The Impact and Value In the design and production of architectural sculpture elements from bio-wood

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Introduction:

As to the wide scientific development in all fields in the twentieth century, a technologies and materials used more efficiency and less expensive with more better physical and mechanical properties, such as GRC, GRG and GRP. And other materials based on mold casting to produce architectural sculpture elements.

Due to the fine properties of the bio-wood product (WPC), which can add different values to the architectural sculpture units that produced from the bio-wood, it was necessary to discuss this thesis through this research to clarify the importance of the bio-wood in general as a modern alternative and environmentally friendly with multiple benefits than natural wood, here comes the importance of replacing the bio-wood instead of the natural wood, in case of the need to produce an architectural sculpture units of wood and under specific considerations, which will achieve a better impact on all aspects related to the applications of architectural sculpture in general.

Key Words:
Bio-wood - Architectural Sculpture - Design

So the research problem appeared in:

• The need of the architectural sculpture field to solutions of design and alternatives more susceptible to the various damage factors.
• Bio-wood does not contribute to the development of the architectural sculpture field.
The Lack of contributing of the bio-wood in the architectural sculpture field.

The research aims to:

• To reach the considerations when applying innovative solutions in the architectural sculpture field.
• Create design system of bio-wood material for architectural sculpture elements.

The importance of research is:

• Utilizing the unique properties of the bio-wood in architectural sculpture elements.

The research assumes:

• It is possible to reach the design and production considerations of the architectural sculpture elements by studying the bio-wood properties.

Research limits:

• Develop a system for the profile design of bio-wood as a modern alternative to the architectural sculpture elements.

Hypothesis of research:

• The research follows the experimental and analytical method.

The Definition of "Wood Plastic Composite" (WPC)

The bio-wood is a composite product of natural plant fibers, with a mixture of different compounds, mainly PVC, PE, PP as raw material, a basic manufacturing component, and other chemical compounds, which differ from plant to another, Which gives the final wpc product its special properties, which outweigh the properties of natural woods, such as color

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pigments, pest control materials, anti-decay agents, fiber reinforcement materials, fire retardants, etc. In the process of producing bio-wood, a wide range of plant fibers can be used, (Locally) mulch and powder all of natural wood and pulp.

Commercial term:

Bio-wood is commercially known as "WPC" abbreviation, which refers to **W**ood **P**lastic **C**omposite or plastic wood compound as it is there is another terms that refers to the same concept.

Historical development:

Before the 1980s, specifically in 1976, in Japan the first bio-wood product was invented. And was widespread and use on a limited scale due to the incompatibility between plastics and wood industries in general in that period, the first industrial experiment for the production of bio-wood was in the interior design of cars and carried out by the American company Woodstock in 1983.

The Bio-wood, properties and features:

Natural Appearance:

Bio-wood has the same appearance as the natural wood, its texture, its granules and its aroma with its varied color and stability.

Resistance of weathering factors:

The Bio-wood products resists weather factors well and resists water permeability, corrosion and its dimensions do not change.

Insects and pest resistance:

The Bio-wood resists the destructive effect of insects, and is less affected to wet weather conditions and does not degrade like natural wood.

Environmental friendly product:

The main components of the bio-wood are: wood powder or natural wood fibers, plastics and other additives.

Low maintenance:

In contrast to the natural wood, the color tone of the bio-wood is stable and does not require a superficial insulation or color coating.

The Bio-wood, Production Methods:

The Bio-wood is produced by extrusion molding, Injection Molding or Compression Molding (Thermoforming).

The Add-Value Considerations in the Design and Production of Architectural Sculpture Elements of Bio-wood:

A number of considerations must be counted on as general rules when applying and producing elements of architectural sculpture of bio-wood:

Aesthetic Considerations:

1- Color tone:

The bio-wood products could be produced by any available color tone, according to the designer's need and according to the product application to be used. The color tone is added to WPC wood mixture in the form of inorganic pigments during the manufacturing process to become part of the product structure.

2. Textures:

Different types of textures could be added to the bio-wood products, such as adding various wood veneer effects by pressing with the heat through the Embossing Machine, also the appearance of natural wood could be produced by softening and sanding through the sanding machine, also grooves and slitting through the profile design in mold could be added.

3-Functional Considerations:

Cutting, spreading, milling, sanding, punching, assembly, pasting and fixing nails by different means, coloring (after production process) are all could be applied to the bio-wood.

4-Environmental Considerations:

The Bio-wood products are environment friendly materials with enormous better mechanical and physical properties than natural wood, it's resulting from recycling natural wood and plastics, the Bio-wood products are 100% recyclable (the recycling rate depends on the type of the components).

5-Economic Considerations:

In 2016. The global market of the bio-wood products has been estimated at 2,551 million USD. and is expected to reach 6,584 million USD. by the 2023. In general, a WPC wood compound, as a result of their unique composition than natural wood, have significant economic advantages such as reducing energy costs for producers and reduce the negative environmental impact of the final product and achieves energy sustainability.

Architectural Sculpture:

The term "style" or "order" in architecture refers to the building to define its character and to determine its form. The architectural styles of differs through the human history, and the most famous of these models are the western classical architectural styles that originated in the civilizations of ancient Greece and ancient Rome, the Doric, the Ionic, the Corinthian, the Tuscan and Composite orders, respectively.

