"Mineàpolis®" - An innovative sea container construction in Vilanova i la Geltrú
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***Abstract*—**

Sea containers are used globally for shipping and have been for over 60 years. There are millions of them worldwide sitting unused in ports, but recently individuals and businesses are realising the potential of sea containers and using them to construct permanent buildings faster and cheaper than traditional buildings. **[1]**

Neàpolis, an innovation agency and growing technological company situated in Vilanova i la Geltrú encountered a problem due to a lack of business space. To solve this problem they recognised the potential and the innovative use of sea containers as commercial premises.

A project was announced to design and plan a new multipurpose building that should be located next to the main Neàpolis headquarters using these sea containers.

To fulfil the given requirements research on existing sea container buildings, designs for exterior & interior as well as a foundation analysis, an entire construction planning and cost estimations have been made. The sun path and the wind in the area have been analysed to decide about renewable energy and a structural analysis has been performed.

Keywords: **Cowork, Innovation, Maker space, Sea Container Building,**

I. Introduction

The present article contains information about the project carried out to plan an innovative sea container building in Vilanova i la Geltrú. The realization of the project has been done by an international team of six students taking part in the European Project Semester 2017 (EPS) in cooperation with the local innovation agency Neàpolis.

As it is well known the technology sector nowadays is fast-growing. Neàpolis as a technology company is also experiencing this trend and has to expand physically, to ensure sufficient innovation space for the future. For this circumstance Neàpolis is cooperating with the Universitat Politècnica de Catalunya (UPC) and announced the mentioned project. The main task of the project is to design, plan & analyze an attractive multifunctional building using (primarily) sea containers.

Figure 2 - Sea Container [2]

The design includes alongside the exterior look of the architecture, a proposal for the green space around and furthermore the interior arrangement of the rooms. Respecting the appearance of the town Vilanova i la Geltrú the construction must fit in the neighborhood and surroundings next to the already existing Neàpolis building on La Rambla Exposició, 59-69.

The requirements for the new business property are listed subsequently: space for at least 30 people within cowork offices, a maker space, a bar/café and an exhibition area.

Furthermore, the modularity – the possibility to expand the space if more and diverse needs will appear is a main aspect of the project.

Considering all the mentioned facilities, the project will satisfy the need of more working space for start-up companies, entrepreneurs and established technology companies in the region.

II. Urban Laws and Implementation of Renewable Energies

At present the construction site of this project is qualified as "Green Zone" according to the current General Plan of Urban Ordinance and this information is provided by the Department

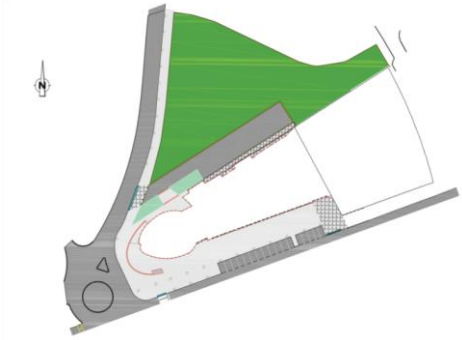

Figure 1: Construction site beside Neàpolis highlighted in green

of Urbanism of the City Council of Vilanova i la Geltrú. As it is not allowed to build any building on an area qualified as

"Green Zone", its qualification must be changed first to equipment.

To achieve this, a specific modification of the general plan must be made with two conditions and it is believed that there is high chance that these conditions could be met in the near future. Therefore, it can be assumed that it is possible to build the sea container building on the plot which is beside the current Neàpolis building.

Implementation of renewable energies on this project while desirable is unfortunately not economical. Research was made into solar power, wind energy and the local climate but neither option looked viable. This is because of the low average wind speed in Vilanova that could not even make a small-scale wind turbine to work efficiently. Regarding the solar power, it could be a worthwhile investment on the condition if the "sun tax" is removed from Spanish national law. It is believed that these taxes and fees could double or triple the normal time to make the usage of solar panel to become profitable. Thus, it is not advisable to use these two renewable energies for this project at the moment.

III. EXTERIOR DESIGN

In order to confirm that the sea container building would blend in perfectly with the surroundings, the appearance of the current Neàpolis building and the geography of the potential construction site were studied first. Apart from that, the potential number of workers and the purposes of the sea container building were also kept in mind. All of these factors were given a high consideration during the designing process of the exterior and as a result, an agreed final design between the team and Neàpolis was successfully completed.

