The project of isolation ward of suspected cases of the Third People's Hospital of Jiangdu District in Yangzhou

Project Name: The project of isolation ward of suspected cases of the Third People's Hospital of Jiangdu District in Yangzhou
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Design Cooperation: Jiangsu Zhiqi Internet Of Things Science, Nanjing Tianshuyun information technology Co. ,Ltd.
Location: Jiangdu District in Yangzhou
Site Area: 1379.5 ㎡
Gross Floor Area: 1561.74 ㎡
Photography: Jiangsu Zhiqi Internet Of Things Science

During the Spring Festival in 2020, the Third People's Hospital of Jiangdu District in Yangzhou urgently requested the provision of a rapidly constructed isolation ward of suspected cases in response to the severe situation of COVID-19 outbreak(Figure 1). Nanjing University Architectural Planning, Design and Research Institute, together with Jiangsu Medical Building BIM Family Library Research Center and Jiangsu Zhiqi internet of things science, mobilized for an emergency situation, and completed the "three-zone two-channel"-standard floorplan of isolation ward that meets the education and treatment requirements for infectious diseases in just one night,along with the design of construction drawing of the building structure, water, electricity, heating, and weak electricity. The whole process pf design and construction of the entire wards took only 14 days. Isolation wards are built by containers in a rapid way, which have 2 floors in total. Each floor includes 16 single isolation wards, and 32 wards in all.

Figure1:Project Overview

1 .Overall layout

The project is located on the vacant land on the north side of the inpatient building of the Third People's Hospital of Jiangdu District, adjacent to the vacant dormitory building on the west side and a one-floor bungalow to be demolished on the north side, which is in the south of the motorway. On the east side is a semi-underground sewage treatment station. The entire site is very small, which is extremely challenging for design and construction. The construction organization plan sets the medical supplies and logistics support points on the west side of the site, and the construction material flow line is located on the east side of the site. They enters from the north side road through the school and is separated from hospital personnel on the move to ensure safety (Figure 2). The masterplan design sets the entrance of medical care and materials in the northwest corner, and the entrance of doctors and patients in the southeast corner.The cleansing and segregation flow is clear and avoids crossing.

