ICE as Construction Material Using PYKRETE

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Abstract- It is the application of ice as a construction material and also has some limitation. Ice Is relatively weak material and shows an extreme creep behavior compared to conventional construction material. Mechanical properties of ice are strongly temperature-dependent and untimely protection is necessary even in coldest area. It has been found that the properties of ice and sea ice can be improved by reinforcement by forming these ice composites. The classification of the various methods of ice reinforcement is presented. In spite of many papers about ice composites have vary limited applications. An overview of all existing construction methods, which involve ice structure, is provided in the paper. At the present time only two types of ice composites such as pykrete, ice reinforcement, have been applied successfully in engineering of structure in various projects. Brief information about these projects are presented. The description of the projects or the 'Pykrete Dome' is expanded. The world largest pykrete dome is constructed in Finland. In 2st world war pykrete proposed it as a candidate material as a supersized aircraft carrier. Pykrete features unusual properties, including a relatively slow melting rate due to its low thermal conductivity, as well as a vastly improved strength and toughness compared to ice. These physical properties can make the material comparable to concrete, as long as the material is kept frozen. Pykrete is slightly more difficult to form than concrete, as it expands during the freezing process. However, it can be repaired and maintained using sea water as a raw material. The mixture can be molded into any shape and frozen, and it will be tough and durable, as long as it is kept at or below freezing temperature. Resistance to gradual creep or sagging is improved by lowering the temperature.

Index Terms **-** Ice as construction material, Pykrete, Bunkers for military use, Bullet proof material, Increase melting point, toughness, tensile strength..

I. INTRODUCTION

Pykrete is a frozen composite material, originally made of sawdust or some other form of wood pulp such as paper and ice. This frozen material i.e pykrete as ice block can be used for various construction project in cold region. Like Kashmir, Antarctica, Switzerland, etc. Geoffreypyke managed to convince potential of his proposal in World War 2 he prepared is a candidate material for a supersized aircraft carrier. For British navy pykrete features unusual properties. Vaseline, Pronk [2015] investigated that It is known the application of ice as a building material has some limitations. Ice is a relatively weak material and shows an extreme creep behaviour

compared to conventional building materials. F. Donald Haynes, Charles M. Collins [1992] proposed that Ice

Bridges and ice roads are constructed on rivers, lakes and oceans every winter in cold region around the world. Often, this construction consists of removal of snow from the natural ice cover to allow thickening of the ice sheet by natural growth or flooding of the ice with successive thin layers of water, which freeze and thicken it from the surface. In either case, the thickening of the ice sheet increases its bearing capacity. Arntz, Hermens [2016] presented that Heinz Isler (1926-2009) worked with fabric formwork to design and produce shell-structures made of ice. Isler was known as an innovative and out-of-the-box thinking man. He used gravity in his form finding for funicular and stable forms for shell structures. He started experimenting with physical models around 1957. One of his working methods involved the use of suspended stretched sheets to be frozen in the open air. Every winter he did some experiments by freezing frozen fabric or spraying water over objects like plants, hanging ropes and fine garden netting. Beside the winter experiments with hanging material, Heinz Isler also did some experiments with balloons sprayed with water while it was freezing. This resulted in an ice palace. M. F. Perutz [1946] It was only natural, therefore, that a proposal for the apparently cheap construction of gigantic aircraft carriers, capable of operating land-based aircraft thousands of miles from their base, was seriously considered. In October 1942 Mr. Geoffrey Pyke, the originator of the plan, submitted a memorandum to the Chief of Combined Operations in which he proposed that an iceberg, either natural or artificial, should be hollowed out to shelter aircraft and leveled to provide an adequate runway. It must have a mobility of at least a few knots and be guaranteed against melting, if not indefinitely at least until it had fulfilled its strategic purpose. Mr. Pyke pointed out that all strategic materials such as metals, wood and concrete were already being used to the full for the war effort and that ice, requiring for its manufacture only I per cent. of the energy needed for an equivalent weight of steel, would be ideal as a basic material for the construction of large carriers.

