Polyester and Wood Composite (PWC) as Substitutes for Carved Wood Sculptures

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Abstract

Wood is one of the oldest sculptural media, but not many wood sculptures of antiquity have survived because it is not a durable material. Wood sculptures cannot withstand the vagaries of nature without some form of treatment. Those treated and protected from direct weather conditions may still disintegrate significantly after some time. The need to enhance the ways of working with wood for better resistance to weather conditions and other biological attacks is the focus of this study. This paper is the outcome of a studio observation, working with polyester and wood dust as a composite. Termed Poly-wood Composite (PWC), it was used for the production of sculpture. PWC as a material is fluid or paste-like until a polymerization process is triggered. The work process employed the casting technique because of its fluidity. The variation of PWC used in the process of the fieldwork, measurements, process and outcome of the cast, and analysis of the result were documented. It was observed that various textures and effects could be achieved by adjusting the ratio of the composite. The result is believed to be an improvement on the direct use of wood. The research draws attention to new possibilities of working with wood for outdoor sculptures, as well as the provision of alternative uses for industrial wood dust waste as a viable sculptural medium, which may assist in environmental conservation.

Introduction

Wood carving as an art tradition has been on for thousands of years yet few examples of these ancient pieces have survived till date, due to the vagaries of nature and other causes. Outdoor wood sculptures are especially victims of the degradation process triggered by weather conditions. Whereas sculptural materials like marble, plastics, and metal are better suited for outdoor sculptures due to their chemical and physical properties, directly carved wood is intrinsically disadvantaged. The use of a composite of wood and a material resistant to weather conditions may be the way forward for outdoor sculpture, which is the crux of this studio work and report.

The study employed the use of pulverised wood and shavings with polyester resin as its matrix in compounding PWC for cast sculpture. Specifically, it explored the transitional potentials of polyester resin and the fine particles of pulverised wood in creating composite sculpture, working with PWC in its fluid state and allowing it to set into a hard, rigid and compound material.

Conceptual Framework

The conceptual framework for this study is 'Imitation'. Also known as, 'Mimesis' in Greek and 'Imitatio' in Latin, the concept can be traced back to 'Plato's Republic'. In it, Plato argues that art imitates the objects and events of ordinary life (Bloom, 1991). According to Plato, a work of art is a copy of a copy of a Form. He observed that objects in painting look real, and seem to have the resemblance of what they reflect. This observation provided the basis for the concept of Imitation. The artist is viewed in this concept as holding up a mirror to reality (Alperson, 1992). Thus, his artistic creations are seen as nothing more than the reflections in his mirror. The meanings and applications of 'Imitation' has evolved overtime with varying applications and changes according to the context in which it is used (Lindberger, 1985). In contemporary outlook and application, it simply means to copy (1985).

This study adopts the contemporary application of 'Imitation' in a practice-based research environment. It experiments with Polyester and Wood Composites' (PWC) in its attempt to present alternatives, which has the likeness of wood, with an intent for better workability and improved resistance to weather conditions. The impetus to use this concept was derived from the wood castings of James Watson (plate B), where it is used for furniture. Its success proves its possibility for sculpture.

Composites in Materials Technology

A composite material can be defined as a combination of two or more materials that result in better properties than those of the individual components used alone (Campbell, 2010). Usually, the materials used for composites have different properties, which become complimentary when combined. The main advantages of composite materials are their high strength and stiffness, combined with low density, when compared with bulk materials, allowing for a weight reduction in the finished part (Campbell). Most composites are made of just two materials. One of the materials is the matrix or binder that surrounds and binds together fibres or fragments of the other material, which is called the reinforcement (Royal Society of Chemistry [RSC], n.d.). Generally, composites are designed to achieve unique mechanical properties, and superior performance characteristics not possible with any of the component material alone (De Biprasad, Kousik, Palash & Subhankar, 2012). In other words, composite structures have the potential to provide higher performance in applications (Department of Defence Handbook, 2002).