The main features of the exterior design are the large curved section that serves as an entrance to the building and the "V-shape" that the building forms. These two features were designed with the purposes of resembling the Neàpolis headquarters building and fitting the sea container building seamlessly in the construction site. Likewise, the presence of the square extruded windows towards the street was also intended to display the similarity with the current Neàpolis building's architecture. Furthermore, the remaining space left on the construction site was decorated cautiously with the prospective possible expansion in mind.

This design was then rendered next to the Neàpolis building to show the comparison between designs and scale of the building once it is complete.

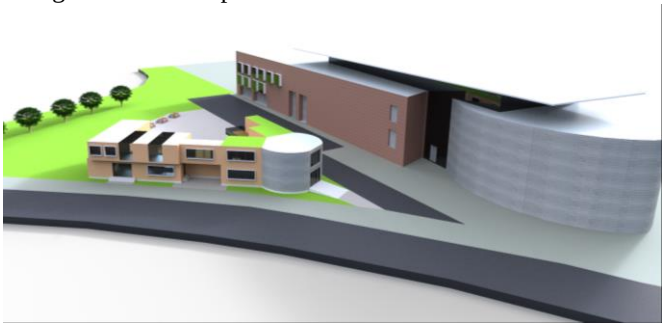

Figure 3 - Model of the building next to Neàpolis

To ensure that the design is possible to be built with containers, a few deformation tests were made. By referring to the outcome of the tests (single container deformation without walls and a load of 5000kg is 0.4mm), the structure of the whole building constructed with the containers is believed to be stronger when the containers welded together and reinforced compared to a single container alone.

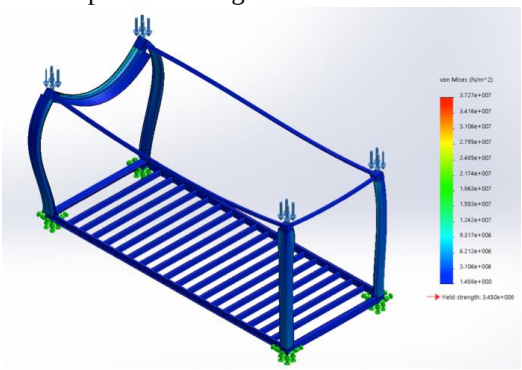

Figure 4 – Deformation test single container in Solid Works

In other words, multiple containers joined together seem to be able to support greater loads resulting in a more stable structure. Thus, it could be assumed that the sea container building could stand any potential loads such as live load and wind loads without trouble in the future. But as this tests are just first estimations detailed stress tests must be performed and the exact location of reinforcements should be identified before starting the construction.

IV. INTERIOR DESIGN

The requirements of the different areas of the building were researched, a survey of people working in cowork offices in Vilanova was conducted to find out what would make the best working environment.

Also a maker space in Barcelona was visited to find out the type of environment that should be replicated in the building. Following this the interior furnishings were modeled and rendered, the 1st floor render is shown as an example.

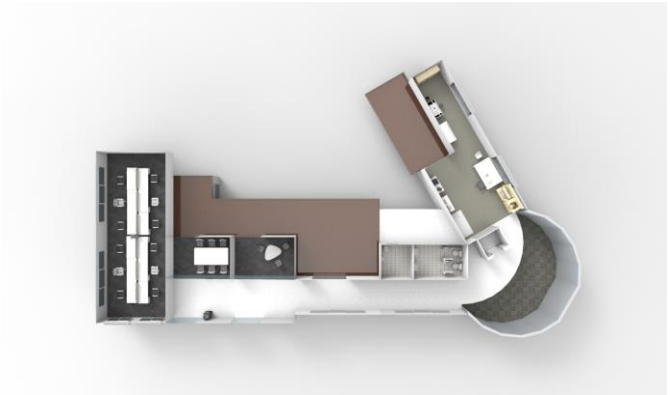

Figure 5 - Model of the Interior 1st floor

In addition to the interior furnishings rough plans for all the utilities have also been made including the electrical, HVAC, water and sewage. An example is shown below of a lighting plan.

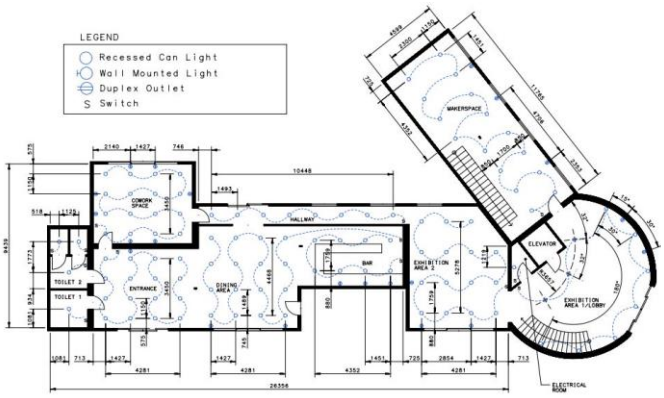

Figure 6 - Lightning Plan for the Ground Floor

V. CONSTRUCTION PROCESS AND COSTS

Constructing a container building is different compared to classical concrete constructions, which are common in Spain. Therefore the construction process has been planned in detail using a Gantt chart.