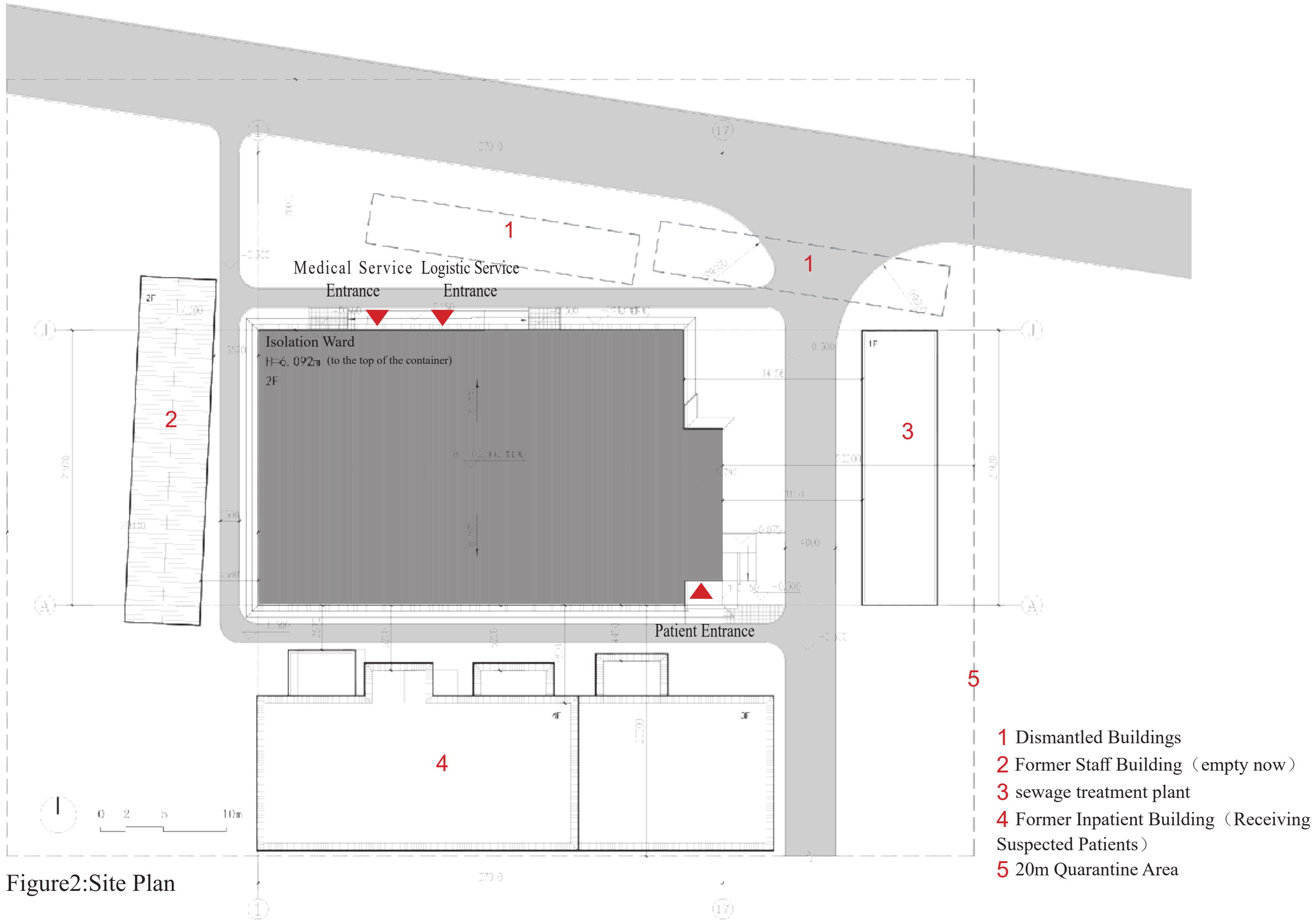
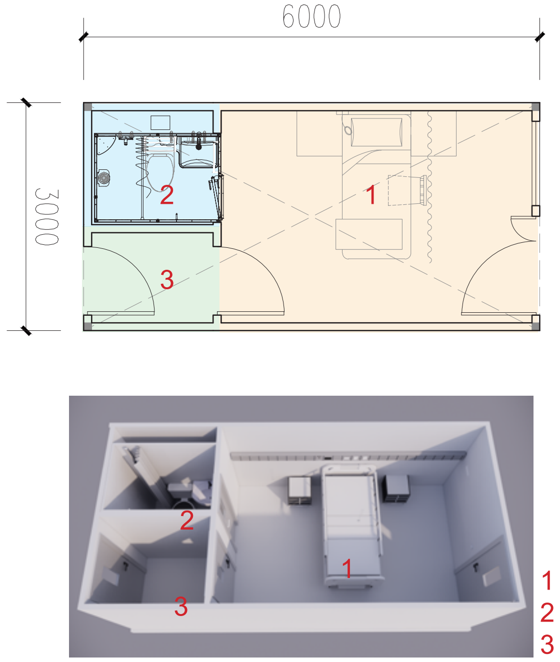


Figure2:Site Plan

2. Rapid construction strategy based on BIM forward design

2.1 Unit module design.

Modular design analysis, industrial production integration, and matching fabrication are the key strategies for the rapid construction of this project. The BIM oriented design runs through the entire project design, construction, operation and maintenance process. It is composed of a series of container modules with different medical or technical support functions. The modules use 6000mm *3000mm and 6000mm * 2000mm standard containers. The two types of containers are combined into a ward module, a nursing unit module, and a health care module for medical personnel. The modular system of each unit can be used alone or connected to form a large-scale mobile hospital (Figure 3~4).



