“Trabocchi”: a Sustainable Technology for Marine Environment

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Summary
Studies about typical places and constructions, allow grasping appropriate suggestions for particular environmental and social situations. It this research program, from the analysis of trabocchi - characteristic constructions for fishing spread in the Adriatic seaboard of Abruzzo (Italy), in which it is optimized the relationship between pile work structures and the dynamic sea stresses – we aim to define indications for sustainable seaside resorts aware of the environmental problems. The trabocchi are outcomes of choices related to the local resources and the material culture, the result of shapes, structures and materials use optimization respect to the specific climatic and technical conditions; they represent also a right reference for building and maintenance processes organization. The architecture of "site" analysis takes on a meaning of re-approach to local building knowledge, characterized by resources economy and solutions simplicity.

Keywords: marine environment; appropriate technologies, material culture, sustainable project, history “lessons”.

1. Introduction
The principal aim of the study on the trabocchi of Chieti (City of Abruzzo, Italy) coastal area is to transfer the specific "qualities", that characterize them as "sustainable products", to seaside resorts design. Indeed, in our region, we have to face particular problems of environmental safeguard and, at the same time, a strong request of tourism development.

The study for the knowledge of the building and structural characteristics is therefore the base, at first, for the rehabilitation and the maintenance of the existing structures, (to keep their presence as the token and the live memory of the material local culture and of an appropriate and ecological operating way) and, then, to configure an aware and sustainable building process in proposing new seaside resorts [1].

2. From "Trabocchi" to "sustainable seaside resorts"
The knowledge of the trabocchi characteristics and, above all, of the constructive ways and of the "climate" – with refer to the relation with the local material and cultural resources – that has given
rise to them, has allowed to enucleate the principal parameters to be considered for the definition of a constructive process able to actualize that appropriate approach, that we appreciate as the most sustainable for equipping the coastal area. So we try to define an omni-comprehensive approach aiming to incorporate the building life cycle "philosophy" also in the programmatic level chooses, in a view that prefers the environmental safeguarding needs [2].

Fig. 1 The” trabocchi” coastal area

The considerations about the sustainability are involved in all the phases of the process, as explained in the following specifications.

In the "promotion phase", the definition of the demands (requirements) and of the aims, concerning the new equipments of the trabocchi coastal area, derive from a decisional process in which it will be consider all the aspects concerning the operation sustainability.

In the "programming phase", it will be drawn up a project study, in which it will be individuate and developed the environmental and functional demands with a cooperation among environmental and technical experts and the local authorities representatives.

In the "planning phase", it will be carried out the project defined (prototype for a seaside resort) by producing specific handbooks and other interactive tools addressed to planners and workers (specific practise codes) including the indications coming from the appropriate technologies knowledge and sustainable principles.

Therefore it will be introduced systems of integrated quality-environment planning, as described in the following points:

- an application of the Life Cycle Assessment to a prototype, aiming to the deep and objective individuation and quantification of the main environmental impacts due to the building (in all the phases of its life cycle, since the working of the original materials to the disassembly/deconstruction and reuse/recycle or components carrying off when the building finishes to have its function);
- an application of the Quality Function Deployment (as supporting methodology for the planning - relatively consolidated and diffused above all in the industrial context - looking for the possibilities of integration with environmental evaluation tools considering the life cycle) to the seaside tourism services, to which the indicated prototype is designed.

In the "building phase", it will be worked out an evaluation, above all, of the yard operation – special systems and equipments - and of the materials freight as well as of the environmental aspects concerning these activities (for example: production and management of the solid waste-materials in the yard). In this process, the planners group will control all the phases till the complete construction of the building.

For the "use and maintenance phase", the indications will be defined on the basis of an active participation of the resort users and managers in the carrying out process.

For the "disassembly/deconstruction phase", it will be drawn up a planning for the employed (in building) materials recycle, when there is not a long use cycle.