Fig 1: Pykrete material

II. MATERIAL AND METHODOLOGY

The most important parameters have been discussed in this research paper.

A) Material

1) ICE

Ice is water frozen into a solid state. Appear transparent or a more or less opaque bluish – white color and depends on the impurities such as particles of soil or bubbles of air. Ice molecules can exhibit seventeen or more different phases (packing geometries) that depend on temperature and pressure Ice is typically thought of as being brittle at low temperature and deforming at high temperature. Ice behaves like more complicated than this. Ice is characterized as brittle-plastic. When ice subjected to stress brittle fracture and its results even near the melting point temperature. It is the result of the stacked layers of the hexagonal crystal structure. At high temperature these layers dislocate and slip over one another like a stack of cards resulting in deformation. Brittle fracture occurs when load quickly applied because the moving dislocations cannot move fast enough to keep up with the applied load. Rate of deformation decreases at lower temperatures but still occurs when a load is applied over a period of time to a fixed location.

2) SAWDUST

Pykrete, also known as picolite, is a composite material made of approximately 14% sawdust (paper shreds or wood pulp) and 86% water by weight then frozen. It is invented during World War II by Max Perutz. The material was proposed to United Kingdom's Royal Navy, by Geoffrey Pyke, For a candidate material for making a huge, unsinkable aircraft carrier, was proposed to United Kingdom's Royal Navy, by Geoffrey Pyke named Project Habakkuk. Steel and aluminum were in short supply and required for other purposes. Pykrete has some interesting properties, notably its relatively slow melting rate (due to low thermal conductivity), and its vastly improved strength and toughness over pure ice, actually closer to concrete, while still being able to float on water. Pykrete can be easily formed using water and any porous and fibrous material, such as shredded paper or sawdust. Anything that can be molded with this wet pulp can be frozen into a strong and non-brittle solid. Sawdust is the main component of particleboard. Wood dust is in the form of particulate matter, and particulates. Research on wood dust health hazards comes within the field ofoccupational health science, and study of wood dust control comes within the field of indoor air quality engineering.

3) PAPER

Paper is a thin material produced by pressing together moist fibers of cellulose pulp derived from wood, rags or grasses, and drying them into flexible sheets. It is a versatile material which has many uses, including writing, printing, packaging, cleaning, and a number of industrial and construction processes. The pulp papermaking process is said to have been developed in China during the early 2nd century CE, possibly as early as the year 105 CE, by the Han court eunuch CaiLun, although the earliest archaeological fragments of paper derive from the 2nd century BCE in China. The modern pulp and paper industry is global, with China leading its production and the United States right behind it.

4) COCONUT COIR

Coconut husk ash is a industrial waste which is used worldwide as fuel waste material. The combustion yields ashes containing high amounts of unburned matter, silicon and aluminum oxides as main components.

B) Various Mixture Used

Description	Symbol
Water	W
Saw dust	SD
Paper	P
Water +10% Saw dust	W + 10% SD
Water +12% Saw dust	W + 12% SD
Water +14% Saw dust	W + 14% SD
Water+ paper	W + P

Table 1: (Various Mixture Used)

III. OBJECTIVE

- To Increase Melting Point As Compared To Regular Ice Block.
- To Increase Crushing Strength.
- To Increase Compressive Strength.
- To Make This Material Use For Military.
- To Compare The Properties Of Regular Ice Block And Pykrete Ice Block And Paper Pykrete Block.

IV. SCOPE OF WORK

- Will be use to make military bunkers in glaciers.
- Will use to make ice domes and igloos.
- Use for making sustainable decorative material.
- Lining of ship to make it bullet proof.