Composites are useful in almost every sphere of human life and development, and are continually evolving as the material needs of industries unfold. Several materials have been experimented with, and used as composites in various industries. Some commonly used composites are: Metal Matrix Composites (MMCs); Polymer Matrix Composites (PMCs); and Ceramic Matrix Composites (CMCs). This study can be classified under Polymer Matrix Composite.

Wood and Wood Composites

Wood sculpture is one of the oldest forms of sculptural practice. In Rich's (1988) observation, wood as an artistic medium have used extensively for almost 5,000 years. The earliest form of wood sculpture is carving. This may be due to the availability of wood in all regions of the world. In Africa, wood is a favourite material for art (Leuzinger, 1976). This can be implied also for other cultures outside Africa where wood was readily available, providing an easy and cheap media for sculpture. A carved wood is interesting to look at. It has the beauty and appeal that is unique to the medium especially when properly finished. Wood sculptures can take many forms. They include carvings, assemblages (plate A), castings (plate B), wood chips and shavings (plate C) mixed media (plate D) and wood encasement (plate E).

Plate A: Wood Assemblage By Larry Simons. Source – www.pinterest.com

Plate B: Cocktail tables, wood casting. By Jameson Winship. Source - https://livinator.com/functional-art-furniture/wood-casting-collection-by-hilla-shamia-design-studio-thisiscolossal-com/

Plate C: Wood chips sculpture
By Sergei Bobkov
Source - www.pinterest.com

Plate D: Continuity in Space
(wood and metal - 22” x 22” x 4”), By ShirleyWagner, 2015. Source - http://shirleywagnerartist.com/

Plate E: Teak Wood encased in acrylic resin. Source - www.pinterest.com)

In chemical terms, wood is best defined as a three-dimensional biopolymer composite composed of an interconnected network of cellulose, hemicelluloses, and lignin with minor amounts of extractives and inorganics (Rowell *et al.,* 2005). Like many natural elements, wood is a composite of some sort. Soft woods can be distinguished from hard woods for instance, by the structure of the network, and the percentages of the constituent elements (Rowell *et al.*). However, wood in its natural state cannot be altered to attain specific properties that are possible with a composite. The integration of plastics with wood as a composite may have been introduced for many reasons, ranging from cost effectiveness, to weight and strength. The low environmental impact of plastics may also have been a serious consideration in the introduction of wood and plastics in a variety of composites (Schwarzkopf & Burnard, 2016). The particle board and medium density fibre-board (MDF) are examples of wood and glue composites used in the furniture industry (Arauco, n.d.).

Polyester Resin

Polyesters, also referred to as Polymers are substances whose molecules consist of a large number of units of a few types: the units themselves, consisting of a number of atoms, are usually referred to as the segments of the polymer (Dholakiya, 2012). Units of polymer (monomers) can synthesize in a polymerization (fusion) process.

Polyesters are one of the most widely used synthetic copolymers for fibres, plastics, composites and for coating applications. The advancements in materials science over the past few decades may have led to a dramatic increase in the use of synthetic polymers by both artists and conservators (Cappitelli & Sorlini, 2008). Polyester resin is an excellent binder. It can act as a bonding element for several materials while retaining its strength. It is used as a bonding agent for composites of silica, marble dust, plaster and other materials. This property makes it suitable for casting in sculpture.

Materials and Methods

The simple random sampling technique (SRST) was employed to sample polyester resin, wood dust and shavings. A 100 grit size sieve was used to sieve the wood dust to the required particle size while a scale was employed to measure the weight. The volume of the polyester resin was measured using a measuring jug. Bowls were using for mixing the composite of wood dust and polyester resin. Sand papers, an angle grinder and rasp file were employed for the surface finish of the PWC casts.