The building plan will aim to a construction completely demountable and to the criteria of the higher recycle possibilities of the used materials. That is to say that the planning will have to foresee the building process reversibility and the proposals for adequate systems and techniques (reverse logistics systems).
The constant comparison with the sustainability principles will produce the following social and ecological demands, adequately implemented in the program or better, in the qualitative environmental performance evaluation of the planning for the seaside tourism services:

- use of homogeneous and recyclable building materials (mono materials) with a low environmental impact potential, such as wood (also improved) for structures, facades and internal partitions, linoleum and natural wood for flooring.
- dry junctions (bolts, etc.) of the structural elements to facilitate the disassembly at the end of the equipments use.
- use of passive systems for the energetic control (in particular for cooling and lighting), such as the appropriate orientation of the facades, the optimization in the natural light use, the natural ventilation and the direct solar radiation control.
- use of the south exposed surfaces for the installation of solar/photovoltaic collectors for the auto-production of warm water and electric energy with renewable sources.
- use of the rainwater for the sewers and for irrigating the vegetation.
- use of movable and flexible internal partitions, for an easy adaptability to the future demands.
3. Knowledge levels for the rehabilitation of “Trabocchi”

In the last years, trabocchi have been counted in a census, catalogued and plotted. At the same time, the Authority of Abruzzi Region has given specific rules (laws n. 93/1994 and n. 99/1997), which have not caused positive effects because not fitted out with completed technical and normative tools.

With the purpose of warranting the "survival" of these structures, it has been developed a study orientated to the production of specific indications and rules for the rehabilitation of the trabocchi, defining a maintenance strategy aiming to promote the "prevention" and to hinder the request of emergency interventions as well as presupposing an integration between ancient traditions and contemporary procedures.

To back the “outliving” of trabocchi and of their technological and structural “ingenuity” (aiming to reduce building costs and wear causes), it has been fundamental to acquire a knowledge stock concerning principally with: the identity and the origins of the constructions; the building system and its parts; the structural behaviour; the material, dimensional and formal characteristics; the building rules; the most common damaged/decay phenomena; the maintenance requirements [3].

In this viewpoint, it is fundamental “learning” the ancient building rules and translating them into contemporaneous term, consulting the last repositories of the traditional “secrets”, to understand the principles that make “slightness” solidity, simplicity ingenuity.

With the work in progress, we are trying to define complete and efficacious technical information. The acquired knowledge have revealed the “secrets” about a trabocco building and maintenance, about which, in the following writing, the principal aspects are described.

Almost all the components of the trabocco have a structural function; indeed, the presence of closing and partition elements is minimal and ornaments nearly inexistent.

Materials: the employed timbers are acacia, chestnut-wood and, only sometimes, fir-wood; expressly cut off from the sources or got back from the scraps of the electric energy or telephone network stakes. All elements junctions systems are hinges or daps realized with: bolts (till 1 metre of length and with a section of 16-18 millimetres), nails, wires and sometimes cords.

Foundation structure: the system is secured to the sea bottom, preferably, by fixing the foundation elements (with approximately 200 millimetres H-beam or portions of railway tracks) into the rocks cavities or putting them directly on the sand bottom (when there are no rocks). The solution to the problem of sinking into the sand consists in enlarging the bearing surface with metal plates or, better, with long bolts crossed arranged (that have more resistance to the slipping phenomenon than the plates). Foundations height is oversized of about 30 centimetres to foresee lowering caused by sea bottom movements. The best period of the year for realizing foundations is January because, even if the climate is colder than in the other months, the water of Adriatic sea is calmer and more limpid.
Vertical structure: the elements (piles/stakes with a diameter of 12-18 centimetres) are built with peculiar shrewdness. The placing of the piles in the seawater follows the securing of the land stakes - “vinch’s piles” – at each of them a beam is fixed, this is useful to reach the water (the worker walks on the beam fastened with a ropes system). The free extremity of the same beam carries the stake to be placed in the sea, which is called “false” because it is replaced in course of construction. The provisional elements (“false”) have a small height (about 3,5 meters) due to the “building yard” conditions, therefore – when the wooden beam floor (which allows to move more easily on the water) is built up – they are replaced with higher (about 10 meters) stakes (“antenna piles”). The replacement occurs putting side by side the higher and the “false” stakes; the latter are removed when the definitive ones are fixed. If the wooden beam floor must be placed far from the shore, a gangway is realized (see Figure 4).