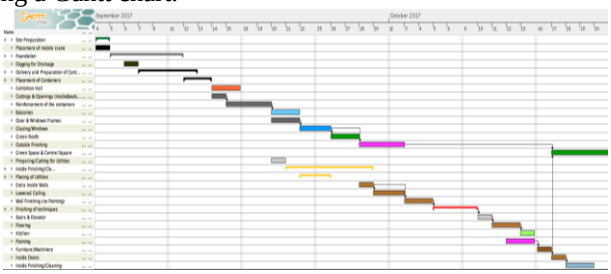

Figure 7 - Overview of the entire Construction Process

Similar tasks can be found in the beginning of the process - the site preparation and the foundation. Totally different is the assembling of the "shell". A sea container already contains floor, walls and roof which makes it much faster to construct than traditional construction. But some special characteristics have to be considered, especially the - in most of the cases toxic - wooden floor and the insulation of the metal shell. Concluding it is not as simple as it looks like at the first sight to construct an attractive building with sea containers, but it is worth comparing the construction time. The construction time is reduced by more than 50% (approx. 2 months vs. approx. 5 months). [3]

Comparing the calculated prices for the container construction to the expenses of a normal concrete building, saving money while using containers is a big aspect. Through using a general number for concrete buildings in Germany which is stated with 1.400 € per m^2 (without interior) [4] the same size building within an interior effective area of 490 m^2 would cost 686.000 € which means the container building is almost half the price (56%). All the prices for the different parts of the construction are shown in the next figure.

Table 1: Cost Calculation

Cost Centre	Cost	Percentage of total costs
Sea containter	58,000.00 €	12.52%
Transportation	31,537.50 €	6.81%
Site Preparation, Foundation & Sewage	29,420.66 €	6.35%
Construction/Exterior Work	110,106.31 €	23.76%
Techniques (Electricity wiring, santitary piping, etc.)	31,545.74 €	6.81%
Interior (Insulation, Flooring, Painting, etc.)	43,925.92 €	9.48%
Coworks Furniture	6,263.82 €	1.35%
Common Areas Furniture	4,701.93 €	1.01%
Toilets	1,094.88 €	0.24%
Bar/Cafeteria and Kitchen	9,259.24 €	2.00%
Maker Space (Machinery & Furniture)	61,465.87 €	13.26%
Surrounding	10,684.70 €	2.31%
Sallary	64,672.00 €	13.96%
Finishing (Cleaning & sign off)	700.00 €	0.15%
TOTAL COST (all incl.)	**463,378.56 €**	100%
TOTAL COST (without MakerSpace Interior)	**401,912.69 €**	
TOTAL COST (without any Interior)	**381,687.70 €**	

VI. CONCLUSION

As the elaboration of the project shows it is possible to construct an innovative multifunctional building using mainly sea containers in the Catalonian region. But it is also not as simple as it looks like in the beginning. A lot of different aspects must be taken in consideration and have to be respected.

In conclusion a lot of advantages (reduced costs, less construction time, ecological repurposing, innovative design & more) of container buildings stand against a few but serious disadvantages (toxic flooring, insulation, legislation & narrow knowledge). These disadvantages have to be kept in mind when making decisions if building with sea containers or not.

Advantages	Disadvantages
Time saved during construction due to the frame already being in place	Local Regulations around a container building could restrict it
Cost of container building is typically less	Condition of a used container
Modularity and expandability of a container design is typically easier	Limited shape of a container requires modification to make a workable space
Eco-friendly if repurposing containers	Toxic pesticides used on the floor of containers
Available worldwide due to global shipping industry	

Table 2 - Advantages and Disadvantages Summarized

Even though there are some missing parts to finish the project entirely, the project team achieved all of the main goals set out by Neàpolis.

All stakeholders - the team members, the supervisors and Neàpolis are very satisfied with the outcome of the project. The project team hopes that the project will be continued after the EPS 2017 and is fully completed in the near future.

VII. Acknowledgments

The authors would like to thank the company Neàpolis for providing this project and the opportunity to work together. In particular thank you to the supervisors assigned to this project, Félix Ruiz Gorrindo from Neàpolis and Ariadna Llorens Garcia from the Universitat Politècnica de Catalunya.

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