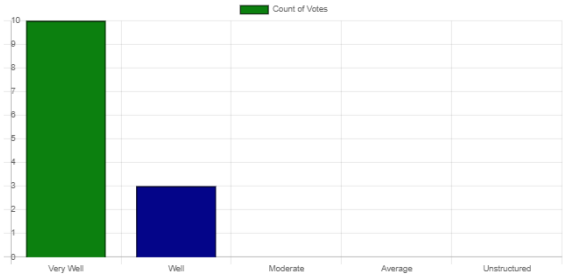
Sl. No	Salutation	Name	Email Id	Department/ Organisation	Designation
12	Mr.	Pushkar Pawar	ar.pushkar86@gmail.com	School of Planning and Architecture New Delhi	PhD Scholar
13	Ms.	Radhika Gopinath	radhikag.architect@gmail.com	Dream Designers Studio	Proprietress
14	Mr.	Ram Chandra Singh	singhrc.wii@gmail.com	SEL	Consultant
15	Ms.	Renuka Awatramani	renuka.kamla@gmail.com	USAP, GGSIPU	Associate Professor
16	Ms.	Renuka Singh	ar.renukasingh@gmail.com	Department of Architecture, Planning and Design, IIT BHU	Assistant Professor
17	Ms.	Sajida Shahnum	sajidashahnum@gmail.com	USAP, GGSIPU	Assistant Professor
18	Ms.	Sakshi Gupta	ar.sakshijain@gmail.com	USAP GGSIPU	PhD Scholar
19	Ms.	Shalini Raman Vig	shalini.sra@gmail.com	SPA-D	PhD Scholar
20	Ms.	SumedhaDua	dua.sumedha@gmail.com	SPA-D	University Professor
21	Mr.	Sushil Chokhani	sushilchokhani1@gmail.com	Visiting Professor	Professor
22	Dr.	Tabassum Yasmeen	tabbujamia@gmail.com	Jamia Millia Islamia	Guest Faculty
23	Dr.	Upender Yadav	upentaashwi21@gmail.com	Border security force	Chief medical officer

Sl. No	Salutation	Name	Email Id	Department/ Organisation	Designation
24	Prof.	Vidushi Singh	vidushisingh01@gmail.com	Vastu Kala Academy, Guru Gobind Singh Indraprastha University	Assistant Professor
25	Mr.	V. K. Jain	arvkjain@yahoo.com	Retried Architect	Architect
26	Ms.	Pankaj Dhayal	pankaj.phd.299arch22@spa.ac.in	SPA-D	PhD Scholar
27	Dr.	Bandana Jha	bandana.jha@spa.ac.in	SPA-D	Professor
28	Dr.	Prabhjot Singh Sugga	ps.sugga@spa.ac.in	SPA-D	Associate Professor
29	Ms.	AmishaJangra	amisha737@gmail.com	SPA-D	PhD Scholar
30	Dr.	KshetrimayumBangkim Singh	bangkim.singh@spa.ac.in	SPA-D	Assistant Professor
31	Mr.	Nishant Gautam	nishantg@spa.ac.in	SPA-D	Assistant Professor
32	Ms.	Neerja Lugani Sethi	lugani@ipu.ac.in	Guru Gobind Singh Indraprastha University	Professor
33	Mr.	Mohammed AtharMansury	athar.mansury@spa.ac.in	School of Planning and Architecture New Delhi	Assistant Professor
34	Mr.	Raja Singh	rajaphd@spa.ac.in	SPA-D	PhD Scholar

