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Floating Cities on Ice Platform

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Abstract: Many small countries are in real need of additional sovereign territory. Sometimes, they even build on rotting landfills and install various kinds of expensive artificial islands. The ocean covers 71% of our Earth's surface. Those countries (or persons of wealth) starting the early colonization of the ocean may obtain advantages through additional territory or creating their own independent state. An old idea is building a big ship. The best solution to this problem, however, is the provision of floating cities, islands, and states. The authors propose to employ floating cities, islands, and states as cheap floating platforms created from a natural ice field taken from the Arctic or Antarctic oceans. These platforms protected by air-film (bottom and sides) and a conventional insulating cover (top) and having a cooling system can exist for an almost unlimited period of time. They can be multiplied in number or increased size at any time, float even in warm-water subdivisions of the world-ocean, travel to different countries on continents and islands, serve as artificial airports, harbors and other marine improvements, as well as floating cities and industrial bases for virtually any use.

Author has researched and computed the paramount parameters of these floating ice platforms, other methods of building such floating territory, compare them and show that the suggested method of realization is the least costly and most efficient means for sustainable ocean colonization by mobile humans.

Keywords: Floating cities, ice floating platform, ocean colonization.

INTRODUCTION

Short Information About Oceans, History Large Ship, and Ice Fields

An *ocean* is a major body of saline water, and a principal component of our planet's remarkable hydrosphere. Approximately 71% of the Earth's surface (an area of 361 million square kilometers) is covered by ocean, a continuous body of seawater that is customarily divided into several principal named oceans and smaller named seas. More than half of this area is deeper than 3,000 meters. Average oceanic salinity is around 35 parts per thousand (ppt) (3.5%), and nearly all seawater has a salinity in the range of 31 to 38 ppt. Interestingly, the place furthest from the world-ocean—that is, the official "pole of inaccessibility" is in Asia (46^0 17' North latitude by 86^0 40' East longitude), according to Daniel Garcia-Castellanos and Umberto Lombardo's "Poles of Inaccessibility: A calculation algorithm for the remotest places on Earth", SCOTTISH GEOGRAPHICAL JOURNAL 123: 227-233 (September 2007).

The volume of Earth's ocean is approximately 1.3 billion cubic kilometers, and its average depth is 3,790 meters. The vast volume of the deep ocean (anything below 200 m) covers about 66% of our Earth's surface.

The total mass of the planetary hydrosphere is about 1.4×10^{21} kilograms, which is about 0.023% of the Earth's total mass. Less than 2% is freshwater, the rest is saltwater, mostly in the ocean.

Though generally recognized as several 'separate' oceans, these waters comprise one global, interconnected body of salt water often referred to as the "world-ocean" or "global ocean". That includes: Pacific Ocean, the Atlantic Ocean, the Indian Ocean, the Southern Ocean, and the Arctic Ocean.

Ocean colonization is the theory and practice of permanent human settlement of oceans. Such settlements may float on the surface of the water, or be secured to the ocean floor, or exist in an intermediate position. "Marine city" is defined at length at http://parole.aporee.org and the history of such facilities is briefly outlined in "Prototype cities in the sea", authored by Sandra Kaji-o'grady and Peter Raisbeck, for THE JOURNAL OF ARCHITECTURE 10: 443-461 (September 2005).

One primary advantage of ocean colonization is the expansion of livable area. Additionally, it might offer various other possible benefits such as expanded resource access, novel forms of governance (for instance mini-nations), and new recreational activities for athletic humans.

Many lessons learned from ocean colonization will likely prove applicable to near-term future outer space and other-planet colonization efforts. The ocean may prove simpler to colonize than interplanetary space and thus occur first, providing a proving ground for the latter. In particular, the issue of legal sovereignty may bear many similarities between ocean and outer space colonization with space station settlements; adjustments to social life under harsher extra-terrestrail circumstances would apply similarly to the world-ocean and to outer space; and many technologies may have uses in both environments (Figs. **1-3**).

Economy of world-ocean. Central to any practical attempt at ocean colonization will be the underlying global and

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engineer's requirements of "economic feasibility" but the downside is a severe reduction in top speed, making the ship useless for any existing requirements. For example, it would be too slow to be a cruise ship or a cargo ship.