The Considerations of the design and production of the architectural sculpture elements from the bio-wood:

1. The production of architectural sculpture elements from the bio-wood varies according to size, shape and detail.
2. The architectural sculpture element could be divided into multiple parts, each with a special mold, and possibly by different production method, and then assembled at the installation with a specific mechanism to achieve the flexibility of installation.
3. The installation of The bio-wood architectural sculpture element requires to design of special installation profiles (substructure), and consider to design points of contact between the substructure profile and the sculptural element to ensure the quality of the shape after installation and hide the installation parts and facilitate the installation.

The Applied Study:

Hypothesis: The research assumes a simple facade that needs to be designed and produce its main architectural sculpture elements of bio-wood material.

The System of design and production: after analyzing the façade, a design system must be prepared which consists of upper Cornice inspired from the capital of the Ionic column (the egg and the spear), and then straight half-columns of the same order.

The Design and production of column parts:

The half of the capital is designed to be produced by injection method in the thermal mold because it contains details. In the same way, the half of the base is designed and produced, and then the shaft is designed and produced by extrusion.

The Substructure profile:
A special installation profile shall be designed and produced by extrusion considering that it must be compatible with the all parts of the column, its dimensions and volume, and that profile must contains a fillet that compatible in dimensions with a gutter in the column part, then the substructure profile cut in the production line for standard lengths, then installed on the wall with screws then the column part is installed on it by pressing.

Details of design and production of the main facade cornice:
The design and production of the main facade cornice from the bio-wood is divided in two profiles (a) and (b), the profiles (a) is designed by extruding mold with consideration that the design must contains a fillet compatible in dimensions with a gutter in the column part (b), the profile (b) which contains ornaments is produced by injection method in the thermal mold and fixed by pressure after installing the profile (a) on the wall with screws.

The Research reached the following results:

- The bio-wood is an industrial product consisting of a combination of wood / plant fibers with different polymers and additives.
- The bio-wood products are superior in its properties to natural wood and avoid its defects.
- The bio-wood is a recyclable product.
- The method of production of the bio-wood extrusion method suitable for elements that require different lengths and do not contain ornaments or complex parts while the method of injection molding in the thermal mold fits the elements with details and ornaments.
- The production of an architectural sculpture element may require more than one mold and more than one production method.

Key Recommendations:

- There is a need to expand of the bio-wood industry in Egypt to put it on the global map of the bio-wood market and achieve high economic return and preservation of the environment and the provision of timber to the local market and increase employment opportunities.
- The quest for the production of architectural sculpture elements of bio-wood for the importance of its unique properties.
- More professional and applied studies that linked art to industry and serve society and achieve economic returns must be done in that field.

Research's most important references:

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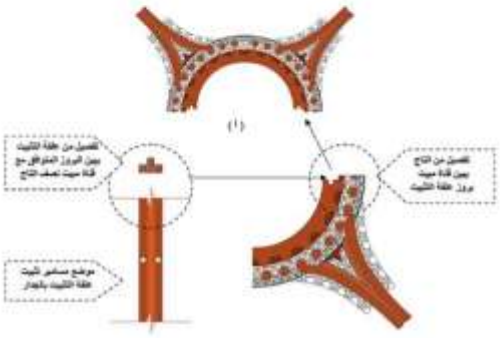
2) **Carus,Michael**:*Global Trends in Wood-Plastic Composites (WPC)*, Asta Eder Composites Consulting, Vienna, Austria, nova-Institut, Hürth, Germany, bioplastics magazine [04/13] Vol. 8.,2013.
3) **Douglas J. Gardner ,Yousoo Han & Lu Wang**:*Wood Plastic Composite Technology*, Article Published online: 4 June 2015.

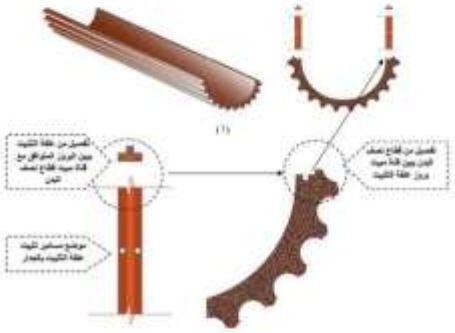
The Research's most important Photos:

WPC Wood Mold InjectionLine

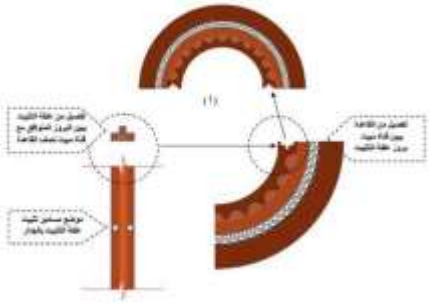
WPC Wood Extrusion Line



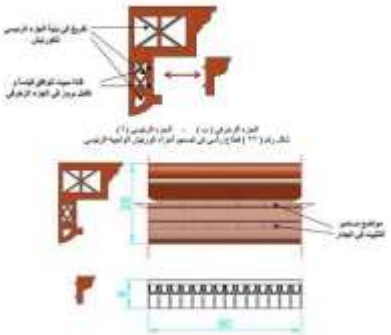
Column Capital Design System (Details)



Column Shaft Design System (Details)



Column Base Design System (Details)



The Main Cornice Design System (Details)

The Facade With the Architectural Sculpture Element from The Bio-Wood (WPC)

The Final WPC Wood Architectural Sculpture Elements