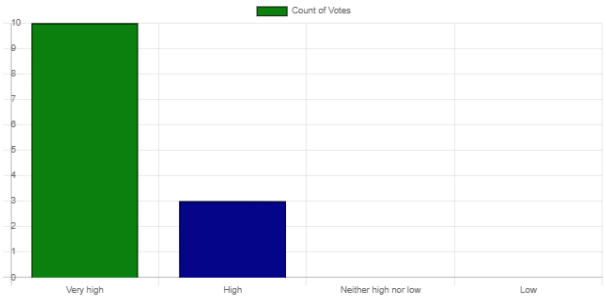
FEEDBACK

Feedback Result

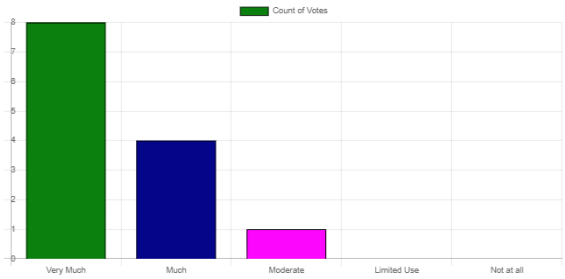
I think the structure and organization of the course fulfilled the objectives of the Training programme.



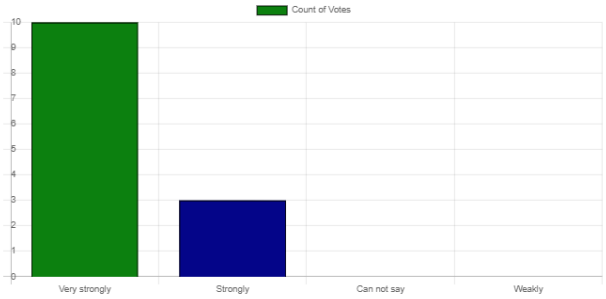
Practical orientation of the Training programme.



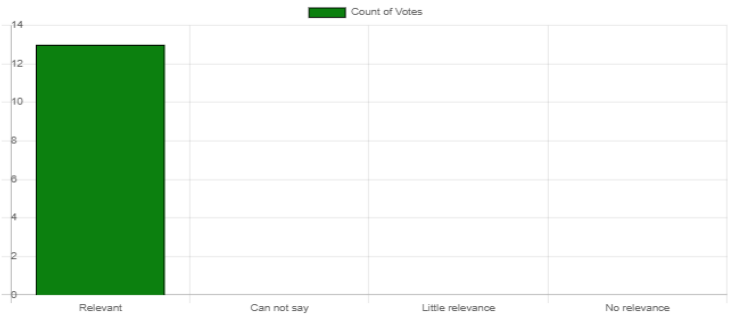
I feel this programme would be useful to me immediately in my job.



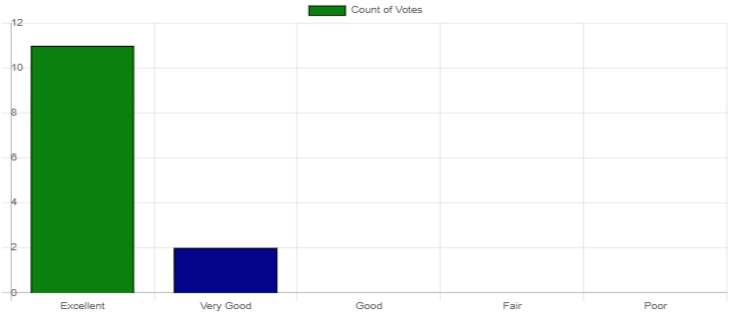
I feel this inspires me to take up assignments related to Disaster Management.



I found the course materials supplied to us to be



Your overall impression of the training programme.



BROCHURE

PROGRAMME DETAILS

The programme details including the program agenda, information on resource persons, exercises shall be provided separately.

SUGGESTED READINGS

- Guidelines on Hospital safety by NDMA, 2016
- Guidelines on Seismic Retrofitting of Deficient Buildings and Structures by NDMA, 2014
- Critical Infrastructures and Disaster Risk Reduction, training module by NIDM 2013
- National Disaster Management Plan 2019
- PM 10 Point Agenda on DRR
- SFDRR (2015-2030) UNDRR
- NDMA guidelines on DRR
- DM Act 2005
- NDMA SOP for DM (http://www.ndma.gov.in/images/ policy plan/NDMA-SOP-for-Disaster-Management.pdf)
- SOP for Responding to Disasters (http://ndmindia.nic.in/)
- Disaster Management in India by MHA

Any other content suitable by respective faculty members will be added later.