1 ward
2 toilet
3 Buffer Room

Figure3:Unit module design

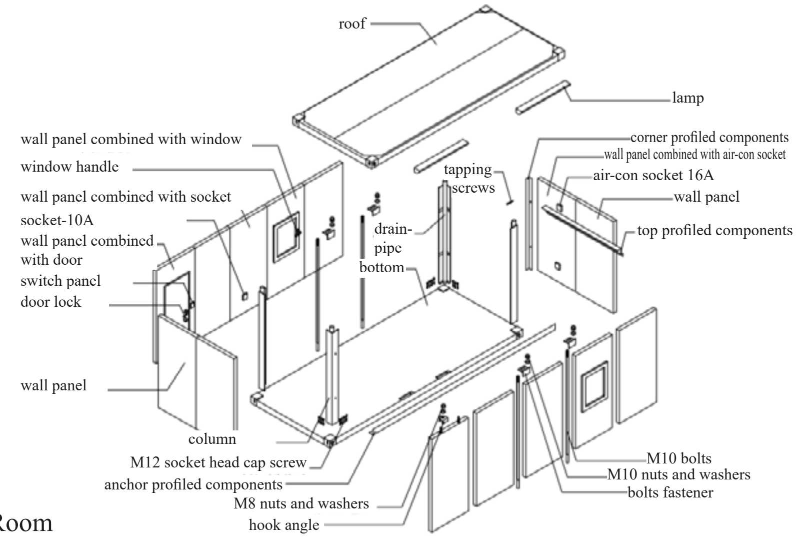
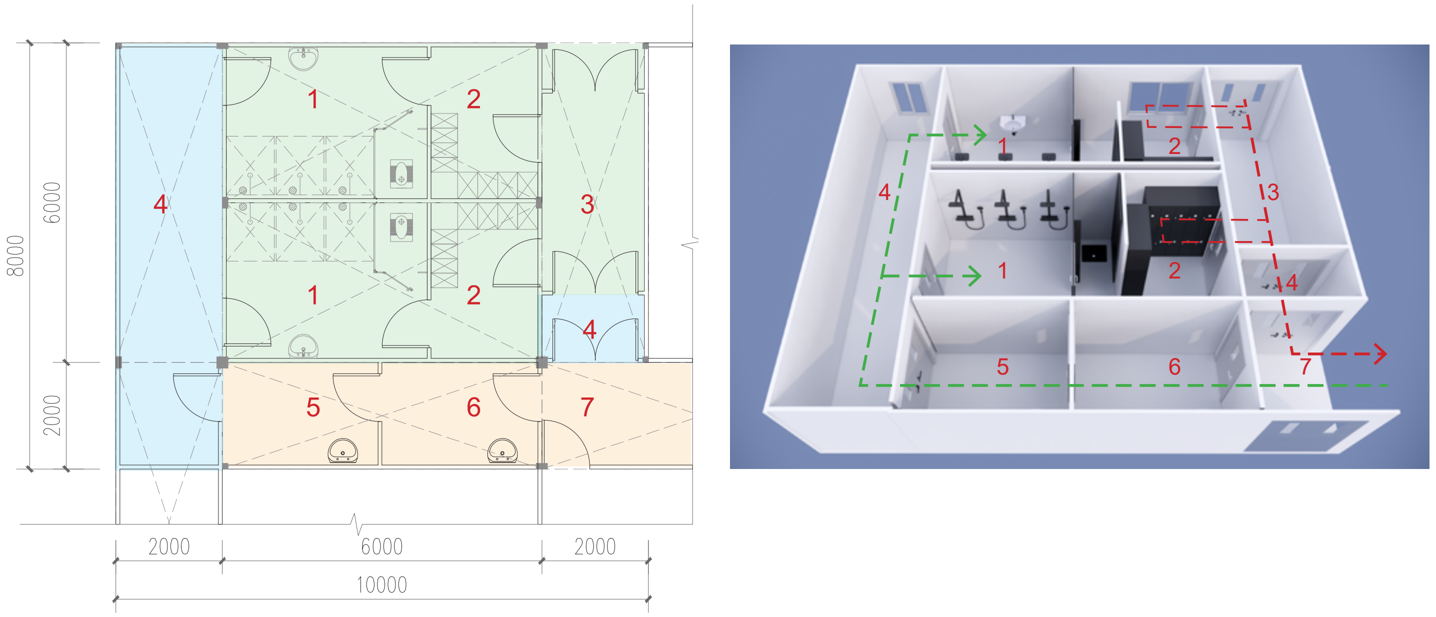