But what if this enormous barge was assigned a voyage that required slowly cruising around the world, closely following the shoreline, and completing one circum-navigation approximately every three years? If the designers then incorporated the following amenities into this big barge, what would result?

- 18,000 living units, with prices ranging from $180,000 to $2.5 million, including a small number of premium suites currently priced at $44 million. 3,000 commercial units in a similar price range
- 2,400 time-share units
- 10,000 hotel units
- A World Class Casino
- A ferryboat transportation system that provides departures every 15 minutes, 24 hours a day, to 3 or more local cities giving ship residents access to the local neighborhood and up to 30,000 land-based residents a chance to spend a day on the ship.
- A World-Class Medical Facility practicing Western and Eastern medical doctoring as well as preventive and anti-aging medicine.
- A School System that gives the students a chance to take a field trip into a different country each week for academic purposes or to compete with local schools in numerous sporting events. For example; The Freedom Ship High School Soccer team plays a Paris High School team this week at home and an Italian team next week in Italy, while the Freedom Ship High School Band presents a New Orleans Jazz musical at a concert hall in London in the UK.
- An International Trade Center that gives on-board companies and shops the opportunity to show and sell their products in a different Country each week.
- More than 41 ha of outdoor Park, Recreation, Exercise and Community space for the enjoyment of residents and visitors.

Project Habakkuk or *Habbakuk* (spelling varies) was a World War II-hatched plan by the British to construct an aircraft carrier out of Pykrete (a 14% mixture of wood pulp and freshwater ice), for use against German U-boats in the mid-Atlantic, which was out of range of protective Allied land-based airplanes.

The *Habakkuk*, as proposed to Winston Churchill (1874-1965) by Lord Mountbatten (1900-1979) and Geoffrey Pyke (1893-1948) in December 1942, was to be approximately 610 m long and 91 m wide, with a deck-to-keel depth of 61 m, and bulkhead walls 12 m thick. It was intended to have a draft of 150 feet, and a displacement of 2,000,000 tons or more, to be constructed in timber and freshwater-rich wartime Canada from 280,000 blocks of ice.

The ice *Habakkuk* itself was never begun but experiments were conducted in the field.

Arctic and Antarctic (Southern) oceans. The ice fields of these oceans will be used for getting float platforms.

The amount of sea ice around the poles in winter varies from the Antarctic with 18,000,000 km² to the Arctic with 15,000,000 km². The amount melted each summer is affected by the different environments: the cold Antarctic pole is over land, which is bordered by sea ice in the freely-circulating Southern Ocean.

The Arctic Ocean occupies a roughly circular basin and covers an area of about 14,056,000 km². The situation in the Arctic is very different from Antactic sea (a polar sea surrounded by land, as opposed to a polar continent surrounded by sea) and the seasonal variation much less, consequently much Arctic sea ice is multi-year ice, and thicker: up to 3–4 meters thick over large areas, with ridges up to 35 meters thick. An *ice floe* is a floating chunk of sea ice that is less than 10 kilometers in its greatest dimension. Wider chunks of ice are called *ice fields*.

The North Pole is significantly warmer than the South Pole because it lies at sea level in the middle of an ocean (which acts as a reservoir of heat), rather than at altitude in a continental land mass. Winter (January) temperatures at the North Pole can range from about −43 °C to −26 °C, perhaps averaging around −34 °C. Summer temperatures (June, July and August) average around the freezing point (0 °C). In midsummer of South pole, as the sun reaches its maximum elevation of about 23.5 degrees, temperatures at the South Pole average around −25 °C. As the six-month 'day' wears on and the sun gets lower, temperatures drop as well, with temperatures around sunset (late March) and sunrise (late September) being about −45 °C. In winter, the temperature remains steady at around −65 °C. The highest temperature ever recorded at the Amundsen-Scott South Pole Station is −13.6 °C, and the lowest is −82.8 °C. However, this is by no means the absolute lowest recorded anywhere in the Earth, that being −89.6 °C at Antarctica's Vostok Station on July 21, 1983.

DESCRIPTIONS AND INNOVATIONS

The macro-engineering concept is to efficiently use a cheap floating platform taken from the ice fields in Arctic and Antarctica's Southern Ocean for the floating cities, island, and states. These cheap platforms protected by air-film (bottom and sides) and conventional insulating cover (top) and having cooling systems to deal with any leak-through heating can sustain the platform for an unlimited time. They can be increased in number or size at anytime, floated in warm oceans, travel to different continents and countries, serve as artificial airports, harbors and other marine improvements, as well as floating cities and industrial bases for virtually any use.