EVALUATION OF THE PROGRAMME

The training programme shall have a dedicated session for feedback and valediction. The participants will be provided with an evaluation proforma, which may be completed and handed over to the programme staff.

CERTIFICATE

Certificate will be awarded to the participants on successful completion of the course.

BOARDING, LODGING AND VENUE OF THE PROGRAMME

The boarding and lodging for the outstation participants will be arranged by SPA Delhi host team. Travel expenses of the participants will be borne by respective nominating organizations/departments/institutes.

The programme will be held at SPA, Delhi. It will commence at 10:00 AM on Monday, July 11, 2022 and will conclude on 5:00 PM on Friday, July 15, 2022. The deliberations during the training programme will be done primarily in English language.

REGISTRATION

The delegates/ participants of the programme will assemble at the venue at 10:00 A.M on Monday, July 11, 2022 and will register themselves on-site and also at NIDM training portal beforehand at https://training.nidm.gov.in/. Organising teams will assist them in registration both online and offline.

HOW TO REACH AT THE VENUE

Delhi is well connected via flight, trains and buses from all over the country. NDLS railway station from SPA Delhi is at 4.4km distance. ITO Delhi Metro station is the closest DMRC metro available.

ORGANIZING TEAM

NIDM, Delhi	SPA, Delhi
Patrons	
Shri Taj Hassan, IPS Executive Director	**Prof. Dr. P.S.N. Rao** Director
Conveners	
Dr. Amir Ali Khan Associate Professor, Resilient Infrastructure Division Email: amir.nidm@nic.in	**Dr. Anil Dewan** Professor and Head, Dept. of Architecture Email: a.dewan@spa.ac.in
Programme Coordinators	
Ms. Yogita Garbyal Young Professional, NIDM Email: yogita.nidm@nic.in	**Dr. Khushal Matai** Asst Prof, SPA Delhi Email: khushal.matai@spa.ac.in **Mr. Thomas Pegu** Asst Prof, SPA Delhi Email: thomas.pegu@spa.ac.in

For further details or information, please contact:

Dr. Amir Ali Khan
Assoc. Professor, Resilient Infrastructure Division, NIDM
National Institute of Disaster Management (NIDM),
Ministry of Home Affairs, Government of India
Plot no. 15, Pocket-3, Block-B, Sector-29, Rohini, Delhi -110042
Email: amir.nidm@nic.in Ph.:- 011-20873423
Website: www.nidm.gov.in

Dr. Anil Dewan
Professor & Head, Department of Architecture
School of Planning and Architecture, Delhi
(An Institution of National Importance under an Act of Parliament.)
6 Block-B, Indraprastha Estate, New Delhi – 110002
Email: drhi_fdp@spa.ac.in
Contact: +91-9868120869
website: http://spa.ac.in/Home.aspx

Faculty Development Training Programme on

Disaster Resilient Healthcare Infrastructure (July 11-15, 2022)

Venue: School of Planning and Architecture, New Delhi

Organized by

National Institute of Disaster Management
Ministry of Home Affairs, Govt. of India
New Delhi – 110042 (www.nidm.gov.in)

in collaboration with

School of Planning and Architecture, New Delhi
4-Block-B, Indraprastha Estate, New Delhi 110002

BACKGROUND

NIDM has been mandated by **Sub-section 8 and 9, Section 42, Chapter 7 of Disaster Management Act 2005** to develop training modules and educational materials, undertake training, research, documentation and publication for capacity development and dissemination of knowledge/ information related to disaster management, assist **in formulation of policies, plans, strategies and frameworks for disaster risk reduction and resilience** as well as promote awareness among different stakeholders for enhancing human capacity to avoid, prevent, mitigate, prepare, respond and recover efficiently in a proactive, holistic and integrated manner.

The Institute has been organizing various training courses and conducting seminars / workshops / conferences covering wide spectrum of themes at the national and international levels besides publishing several training modules and other documents including case studies, templates and disaster reports.