The materials used for the study include wood dust, Sieve (100 grit size), Polyester resin, accelerator and catalyst, Clay, Spatula, Welding machine, Metal rods, Angle grinder, Rasp files, Plaster of Paris, Iron oxide pigments, Motor engine oil for lubrication and Sand Papers.

Procedure

The compounding and exploration with the PWC's were done in this order:

Step 1: Fine and coarse wood dust and shavings (Plate 1), Polyester Resin with its accessories (Plate 2), Iron Oxide Pigments (Plate 3), Weight Scale (Plate 4) for measuring the wood dust, Measurement Jug (Plate 5) for measuring the polyester resin, and a sieve with grit size 100 (Plate 6) for sieving the wood dust were procured for the study. Thereafter, ten composites were compounded as shown in table 1. This involves mixing the items (polyester resin, wood dust and iron oxide) inside the bowl in the proportions indicated in table 1.

Step 2: Four initial casts (plate 5) were made from composites 4, 6, 8 and 10 to ascertain the possible outcome and surface colour. Others casts were made using a combination of composites 1, 5 and 10; and 2, 7 and 9 to see how the composites interact when placed side by side in a single mould as shown in plates 6 and 7. In plate 8, coarse wood dust and shavings as indicated in composite 3 was cast to observe the surface texture. The combination of composites used for plates 5, 6, 7 and 8 is presented in table 2.

Composite No.	**Materials**
1	200gms of fine wood dust + 1 litre of polyester resin.
2	300gms of fine wood dust + 2 litres of polyester resin.
3	300gms of coarse wood dust and shavings + 2 litres of polyester resin.
4	200gms of fine wood dust + 1 litre of polyester resin + 2gms of Red Iron Oxide pigment.
5	300gms of fine wood dust + 2 litres of polyester resin + 2gms of Red Iron Oxide pigment.
6	200gms of fine wood dust + 1 litre of polyester resin + 2gms of Blue Iron Oxide pigment.
7	300gms of fine wood dust + 2 litres of polyester resin + 2gms of Blue Iron Oxide pigment.
8	200gms of fine wood dust + 1 litre of polyester resin + 2gms of

	Yellow Iron Oxide pigment.
9	300gms of fine wood dust + 2 litres of polyester resin + 2gms of Yellow Iron Oxide pigment.
10	200gms of fine wood dust + 1 litre of polyester resin + 2gms of Black Iron Oxide pigment.

Table 1: Details of materials used in the blending of the ten (10) PWCs

Composite No.	**Plate Number**
4	5 (blue)
6	5 (yellow)
8	5 (red)
10	5 (black)
1, 5 & 10	6
2, 7 & 9	7
3	8

Table 2: Selected composites used for the sample casts

Step 3: Following the outcome of step two, two composite were explored further to cast a piece of three-dimensional sculpture following the process below.

– Application of the Composites: The artist worked from an already prepared mould (plate 9). Surface separators (regular motor engine oil) were applied on the inside of the mould using a brush. This prevents the PWC from sticking to the mould during application and separation. Composite No. 2 was applied on the mould (plate 10), followed by Composite No. 6 to delineate the texture and colour (plate 11). This was allowed to set and harden for about two hours.

– Separating the Casts: The cast PWC is separated from the mould (plate 12) by carefully chipping off bits and pieces of the mould to reveal the cast. Parts of the separated casts are joined using the same material.

– Finishing: The finishing of each of the cast was done using abrasives (sand papers) of various grades to grind overflows to reveal the material used (plate 13). No attempts were made at using superficial colourants on the surface of the casts. The intent is to present the final work with an integral rather than a superficial colour. A clean cloth immersed in motor engine oil was used to clean off the surface dust and other residue left from the sanding process to reveal the finished cast (plate 14).

Findings

The outcome of the study show some proof that PWC casting may be a viable alternative for wood carving sculpture. The composites can be modified to reflect several varieties of wood available for use, which is easier and quicker to work with than the conventional method of wood carving.