One possible means of construction is as follows: A scouting aircraft (helicopter) confirms a satellite-surveyed ice field as suitable and delivers to it a small tractor (Fig. **6**) with extensible wire–saw. The tractor saws up the ice platform to hew there from a platform of a specified size (including allowance for melting before insulation for example,

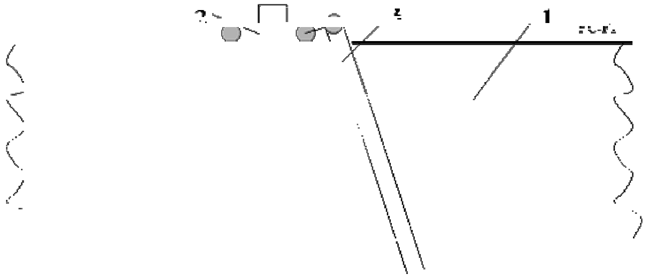

Fig. (6). Cutting of floating platform from ice field. *Notations*: **1** – ice field in arctic (Antarctic) ocean; **2** – small tractor with band-saw or slicing wiresaw; **3** – mechanical band saw or slicing wiresaw.

500×500×10 m) (Fig. **7a**) and an ice-breaker ship tows this platform to open water. Here the platform is equipped with air-film covers, protected by from warm water on all sides. Platform is towed to a place where it will be provided for with final protection and other improvements; a suitable location for building the city or other floating improvement that it will come. One method of adding thermal protection of the ice is the following: The double film is submerged lower than the bottom of platform, moved under the platform (or the platform is moved over film) and filled with air. The air increases the lift force of platform and protects the bottom, sides and top of the platform from contact with warm water and air (Fig. **7b**, pointer 3). Simultaneously, the coolant fluid (it may be chilled air) flows through the cooling tubes 4 (Fig. **7b**) and keeps the ice at lower than melting, or indeed softening, point.

The top side of the platform may be covered with conventional heat protection and insulation means on top of which construction elements may be added (film, ground, asphalt, concrete plates, houses, buildings, gardens, airdrome runways, and so on).

The other method allows us to custom-produce ice of any thickness and composition, including ices of low density (high lift force). Thin plastic tubes are located under the ice-bottom to be (which may be isolated from circulation by a film barrier) and cold air (in the Polar Regions, or in winter, simple outdoor air) is blown through them. One freezes the water and produces an ice platform. The ice has a lower density and a high lift force (load capability) because the ice has internal channels (tubes) filled by air. We may evade spending energy for it in cold countries or in winter. The arctic (Antarctic) winter air has temperature of -40 to about -50°C. In the Arctic Ocean, seawater is useful as a heat source (having 0°C) which can heat the outer air up to -3-5°C, turning an the air turbine, the turbine then turning the pump air ventilator. The corresponding estimation is in theoretical section. We can get the ice density of γ = 500 kg/m^3 having load capability of 500 kg/m^3 (the conventional ice has the lift force 80 kg/m^3). For decreasing the ice density, macro-engineers may use cork filler material or other such available low-density matrix fillers.

In second method, we can produce platform from *Pykrete* (also known as *picolite*). That is a composite material made of approximately 14% sawdust (or, less frequently, wood pulp) and 86% water by weight then frozen, invented by Max Perutz. 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 is slightly harder to shape and form than concrete, as it expands while freezing, but can be repaired and maintained from the sea's most abundant raw material.

The pykrete properties may be significantly improved by employing the cheapest available strong artificial fibers (such as basalt fibers, class or mineral wool, and others).

The composites made by mixing cork granules and cement have low thermal conductivity, low density and good energy absorption. Some of the property ranges of the composites are density (400–1500 kg/m^3), compressive strength (1–26 MPa) and flexural strength (0.5–4.0 MPa).

The platform of floating city has protection (walls) 6 (Fig. **8**) against stormy ocean waves, joints 7 (Fig. **8b**) which decrease the platform stress in storms, propellers for maneuvering and moving. The platform may also have an over it a filmic AD-Dome (Fig. **8b**, pointer 9) such as is offered in [2. 11]. This dome creates a warm constant "deck" temperature, protects the floating city from strong winds and storms.