Horizontal structure: vertical carrying elements are stiffened with two crossed arranged beams (“winch’s cross” at the centre of which it is placed the winch used to move the fishing-nets) and four perimetric beams (same stakes materials and dimensions). The realization of the wooden beam floor (made with a 5 x 20 centimetres section and a 80-160 centimetres length planks) gives the surface on which workers can move to build not only the “antenna piles”, but also the “antenne” and the “small antenne” (carrying elements for the fishing-nets). The junction of the “antenna” parts can be done either before building the complete element, jointing them at the wooden beam floor, or building a piece at a time and jointing it to the former, in elevation.

Functional equipments: the winch allows reaching the right elevations and placing the “antenna” elements, fastened with a wire ropes system hooked with iron bolts (only more recently in steel) driven in the stakes. This solution prevent the flowing of the ropes on the external surface of the stakes, reducing the mechanical and dynamical wear causes, and permit to regulate the tensitional state of the elements. The construction is completed with the hut, a spatial unit designed to the shelter and the stowage of fishing tools, and with the others carried elements (fishing-nets, etc.). The hut is a volume closed by wooden panels (squared 15 x 15 centimetres section and about 1,70 metres height stiffening elements and a 5 x 20 centimetres section and about 1,60 metres height closing planks).

Maintenance requirements and damages: the trabocchi offer great and easy maintenance possibilities (specially for what concerns control, inspection, guard, substitution), above all because they permit punctual interventions with very easily available materials and components, which need a minimal working and whose damages are directly verifiable and resolvable. The principal constructive wooden elements, generally don not show problems before than 30-40 years after the date of building while the metallic parts and the slighter timber elements last about 7-8 years. The most common damages come from seawater and its movement physical (weakening of the building parts and junctions) and chemical effects (corrosion and rusting of the metallic parts and decaying of timber).
A trabocco, if it does not pass through particularly catastrophic sea storms, it do not need maintenance actions before than 6 years after its building. Building and maintenance operations foresee actions that sometimes get in contrast with the actual safety criteria, however the “old” builders suggest the possibility of operating at ground level and, for the principal bearing parts, of placing the substitutive elements without or before removing those degraded. By the way, it is important to point out that the trabocco principal constructive materials are ecological and soft. The best period for doing inspections and maintenance actions is the month of January either for the sea condition (as explained in the foundation description) or because the strongest sea storms occur in December.

The traditional procedures give important suggestions, indeed, in the past, builders constantly controlled the structures, to ensure their best working. So there were not emergency situations and maintenance, even if not planned, was spontaneously preventive or at the most corrective [4]. On the contrary, today, even if the maintenance is planned, it is not so “spontaneous”, and many trabocchi risk to “disappear”. Then, it is necessary to adopt the traditional procedures applying them in the actual technical and normative tools; moreover considering that the structure endurance can be improved perfecting some technical solutions (such as junction elements, direction of the bearing parts respect to the sea movements, etc.).

3.1 Conclusions
The regulation of trabocchi interventions of rehabilitation (in which, of course, maintenance is also involved), besides deriving from knowledge of the pre-existences characteristics, must, then, recognize and resolve some incongruities with the actual technical and normative context. This aspect must be evaluated above all in terms of safety and more advanced and appropriate technological options because “old” procedures often foresee actions that are dangerous for workers (and sometimes also for users) and, moreover, the traditional technical solutions are improvable to increase the structures performance. The most important results of the trabocchi analysis point out that, learning from the history, we can define planning chooses appropriate to the environmental characteristics (for example in projecting sea resorts). So the deepening of the study, aiming to promote an aware “safeguard” of local constructive cultures, is also a stimulus to define innovative and very sustainable design solutions, getting information from the building traditions of the past.

3.2 References