Figure4:Standard container disassembled diagram

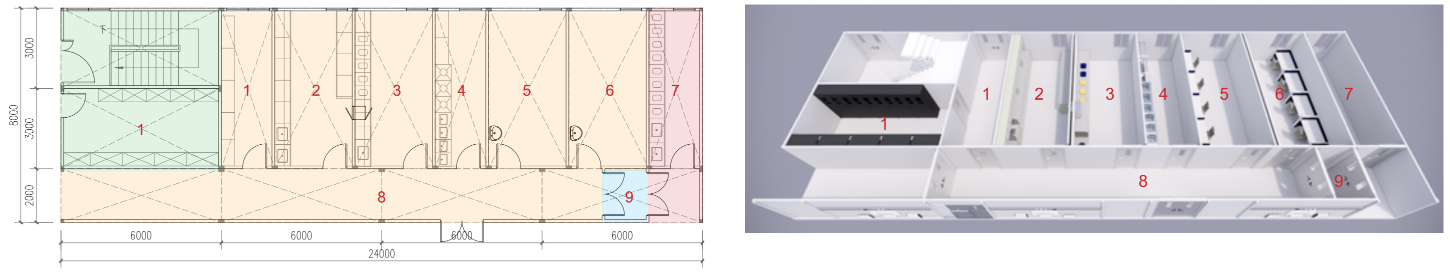
2.2 The functional combination of the module.

The project base is very tight. The isolation wards all use a compact combination of functional modules to shorten the flow lines and reduce the floor space. The ward module adopts the combination of ward sanitary ware and medical buffer zone. Simultaneously, the construction and assembly efficiency is high. The nursing unit sets up the necessary functions such as disposal room, treatment room, medical office, decontamination room and warehouse. The hospital personnel passage module also adopts a highly efficient and compact independent module. When doctors and nurses evacuates, a separate channel and compartment are provided to take off protective clothing and disinfect. Then enter the shower room to wash, and leave the room (Figure 5~7). The rest protection area for doctors and nurses is located in another building outside the venue.



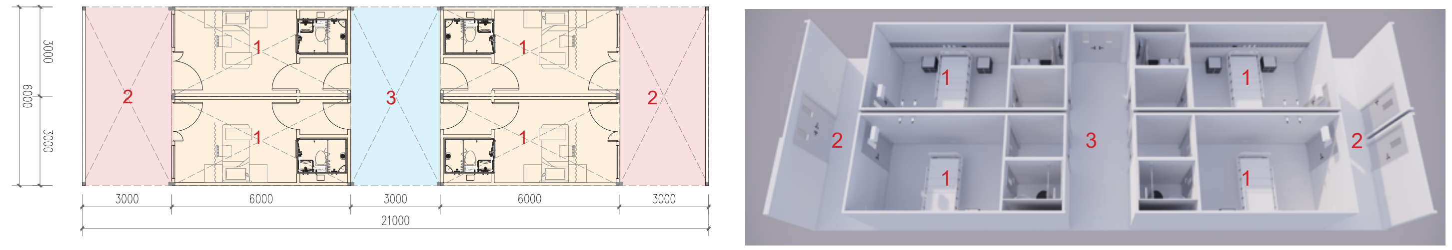
1 Toilets
2 Changing Room
3 Sterile Zone Corridor
4 Buffer Room
5 Disinfection-room
6 Protective Suit Take off Zone
7 Semi-Contaminated Zone
8 Patients Corridor
Evacuation Route
Entry Route