SUMMARY OF INNOVATIONS

1. Using a big natural ice platform for building large floating cities, islands and states.
2. Technology for getting these platforms from the natural ice fields (saw up).
3. Technology (artificial freezing without spending energy) for getting the artificial high lift force ice platform of any thickness (that means any load capability) from low density ice.
4. Composite material where ice is a matrix (base) and cork (or other material) as stuff.
5. Heat protection for natural ice fields by air film balloons.
6. Building the platforms from separated ice segments and connection them by joints.
7. It is offered the protection of the suggested platform by special double walls 6 (Fig. **8**) from ocean storm waves.
8. Protection of the suggested platform by the special transparent film 9 (dome), (Fig. **8b**) and creating a constant temperature in the floating city, plus protection from strong winds and storm.

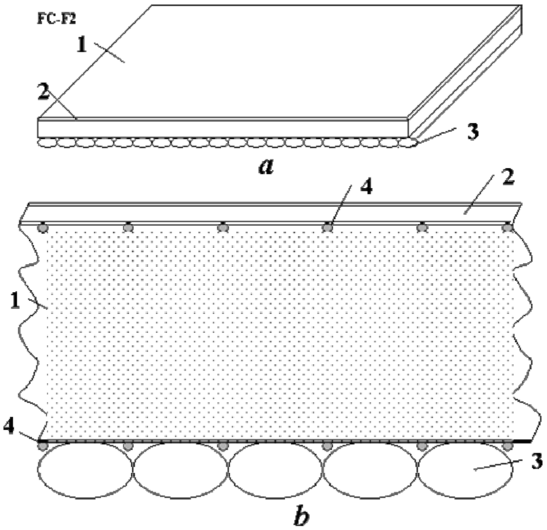

Fig. 7. Ice platform prepared for floating city. (**a**) Common view, (**b**) Cross-section of platform. *Notations*: 1 – ice; 2 – top heat protection; 3 – low (bottom) heat protection and floating support (inflatable air balloon); 4 – cooling tubes.

Table 1. [12], p.331. Heat Transfer Data

Material	Density, kg/m^3	Thermal Conductivity, λ, W/m· °C	Heat Capacity, kJ/kg. °C
Concrete	2300	1.279	1.13
Baked brick	1800	0.758	0.879
Ice	920	2.25	2.26
Snow	560	0.465	2.09
Glass	2500	0.74	0.67
Steel	7900	445	0.461
Air	1.225	0.0244	1

THEORY OF ESTIMATION AND COMPUTATION

1. Material: The important values and characteristics of candidate materials for floating platforms are their price, lift force (in water), life time, strength, chemical stability in water, reliability, and so on. The specific water lift force of matter (L_f) is difference between density of water (d_w) and density of platform matter (d_m).

$$L_f = d_w - d_m, \tag{1}$$

where all value are in kg/m^3.

Air is the cheapest material, having the most lift force. However it needs a strong cover (in vessels, balloons) which can significantly increase the cost of the installation. The other lack (disadvantage) of using air is loss of lift force in case of damage to its container.

Ice is a cheap substance. It may be mined, rather than of necessity built, into a ready-made floating platform. But it has a small buoyancy force and low melting temperature, which are lower then the temperature of ocean seawater. We can decrease these disadvantages by using special air balloons under the platform, heat protection materials and barriers and a refreezing system. If we initially produce the platform by custom freezing, we can produce the custom-tailored, strong light ice having a high lift (buoyancy) force.