The outcome may be more resistant to weather elements, and may survive weathering effect better than direct wood because of the composite element. The outcome is also lighter in weight and easier to transport for large scale and environmental sculpture. One of the properties of polyester is its self-extinguishing nature, which is a significant advantage for sculptural purposes.

Conclusion

The following conclusions were reached based on the findings of the study:

That PWC is an effective alternative to wood for outdoor sculpture because it is able to resist insects and environmental conditions. This implies that it can be investigated further for a wider sculptural application. Again, complex sculptural form can be produced using PWC, implying that the rigidity of form and the limitation placed by the nature of natural wood can be avoided by the use of PWC. Also, the use of casting of form is an effective way of working with PWC. This implies that the method of working with PWC is an already known process and will not be difficult to handle.

Finally, that the use of sand paper and the application of engine oil on the surface of the finished sculpture is effective in the finishing of the PWC surface. This implies that the finishing of PWC surface can be done with conventionally known materials and methods of finishing other polyester surfaces.

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Appendix

Plate 1. Wood Dust (fine) Wood Dust (Coarse) Wood Shavings

Plate 2. Polyester Resin, Accelerator, Catalyst and Fibre Mat (from left to right)

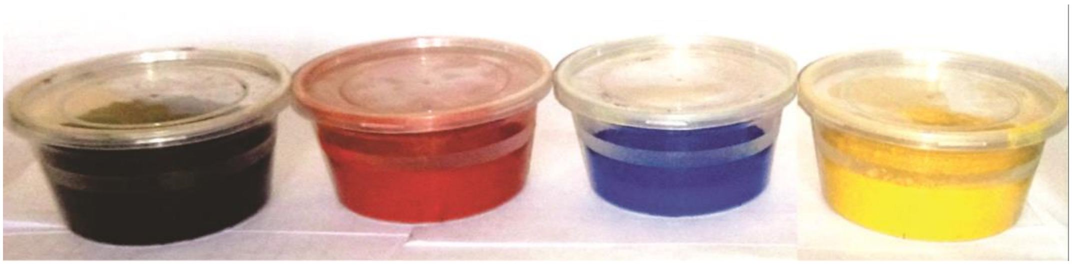

Plate 3: Iron Oxide Pigments used for the research (from left to right)
Black, Red, Blue, and Yellow.

Plate 4: Analogue Weight Scale / Measurement Jug / Stainless Steel Sieve (grit size 100)

Plate 5: Sample Casts produced from Resin, Wood Dust and Iron Oxide Pigments (From left to right) Blue, Yellow, Red and Black

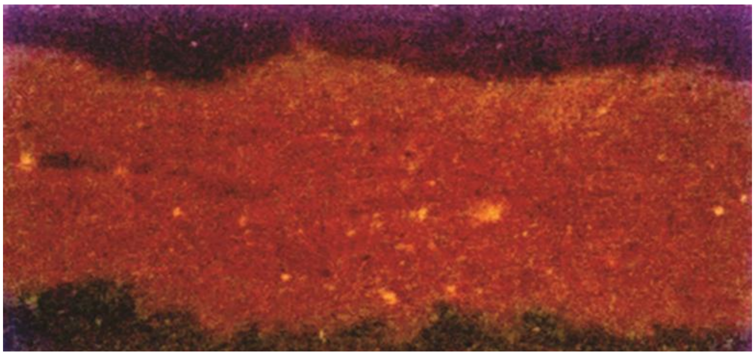

Plate 6: Sample Cast produced using a combination of composites 1, 5 and 10

Plate 7: Sample Cast produced using a combination of composites 2, 7 and 9

Plate 8. Sample Cast produced using composite 3

Plate 9: The ready mould

Plate 10: Application of Comp.

Plate 11: Application of Comp. 6

Plate 12:
Seperated PWC cast

Plate 13. Joining / sanding the cast

Plate 14. The finished cast