NIDM has been trying to bring various stakeholders at one platform through activities like India Disaster Management Conference, National Platform for Disaster Risk Reduction, South Asia Policy Dialogue, East Asia Summit for Earthquake Risk Reduction and Asia Ministerial Conference for Disaster Risk Reduction for better networking, linkages and coordination. Sendai Framework for Disaster Risk Reduction, Prime Minister's 10 Point Agenda on DRR, Climate Change Action Plans, Urbanization Agenda and Sustainable Development Goals have also emphasized on collective synergized action and integrated approach for Climate and Disaster Resilient Safer Sustainable Development.

OBJECTIVES

This training program aims at delineating information and training the faculties and other professionals involved in planning and design of healthcare infrastructure in India. Through this participants will be able to:

- Develop contextual understanding of the risk and resilience of the healthcare facilities in the wake of disasters
- Understand fundamentals of hospital architecture and master planning of healthcare facilities in India
- Collate information regarding the integration of hospital building and medical services for resilient healthcare infrastructure. Assess disaster management plans for healthcare infrastructure in India.

SCOPE

Training of faculties is one of the key elements in formulating appropriate disaster reduction risk (DRR) strategies in order to enable societies and youth to become engaged in the adoption of suitable and conscious risk management and reduction of vulnerability. Global frameworks toward resilience and sustainability have been focusing on the education aspect to achieve the objectives. This faculty training will focus on three agendas first, Fundamentals of Disaster Resilient Healthcare Architecture and Robust Planning of Hospital Campuses in India; Second, Integration of building engineering services to ensure medical functions in the wake of disasters and lastly, Drafting of Disaster Management Plans for Hospital Buildings in India.

BASIC COURSE LEARNING UNITS

Contents of the course would touch upon following aspects, to achieve the objectives:

- Basic Concept of Disaster Management, Disaster Risk Reduction and Resilience.
- Institutional Mechanism in Disaster Management
- Critical Infrastructure and risk mitigation
- Introduction to the Disaster Resilient Healthcare Infrastructure
- Classification of hospitals and introduction to disaster management codes/standards/guidelines for hospital resilience
- Resilience through hospital safety and security practices in hospital buildings
- Planning principles and Master Planning of hospital campuses Current research on resilience building.
- Introduction to resilience measuring framework for hospital safety.
- Hospital Disaster Management Plan
- Group Exercise/presentation/mock drill

TARGET GROUP

This programme is primarily designed to train the academicians, leaders and faculties with the concept of the hospital safety and resilient infrastructure. Accordingly, the target group for this programme would be Faculties from Universities and Research Institutes and State Government officials, etc.

ABOUT NIDM

The National Institute of Disaster Management (NIDM) was constituted under an Act of Parliament to play the role of a premier institute for capacity development in India with the vision to create a Disaster Resilient India by building the capacity at all levels for disaster prevention and preparedness.
Under the Disaster Management Act 2005, NIDM has been assigned nodal responsibilities for human resource development, capacity building, training, research, documentation and policy advocacy in the field of disaster management.
NIDM has performed a crucial role in bringing disaster risk reduction to the forefront of the national agenda. The Institute believes that disaster risk reduction is possible only through promotion of a "Culture of Prevention" involving all stakeholders. The Institute works through strategic partnerships with various ministries and departments of the central, state and local governments, academic, research and technical organizations in India and abroad and other bi-lateral and multi-lateral international agencies.

ABOUT SPA Delhi

School of Planning and Architecture was established in 1959 and later recognized as "An Institute of National Importance under an Act of Parliament", Government of India, in 2015. The School is a specialized University, only one of its kinds, which exclusively provides training at various levels, in different aspects of human habitat and environment. Striving for excellence, has always been in the lead in extending education and research to new frontiers of knowledge. The vision of SPA, already internationally known, is to make it into a distinguished centre of research, innovation, learning, capacity building and scholarly inquiry to become a globally competitive institution by 2025.