5.2. Containers for special health facilities construction in disadvantaged areas.

The second research field concerns the development of structures to promote serious and highly contagious infectious diseases treatment, e.g. from Ebola virus, to be established in disadvantaged area [23]. It seems clear that the container can be an ideal element to be used when it is necessary to intervene expeditiously, ensuring maximum transportability and rapid installation of the equipment. Studies and tests carried out during this line of research have shown the particular aptitude of containers to guarantee maximum efficiency both in terms of health emergency response protocols, in accordance with the EUNID [24] and the Preventive Medicine Department of the U.S. Army Guidelines, who are the maximum referees regarding functional and plant engineering aspects of the high level sanitary isolation departments, and in terms of those adopted by international medical facilities of excellence, such as the National Institute of Infectious Diseases "Lazzaro Spallanzani" in Rome, the "Royal Free Hospital "in London and the " Emory University Hospital "in Atlanta [25]. The containers types used are defined by the “ISO 668: 2013” standard for the 20 'High Cube and 40' High Cube standard and semi-expandable containers. The module modifies and the reinforcing structural frame; made up of steel box profiles movable on rails, adding steel base plates and rods, hinged to angular profiles; produce a semi-expandable container suitable to accommodate three high level isolation rooms, whose surface area amounts to 13.5 square meters. Using this modified container type is beneficial because during transport dimensions remain similar to those of an ISO 40 'High Cube’ container, while, after installation, its width can be increased by 2.05 meters (Figure 14-15). The adoption of such containers have made it possible to increase the mobile hospital facility capacity with regard to the specific epidemic curve performance; in fact, a minimum core was identified that could guarantee twenty-four beds and, progressively, the possibility of expanding it to accommodate up to ninety-six beds is guaranteed. Moreover, everything was designed to ensure the correct differentiation of paths, which are reserved to patients, staff and visitors, as well as an acceptable patient humanisation level of the assistance and care areas.

Figure 13. Unit render.

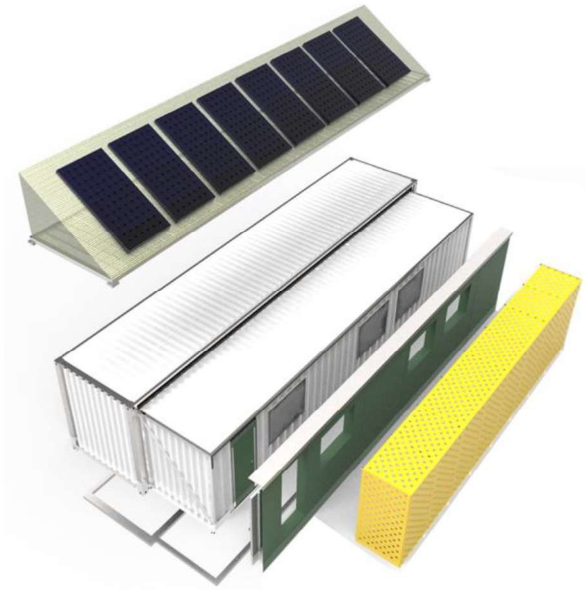

Figure 14. Unit scheme.

The hospital was divided into two main macro-areas: an operative area, where reception, clean-up rooms and diagnosis and intensive care rooms are located, and a recovery area, composed of four longitudinal aisles each consisting of a filter area and twelve high level isolation units (Figure 16).

To ensure biosafety levels in line with the strictest international standards, containers are modified in order to create sanitary filters composed of a staff dressing room at the entrance and outgoing decontamination showers; the containers inner upholstery may consist of specific technical panels for controlled microbial contamination rooms, which are characterized by smooth surfaces and rounded corners, to ensure ease of disinfection and the capability of integrating plant components. Since the hospital has to be transportable and as more energetically autonomous as possible, particular attention was paid to energy efficiency aspects in relation to the container shell design and to the stand-alone photovoltaic and solar thermal plant dimensioning. A dismountable container shell has been designed to make the health facility totally transportable and reusable, also making possible to change the container shell thickness in relation to the particular environmental context; that building envelope provides an Exterior Insulation and Finishing System (EIFS), covered with solar shading, and made of self-supporting polyurethane sandwich panels to be hooked to the containers closing plates and to additional frames anchored to the corner blocks