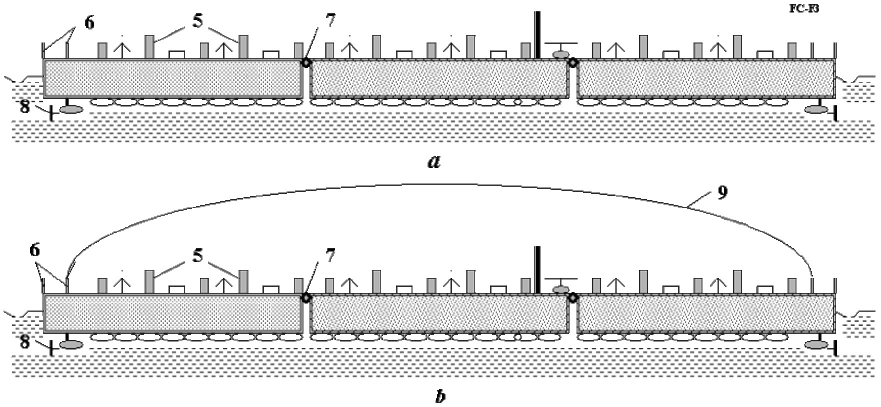

Fig. (8). Floating city on ice platform: (**a**) Open floating city, (**b**) Floating city closed by film. *Notations*: 5 – city; 6 – protection from ocean waves in storm; 7 – turning connection (joint) of separated ice platform; 8 – fully-rotation azimuth thruster propellers; 9 – film dome.

The other systems are metal or concrete constructions, filled by rock, foam plastic, aerocrete and so on. Their disadvantages are well known: A high cost and a huge procurement necessary for big installations (platforms).

Some materials and their properties are presented in Tables **1** and **2**.

As the reader will see, the air layer is the best heat insulator. We do not limit its thickness δ.

2. Computation of Heat Protection: We use in our project the cheap natural ice platform variant.

The heat loss flow per 1 m^2 by convection and heat conduction is (see [12]):

$$q = k(t_1 - t_2), \quad \text{where} \quad k = \frac{1}{1/\alpha_1 + \sum_i \delta_i/\lambda_i + 1/\alpha_2}, \tag{2}$$

where k is heat transfer coefficient, W/m$^{2}\cdot$K; $t_{1,2}$ are temperatures of the inter and outer multi-layers of the heat insulators,

Table 2. [12], p. 465. Emittance, ε (Emissivity)

Material	Temperature, T °C	Emittance, ε
Bright Aluminum	**50 ÷ 500 °C**	**0.04 - 0.06**
Bright copper	20 ÷ 350 °C	0.02
Steel	50 °C	0.56
Asbestos board	20 °C	0.96
Glass	20 ÷ 100 °C	0.91 - 0.94
Baked brick	20 °C	0.88 - 0.93
Tree	20 °C	0.8 - 0.9
Black vanish	40 ÷ 100 °C	0.96 – 0.98
Tin	20 °C	0.28

°C; $\alpha_{1,2}$ are convention coefficients of the inter and outer multi-layers of heat insulators ($\alpha = 30 \div 100$), W/m^{2}K; δ_i are thickness of insulator layers; λ_i are coefficients of heat transfer of insulator layers (see Table **1** Attn.), m. The magnitudes of α are:

1) From water to metal wall $\alpha = 5000$ W/m^{2}K.
2) From gas to wall $\alpha = 100$ W/m^{2}K.
3) From heat isolator to air $\alpha = 10$ W/m^{2}K.

For example, let us estimate the heat flow from water to the bottom surface of ice platform protected by the small air balloons.

Assume the average thickness of air balloons is $\delta = 1$ m, the temperature of seawater at depth 10 m is 10°C. The heat flow from seawater to ice platform is

$$k \approx \frac{\lambda}{\delta} = \frac{0.0244}{1} = 0.0244\ \frac{\mathrm{W}}{\mathrm{m^2K}};$$

$$q = k(t_2 - t_1) = 0.0244(10-0) = 0.244\ \frac{\mathrm{W}}{\mathrm{m^2K}}$$

That ($0.244\ \frac{\mathrm{W}}{\mathrm{m^2K}}$) is a small value. This heat must be carried away (deleted) by cooling liquids or other fluids (i.e., cooled and force-driven gases or mixtures of gases such as Earth's air circulated especially for that purpose).

Estimate now the heat flow from outside air to the platform's top surface protected by 0.1 m wood gasket and 0.4 m humid soil. The air temperature is 25°C.

$$k \approx \frac{1}{\delta_1/\lambda_1 + \delta_2/\lambda_2} = \frac{1}{0.1/0.2 + 0.4/0.657} = 0.9,$$

$$q = k(t_2 - t_1) = 0.9 \cdot 25 = 22.5\ \frac{\mathrm{W}}{\mathrm{m^2K}}$$

If we change the wooden gasket for an asbestos plate of exactly the same thickness, then the heat flow decreases to q = 17 W/m^{2}K. Places where are situated houses, buildings and other structured constructions having concrete bases will have $q = 10 - 15$ W/m^{2}K. Using the wools or air protection significantly decreases the head loss through top platform surface. The average heat loss of top platform surface is about 15 W/m^{2}K. If we insert the air black gap 15 – 25 cm, this heat loss decreases to 1 – 2 W/m^{2}K. The side part of the floating platform may be protected the same as the bottom surface.