Figure5:The hospital personnel passage module and BIM design



1 Storeroom
2 Treatment Room
3 Disposal Room
4 Sanitary Room
5 Doctor Office
6 Nurse Office
7 Feculence Room
8 Staff Corridor
9 Buffer Room

Figure6:The nursing unit and BIM design

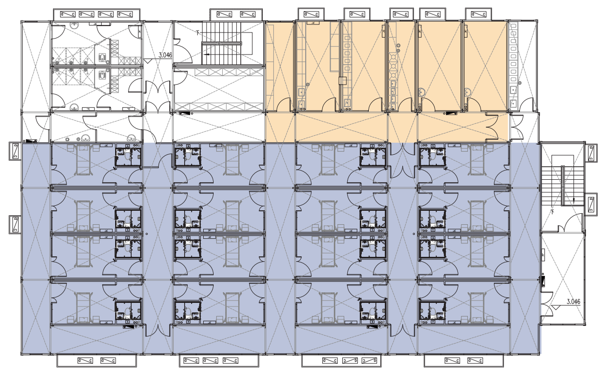


1 Isolation Ward
2 Patient Corridor
3 Staff Corridor

Figure7:The ward module and BIM design

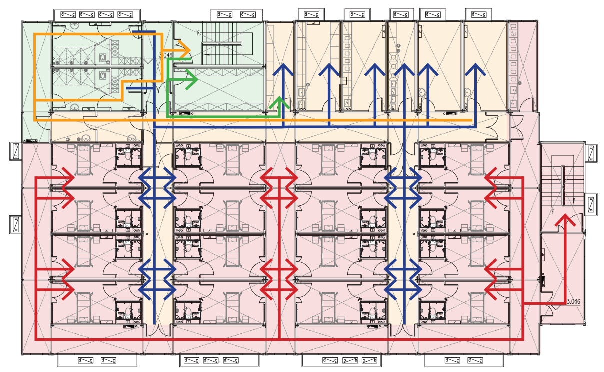
2.3 The design of "parallel side-by-side three-zone two-channel" infection-control streamline and negative pressure ward.

The conventional "three areas and two channels" infection-control streamline sets the medical care unit in the middle, and the medical care unit is divided into a clean area and a semi-contaminated area, and the fishbone ward is used as the contaminated area on both sides. Due to the very tight base of the project, we adopted a parallel layout of three areas and two channels. The medical unit and the ward area are stacked in parallel. The periphery is the patient channel, and the medical unit is connected to the medical channel. Under a compact transportation organization, the "three-zone and two-channel" infection-control streamline was realized. The air-conditioning negative pressure cascade design of the ward is an important measure to protect medical staff and isolate patients from cross-infection. The project uses air-conditioning airflow control to let air flow from the clean area to the semi-contaminated area and then to the contaminated area again to ensure that the ward is at the lowest negative pressure and to control the source of infection not to leak out. Each adjacent area is provided with a buffer zone to ensure the stability of the negative pressure (Figure 8~9).



Administration
Inpatient Area

Figure8:Function analysis diagram



Patient Streamline
Medical Supplies Streamline
Staff Entry Route
Staff Evacuation Route
Sterile Zone
Semi-Contaminated Zone
Contaminated Zone

Figure9:streamline analysis diagram

2.4 BIM design of the pipeline of the negative pressure ward .

There are many air-conditioning pipelines in negative pressure wards, including air supply and exhaust systems, air-conditioning systems, lighting systems , water supply, drainage and firefighting facilities. How to complete the integration of these pipelines in a limited and 3m-high container to ensure the clearance requirements is one of the strengths of our BIM oriented design. We have solved the installation problems of pipeline collision and other equipment through the accurate positioning designed by BIM (Figure 10).