Fig 2: Pykrete dome

Fig 3: Pykrete Bridge

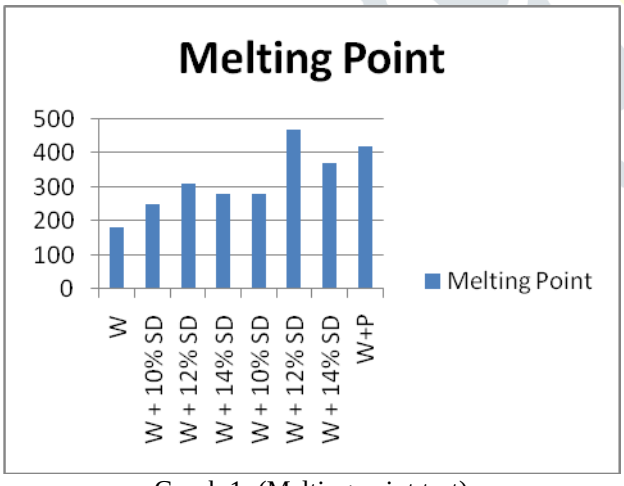
V. TEST PERFORMED

1) Melting Point Test

Observing the melting point of different material at 32 degree calicoes it is observed that the melting point of pykreteamd super pykrete has increased then regular ice block.

Sr No.	Description	Temperature (Degree Celsius)	Time Taken In Mins
1	W	32	180
2	W + 10% SD	32	250
3	W + 12% SD	32	310
4	W + 14% SD	32	280
5	W + 10% SD	32	280
6	W + 12% SD	32	470
7	W + 14% SD	32	370
8	W+P	32	420

Table 2: (Melting point test)



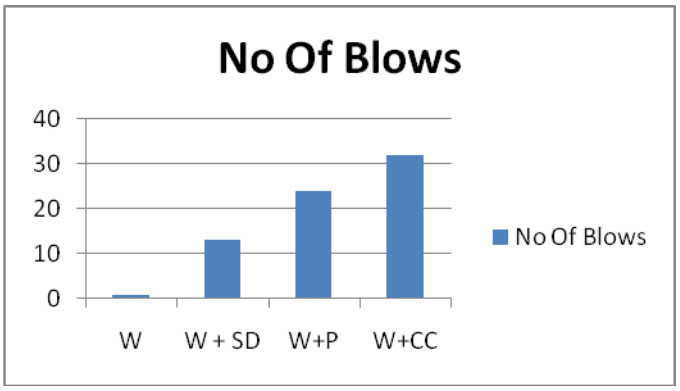
Graph 1: (Melting point test)

2) Impact Value Test

Observing the impact value test of different material it is observed that the impact value super pykrete is greater then pykrete and of pykrete is greater than regular ice block.

Material	No. Of Blows
W	1
W + SD	13
W+P	24
W+CC	32

Table 3: (Impact Value test)



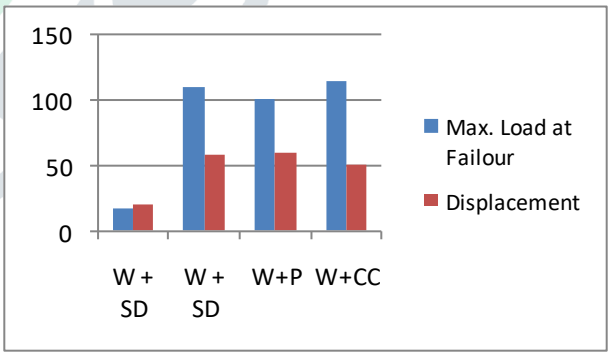
Graph 2: (Impact Value test)

3) Compressive Test

It is usually a laboratory test involving a special machine, a compression tester, to apply controlled compression on test sample. Compressive strength of material is the important parameter and this test is one of the important tests.

Sr no.	Material	Max. Load at Failure	Displacement
1	W	16.50	20.10
2	W + SD	110.45	58.20
3	W+P	100.50	60.00
4	W+CC	115.15	50.20

Table 4: (Compressive test)



Graph 3: (Compressive test)

VI. CONCLUSION

From the present experimental study and literature review it can be concluded that the use of the paper and saw dust in making ice increases it properties then regular ice block. The melting point of pykrte and super pykrete has increased that is about three times the regular ice block. The impact value as well as the compressive strength is increased.

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