3. Freezing of Platform: The freezing of 1 kg water requires energy

$$Q = c_p(t_2 - t_1) + \lambda_p \approx \lambda_p\,, \qquad (3)$$

where $c_p = 4.19$ kJ/kg·C is energy needed for cooling water in 1°C; $\lambda_p = 334$ kJ/kg is energy needed for freezing 1 kg of water.

The energy needed for freezing may be received from the cold arctic air. That computed by equation

$$Q = c_{p,a}(t_2 - t_1)\,, \qquad (4)$$

Here $c_{p,a} = 1$ kJ/kg·K for air.

The computation shows for freezing 1 kg water we need about 22 kg air in temperature -20 C. Every 1 kg air heated from -20 C to -5 C in ocean water absorbs about 15 kJ/kg in heat energy.

4. Other Heat Flows: The radiation heat flow per 1 m^{2}s of the service area computed by equations (5):

$$q = C_r\left[\left(\frac{T_1}{100}\right)^4 - \left(\frac{T_2}{100}\right)^4\right], \qquad (5)$$

$$\text{where}\quad C_r = \frac{c_s}{1/\varepsilon_1 + 1/\varepsilon_2 - 1}, \quad c_s = 5.67\ \left[\frac{W}{m^2K^4}\right]$$

where C_r is general radiation coefficient, ε are black body rate (Emittance) of plates; T is temperatures of plates, °K.

The radiation flow across a set of the heat reflector plates is computed by equation

$$q = 0.5\frac{C_r'}{C_r}q_r\,, \qquad (6)$$

where C_r' is computed by equation (5) between plate and reflector.

Table 3. Average Cost of Material (2005-2007)

Material	Tensile Stress, MPa	Density, g/cm^3	Cost USD $/kg
Fibers:			
Glass	3500	2.45	0.7
Kevlar 49, 29	2800	1.47	4.5
PBO Zylon AS	5800	1.54	15
PBO Zylon HM	5800	1.56	15
Boron	3500	2.45	54
SIC	3395	3.2	75
Saffil (5% SiO_2+Al_2O_3)	1500	3.3	2.5
Matrices:			
Polyester	35	1,38	2
Polyvinyl	65	1.5	3
Aluminum	74-550	2.71	2
Titanum	238-1500	4.51	18
Borosilicate glass	90	2.23	0.5
Plastic	40-200	1.5-3	2 - 6
Materials:			
Steel	500 - 2500	7.9	0.7 - 1
Concrete	-	2.5	0.05
Cement (2000)	-	2.5	0.06-0.07
Melted Basalt	35	2.93	0.005

As the reader sees, the air layer is the best heat insulator. We do not limit its thickness δ.

The thickness of the dome envelope, its sheltering shell of film, is computed by formulas (from equation for tensile strength):

$$\delta_1 = \frac{Rp}{2\sigma}, \quad \delta_2 = \frac{Rp}{\sigma}, \tag{7}$$

where δ_1 is the film thickness for a spherical dome, m; δ_2 is the film thickness for a cylindrical dome, m; R is radius of dome, m; p is additional pressure into the dome, N/m^2; σ is safety tensile stress of film, N/m^2.

For example, compute the film thickness for dome having radius R = 100 m, additional air pressure p = 0.01 atm (p = 1000 N/m^2), safety tensile stress σ = 50 kg/mm^2 (σ = 5×10^8 N/m^2), cylindrical dome.

$$\delta = \frac{100\times 1000}{5\times 10^8} = 0.0002\, m = 0.2\, mm \tag{8}$$

The dynamic pressure from wind is

$$p_w = \frac{\rho V^2}{2}, \tag{9}$$

where ρ = 1.225 kg/m^3 is air density; V is wind speed, m/s.

