

CHAPTER 181

MAN-MADE BEACHES MORE THAN 20 YEARS ON

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Abstract

This article is an overview of the behaviour of artificial beaches based more particularly on three important examples designed by SOGREAH: La Croisette (Cannes), Larvotto (Monaco), Prado (Marseille).

The main conclusions are:

- . a man-made beach in an urban area is generally very well received by the general public,
- . the general behaviour of beaches has proved to be satisfactory and as forecast on the basis of sedimentological scale model studies from the following points of view: stability, water quality, safety, maintenance.

1. Introduction

When SOGREAH was called upon in 1960 to study the possibilities of widening the Croisette beaches in Cannes, this proved to be the first man-made beach ever built. With the rapid growth of tourism since that time, SOGREAH has designed throughout the world more than 60 beaches out of which about a half have actually been built. It is interesting to make a hindsight assessment of the various man-made beaches.

With focusing on three important examples designed by SOGREAH: la Croisette (Cannes), Larvotto (Monaco), Prado (Marseille).

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2. Characteristics of artificial beaches

a)___La Croisette (Cannes)

As a matter of fact, the idea of developing a new beach in front of the shoreline of La Croisette Promenade originated in the need for the town of Cannes to widen the Promenade in order to extend the vehicle traffic and to improve the area reserved for the pedestrians along the shoreline.

Widening directly the Promenade in accordance with the needs would have involved of setting the small beach that existed partially along the Promenade at the time. So, SOGREAH proposed to built a new beach before widening the Promenade. The new shoreline was not parallel to the natural shoreline. It is the reason with the new beach is divided in three parts by groins. The main characteristics of the beach are:

- . widening of the natural beach by 20 m over a distance of 1040 m,
- . deposition of 125.000 m³ of sand with a mean diameter of 0.8 mm,
- . three 60 m stabilisation groynes,
- . expected equilibrium slope: 6.5%,
- . construction over a period of 2 years (1962-1964).

b) Larvotto (Monaco)

Larvotto is doubly an artificial beach:

- . first, this beach was built on a quite rocky coast,
- . secondly, the material used to built the beach was fully artificial: crashed dolomite limestone.

This project presented three difficulties:

- . coastline quite rocky and bottoms slope very steep,
- . wave climate very high ($H_{1:10}$: 8 m),
- . any natural sand available.

Main characteristics of the new beach are:

- . length: 400 m,
- . construction of an underwater platform levelled at -2.5 m,
- . deposition of 80,000 m³ of 3-8 mm gravel on the platform,
- . protection with three 80-100 m long breakwaters spaced 80 m apart in water 6-10 m deep and connected to the shore by groynes,
- . construction took place from 1965 to 1967.

c)___Prado (Marseille)

The scheme involved the development of 33 hectares of reclaimed area in the sea and the building of new beaches totalising an area of 9 hectares with a total length of 2800 m and an average width about 50 m.

The renourishment material used was 3-8 mm diameter gravel (150,000 m³).

Protection is provided by three breakwaters, 150-220 m long and in water 4 m deep, connected to the shore.

3. Changes in beaches since their construction

a)___Renourishment material

. Prado beach:

Precise monitoring was carried out at the Prado beach and after 15 years, the following conclusions could be reached:

- the gravel (hard limestone) is worn and rounded only in an area of the beach that is subject to wave action,
- the average diameters have decreased from 5.5 mm to 3.2 mm (in the area subject to wave action), but wear has stabilised with time. There is no noticeable difference between samples taken between 12 and 15 years after completion,

- the larger the particles, the greater the wear,
- from the methodological point of view, the Los Angeles test appears to provide significant results concerning particle wear. The experimental conditions were:
 - . Los Angeles machine,
 - . 20 kg of gravel + 40 l of sea water,
 - . rotation speed: 30 rpm,
 - . number of rotations: 30 000.
- . La Croisette beach:

No change at all in grain size for the sand.
- . Larvotto beach:

No measurement data are available but visual observations lead to similar conclusions from the qualitative point of view.

b) Behaviour of beaches

In the three cases, and as confirmed by the slight amount of consolidation carried out (see 3.3), the artificial beaches have behaved in a highly satisfactory manner and, generally, speaking, as forecast, particularly with regard to:

- . slopes: of the order of 10% with gravels (Larvotto and Prado, protected by breakwaters) and coarse sand (Croisette, with no protection),
- . no major loss offshore,
- . shoreline: as forecast and stable (within the usual known limits of change).

However, the following points must be underlined:

- . At Cannes, there is a discrepancy between plan view of the promenade and that of the beach because the groynes are not long or high enough (for environmental needs). So, it must be accepted some littoral drift from East to West. Every year before the summer season, some sand (about 2 000 m³) has to be redistributed from the western part of the beach to the eastern part in order to balance its width.
- . In the three cases, a ridge is formed on the upper part of the beach, mainly in winter, accompagnied by a steeper beach profile. This makes it necessary to rework the profile at the start of the summer period.
- . At Larvotto, during severe storms, beach material is thrown together with sea water to the back of the beach where shops and costly equipments are located. Protective boarding is needed in winter. This is removed during the summer.
- . The beach slopes of the order of 10% appear to be steep for bathers and, in particular, for children.

In the three cases, the renourishment required for correct beach maintenance has been limited and has been quitee acceptable from both the technical and financial viewpoints:

- . Cannes:
 - Initial renourishment: 125 000 m³
 - Maintenance (over 20 years): 5 000 m³

- . Larvotto:
 - Initial renourishment: 80 000 m³
 - Maintenance (over 23 years): 5 000 m³
- . Prado:
 - Initial renourishment: 150 000 m³
 - Maintenance: none to date

To interpret these satisfactory results, the following points need to be taken into account:

- . the absence of any tide,
- . the large particle size of the material, which favours stability,
- . the protective and stabilisation structures (groynes, brakwaters) built near the beaches.

This being so, these are highly instructive examples of how artificial beach projects should be designed to ensure reliable use.

4. Water quality

In the three cases, treatment work was carried out in parallel with the construction of the beaches. Water quality monitoring shows that, in general, the water is of class A (good quality) or B (moderate quality), and thus poses no problems for bathers.

For example at Cannes, the water is 70% class A and 26% class B. Exceptionally, polluted water has occurred, but this was the result of very heavy rains. In one case, the pollution was due to a burst pipe.

The water at Larvotto is of good quality, but there are temporary problems of pollution in certain places around the central landfill platform. As at Cannes, there is a correlation between pollution and rainfall.

Measurements taken at Prado beach (1988) show that the water is of good quality. Measurements at different times of the day show that use of the beach by bathers does not notably affect the water quality.

5. Operating problems

Problems of beach operation are not connected with the fact that they are artificial but with their used and more particularly with access and parking facilities.

Maintenance of gravel beaches has proved to be easy with screening machines.

At 8-10%, the beach slopes, which are connected with the particle size of the material used, have appeared to be just acceptable for bathers and particularly for children.

The use of consolidation material with the same particle size as the gravel (3-8 mm) does not appear to be an inconvenience for bathers (the limit of discomfort appears to begin around 5 mm).

6. Conclusions

In conclusion, as these three examples of most important artificial beaches along the French Mediterranean coast show, it is of a great importance to carry out proper design studies before construction of artificial beaches. In this way, the beach is assured of a long lasting stability of the beach with minimal maintenance at little or no cost.