

Phoenicis

The city of Phoenicis, located in Indonesia, has been rebuilt following a devastating natural disaster to create affordable, green, sustainable and flexible housing for the disadvantaged citizens who were rendered homeless.

Housing complexes are arranged around the periphery of the city center allowing easy access, through public transportation, to services and amenities offered by the city. A common area in the center of the city promotes community integration and provides a gathering space for citizens to share experiences. Dwellings are arranged in groupings of four surrounding a common green space, providing a micro-community to mirror the city at large. Each house is made of wedge-shaped modules that are arranged in a circular pattern to form a cylinder. Each module represents one room (bedroom, kitchen, etc.) which can be removed and rearranged according to the needs of the occupants, or in case of damage. Modules fit on top of each other with a system of interlocking mortise and tenon joints and have a lifespan of up to 150 years.

Each house begins with two cylinders, one on top of the other, with a staircase circling the outside of the house. Depending on the needs of the occupants, more floors may be added (the maximum is four, because of regional earthquake hazard), and additional cylinders joined laterally. Individual modules vary in size depending on the purpose. For example, a bathroom wedge will be smaller than a living room wedge. To allow for further flexibility, the module walls are made of soundproof rice paper, like a Japanese Shoji screen, and slide to form a wall or open space.

Families are the target demographic. Elderly or mobility challenged citizens are given cylinders on the ground floor. Robots are available for simple cleaning tasks. Central computers monitor appliance energy and water usage.

Each roof platform contains a garden. The gardens provide thermal insulation for the house as well as taking in CO₂ emissions and turning them into O₂. The green roof system saves up to 75% of the energy used to heat or cool the buildings. Platforms are easily removed and replaced in the event of a house being expanded vertically.

The houses are constructed with curtain walls of cellulose nanocrystal (CNC) reinforced bioplastic, and bamboo skeletons. CNC is extracted from plant material which contains a minimum of 25% cellulose (40-50% for trees). Adding CNC to plastics makes them 3,000 times stronger, creating a strong, lightweight material that will degrade in a landfill. These bioplastics are used in the outer walls of the house, as well as between the floor and the ceiling. The houses employ hydro-wall technology enabling the structure to maintain an even temperature at all times. A rubber bladder within the hydro-wall contains water that absorbs the sun's heat during the day and warms the house with the captured heat at night.

Bamboo is also used on the outside staircases, as well as paneling for floors and walls. Bamboo is easy to grow, matures quickly (3-5 years, as opposed to 40-60 years for oak), is 100% biodegradable, and is a material to which the city's inhabitants are accustomed.

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Similarly, rice paper is a biodegradable and sustainable product that can be used for walls and as floor mats. Rice, one of Indonesia's primary crops, is a familiar and local product.

Traditional Indonesian houses use wooden pegs instead of nails in their construction, and the Phoenicis houses use the same technique. Pegs are preferred to nails because they do not corrode and they swell to the correct shape after a couple of rainstorms. They, like the rest of the house, are 100% biodegradable. The utility infrastructure adapts to the cylindrical pattern of the dwelling. At the center of each house, a network of pipes for water, electricity and human waste passes through the floors. A central computer controls the system and can be accessed through a touch screen display pad located in this central column. Although each cylinder is self-contained, all dwellings are connected so that smart appliances within each home can determine the appropriate amount of water/energy being produced or consumed and can buy or sell water/energy to or from other cylinders in the complex.

Electricity for each complex is generated from solar panels made of photovoltaic paint sprayed on walls and shutters (shutters continuously rotate to present the optimum angle to the sun). The city center has space dedicated to algae-based biofuels which feed into the city's energy grid and help to recycle carbon and produce clean energy. Additional electricity is provided by microbial fuel cell (MFC) batteries and a windmill located next to each housing complex. As a back-up source of power, the city uses the magnetic trains' nuclear power modules, balancing power needs with transportation requirements. WiTricity is used to eliminate the need for wires in the house.

Water is gathered from gutters that encircle the houses, as well as in receptacles on the roof. Water is purified using a series of screen filters, UV light and charcoal filters. Grey water (used water) is used to flush toilets, water plants and for other tasks not requiring 100% clean water. Organic waste is stored in a vat under the house where it is decomposed by bacteria into fertilizer (which is then used on roof gardens). Additional water is extracted from air moisture using a water mill.

Rebuilding a city extends beyond the original construction goals. Maintenance processes must also be built into the reconstruction plan. The municipal engineering team, with its keen understanding of both construction and sustainment, is vital to the long-term health of Phoenicis. For example:

The Water Sanitation Redevelopment Engineer oversees reconstruction and continuity of all water and sanitation resources and infrastructure for the city: advises on design, implementation, and maintenance of clean-water supply systems—including source development, treatment, storage, and distribution; advises on design, implementation, and maintenance of wastewater systems—including collection, treatment, and reuse; advises on long-term ground-water reclamation; and insures compliance with all health standards and environmental guidelines.

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