For example, a storm wind with speed V = 20 m/s (72 km/h), standard air density is ρ = 1.225 kg/m^3. Then dynamic pressure is p_w = 245 N/m^2. That is four time less than internal pressure p = 1000 N/m^2. When the need arises, sometimes the internal pressure can be voluntarily decreased, bled off.

5. Properties and Cost of Material: The cost some material are presented in Table **3** (2005-2007). Properties are in Table **4**. Some difference in the tensile stress and density are result the difference sources, models and trademarks.

MACRO-PROJECTS

The estimation of different variants of floating platforms is presented in Table **5**.

The estimation cost of 1 m^2 of the platform in the contemplated “Freedom Ship” (the cost of cabins are included) is \$33,100/m^2 (2002). At the present time (2008) this cost has increased by a factor of two times more. Average cost of 1 m^2 of apartment in many cities is about \$1000/m^2 (USD).

DISCUSSION

Advantages and disadvantages of the speculated method.

Table 4. Material Properties

Material	Tensile Strength	Density g/cm^3		Tensile Strength	Density g/cm^3
Whiskers	kg/mm^2		**Fibers**	kg/mm^2	
AlB_{12}	2650	2.6	QC-8805	620	1.95
B	2500	2.3	TM9	600	1.79
B_4C	2800	2.5	Allien 1	580	1.56
TiB_2	3370	4.5	Allien 2	300	0.97
SiC	1380-4140	3.22	Kevlar or Twaron	362	1.44
Material			Dynecta or Spectra	230-350	0.97
Steel prestressing strands	186	7.8	Vectran	283-334	0.97
Steel Piano wire	220-248		E-Glass	347	2.57
Steel A514	76	7.8	S-Glass	471	2.48
Aluminum alloy	45.5	2.7	Basalt fiber	484	2.7
Titanium alloy	90	4.51	Carbon fiber	565	1,75
Polypropylene	2-8	0.91	Carbon nanotubes	6200	1.34

Source: Howatsom A.N., Engineering Tables and Data, p.41.

Table 5. Estimation of Different Variants of Floating Platforms

#	Type of Floating Platform	Height, m	Cost,* \$/m^2	Life Time, Year	Load Capacity, ton/m^2	Main-tains, \$/m^{2}year	Draught m	Mass of Platform, ton/m^2	Cooling Energy, W/m^2
1	Air-steel cylinder with steel walls	10 20	100 200	30-50	7 17	1 2	7.6 18.2	0.6 1.2	0
2	Steel cubs with net walls and air balloons	10 20	150 300	40-60	7 17	2 4	7.5 18	0.5 1	0
3	Steel cubs with net walls and foam plastic filler	10 20	150 130	40-60	7 17	1 2	7.6 18.2	0.6 1.2	0
4	Concrete empty cub with walls 0.1m, 100 \$/ton	5 10	400 800	100-200	2.4 6	0.5 1	4 9.2	1.6 3.2	0
5	Aero Crete γ = 500 kg/m^3	10 20	220 440	100-200	4 7	1 2	9 17	6 17	0
6	Ice and 1 m air heat protection in bottom	5 10	2 3	∞	1 2	4 6	5 10	4 8	2 W/m^2 2 W/m^2
7	Air ice, γ = 500 kg/m^3 and 1 m air heat protect.	20 30	4 6	∞	9 15	5 10	19 30	10 15	2 W/m^2 2 W/m^2

* Only material.

ADVANTAGES

1. The offered method is cheapest by tens-to-hundreds of times relative to conventional shipbuilding operations, and beats nearly all but the remotest and most valueless land for cheapness as a construction substrate—yet the product may be relocated to within meters from some of the most valuable real estate on Earth—i.e., docked in Tokyo's Bay (Japan) or near the New York City island borough of Manhattan (USA) or close to China's economically booming Shanghai.
2. Unlimited area enlargement of usable region is technically possible.

3. Easy increase of load capacity by additional freezing of new platform bottom area; and ease of restoring a damage sector.
4. High facility security attainable at a reasonable monetary cost.
5. Unlimited physical life-time. Well, at least not yet undetermined!

DISADVANTAGES

1. Need for a permanent but small energy expenditure (in warm climates) for maintaining the ice at freezing temperatures.

RESULTS

It is a promising new method for obtaining a cheap ice platform suitable for many profitable engineering purposes, and for colonization the World Ocean. Reader finds a closed topic in [1-14].

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