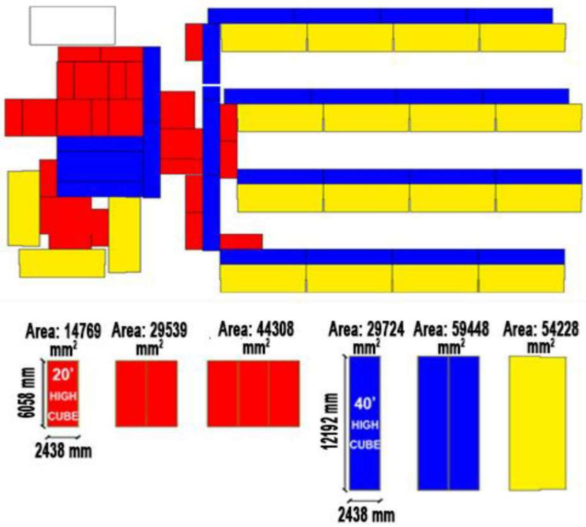

Figure 15. Plan scheme.

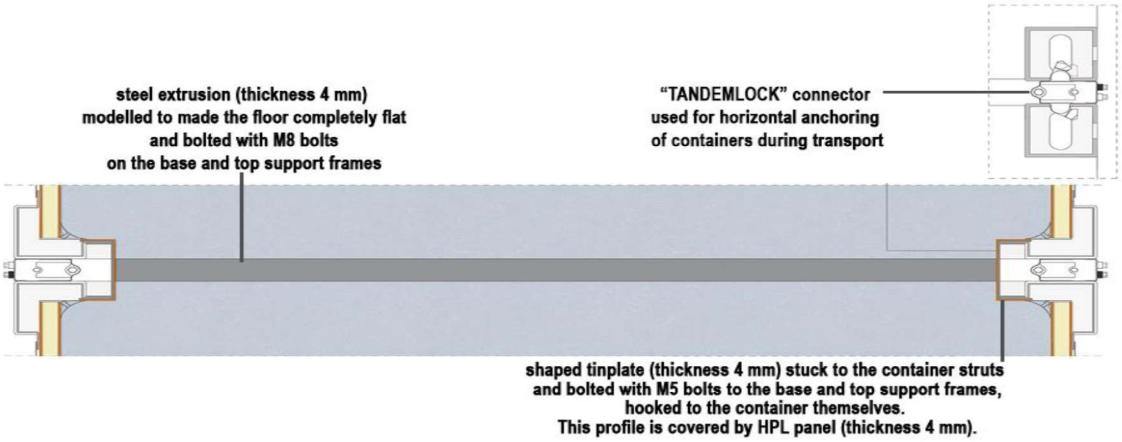

Figure 16. Locking system technical detail.

by twist-lock to avoid to drill the container main structural frame. The junction between two adjacent containers occurs by means of horizontal connection devices as a “tandem-lock”; in order to ensure the seal, a steel press-shaped tinplate profile (thickness 4 mm) shaped in such a way as to be fitted to the container corner struts, and to be screwed to the aforementioned additional frames, has been developed (Figure 17). The internal lining of said profile has been provided in HPL to ensure the flatness and homogeneity of the internal partitions; in order to maximize the speed of construction of the health facility, it was finally assumed that the container support surface was made of simple stabilized gravel, a globally widespread material.

REFERENCES.

[23] Disadvantaged area is defined as area that is more than sixty minutes away from the nearest equipped emergency room (Cfr. D.M. 70/2015).

[24] EUropean Network of Infectious Diseases.

[25] Since the tragic Ebola virus outbreak occurred in Sierra Leone during 2014, the case-study of a hemorrhagic fever treatment hospital to be established in the town of Goderich, Sierra Leone, was specifically examined. From the data collected with the "Emergency" center's logistic staff, it emerged that, unfortunately, in case of emergency it is too complex and expensive to build a health facility in a disadvantaged area that certainly ensures biological risk containment generated by airborne transmission infectious diseases.