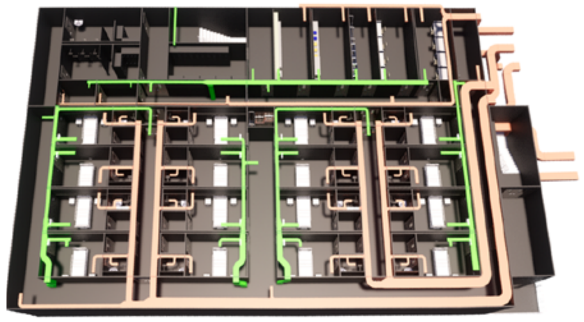


Figure10:BIM design of the pipeline of the negative pressure ward

2.5 BIM design of medical facilities.

BIM's forward design can also accurately arrange furniture and medical facilities inside the ward modules and medical care modules. Whether it is a equipment belt in the ward, a transfer window or a console, it can be implanted according to the actual size provided by the manufacturer to accurately complete the layout and installation of the medical facility (Figure 11).

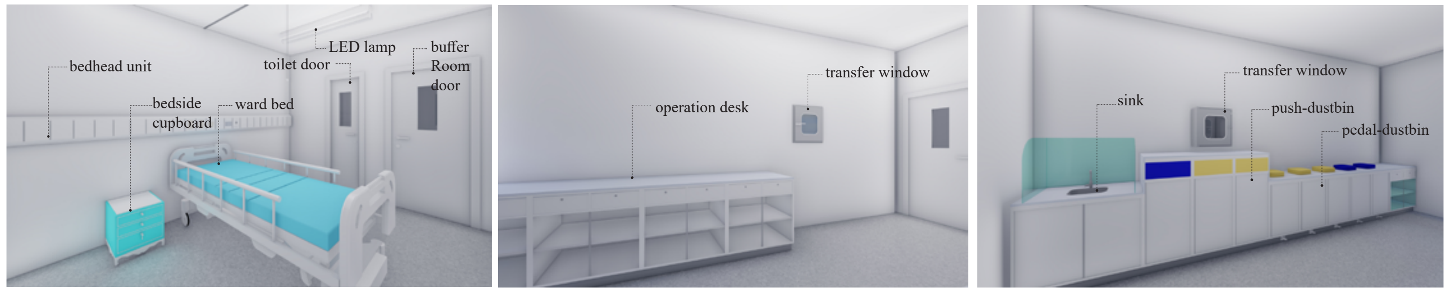


Figure11:BIM design of medical facilities

2.6 Prefabricated construction process.

Due to the tight base and narrow construction site, we controlled the assembly construction process through the BIM design model, and at the same time, through the aerial photography supervision of the cloud platform, the construction timing was commanded to ensure the orderly and smooth completion of the construction (Figure 12-14).

Figure12:Pre-buit-in Pipelines

Figure13:Assembling Containers

Figure14:Lifting containers in place

3 experience summary.

Based on BIM technology, modular design, industrial production, and prefabricated construction is one of the future development directions of the construction industry. This sudden breakout epidemic is a practical test of rapid and intelligent construction.Through the practice of this project, only by putting various functional and technical information into the BIM oriented design, can we successfully enter industrial production and assembly construction. The area of the project base is too tight, so the height difference between indoor and outdoor cannot solve the problem of patient ramp. In order to reduce the indoor and outdoor height difference, we used the raft foundation directly buried sewer pipes, instead of using the commonly used bottom overhead 800mm to shelve the container house, which also brought the problem that roof rain pipes can not pass through the overhead layer.Therefore a light steel slope roof drainage was also made on the box body, which has a certain impact on the shape and also increased some construction costs.

As an important hardware construction project to fight against the epidemic and respond to public health emergencies, the project of suspected-case isolation ward of COVID-19 in the Third People's Hospital of Jiangdu District of Yangzhou completed the design and construction tasks in a relatively short time. In the design process, we tried to use BIM technology to integrate the design strategy of building, structure and equipment as a whole, combined with university research resources to apply for special scientific research projects, summarize the project experience, continue to develop integrated module hardware, hoping to solidify the experience of a single project to be popularized as module products in architectural level to make it potential to become the national reserve measures to respond to public health emergencies.