



Yachts Parameters for Marina Design

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Abstract

The basic dimensions of power and sailing yachts are presented, as well as basic dimensions for two type of berths: Mediterranean ones and finger piers type (characteristicall for US and Australia). The idea was to collect different recommendations data, from different nautical tourism markets: US, Australian, British and Mediterranean, make compare, and give recommendation for Croatia. The other part of work deals with the wind effects on yachts. Wind parameters for wind calculation are defined in different standards. A discussion is presented on the state-of-the-art in marina design to accomplish these parameters from marina design experience in Mediterranean region and worldwide. The result tends to Croatian recommendation.

Fleet of nautical tourism

Types

The basic types of boats which are commonly used in engineers practice are:

1. Power boats (M),
2. Sail boats (S),

and other types:

3. Catamarans,
4. House boats.

Design of marina is deriving from parameters of basic types of boats because they are common users of marina and for the other types can be predicted reduced capacity. Which parameters will be used depend of aim of marina and sort of fleet which will be primary user.

Basic boat parameters

PIANC data are presented 1976. from “International commission for sport and pleasure navigation”) [1]. Here are also presented parameters from “Australian Standards” [2]. US recommendations come from industry cataloges of boats [3], [4].

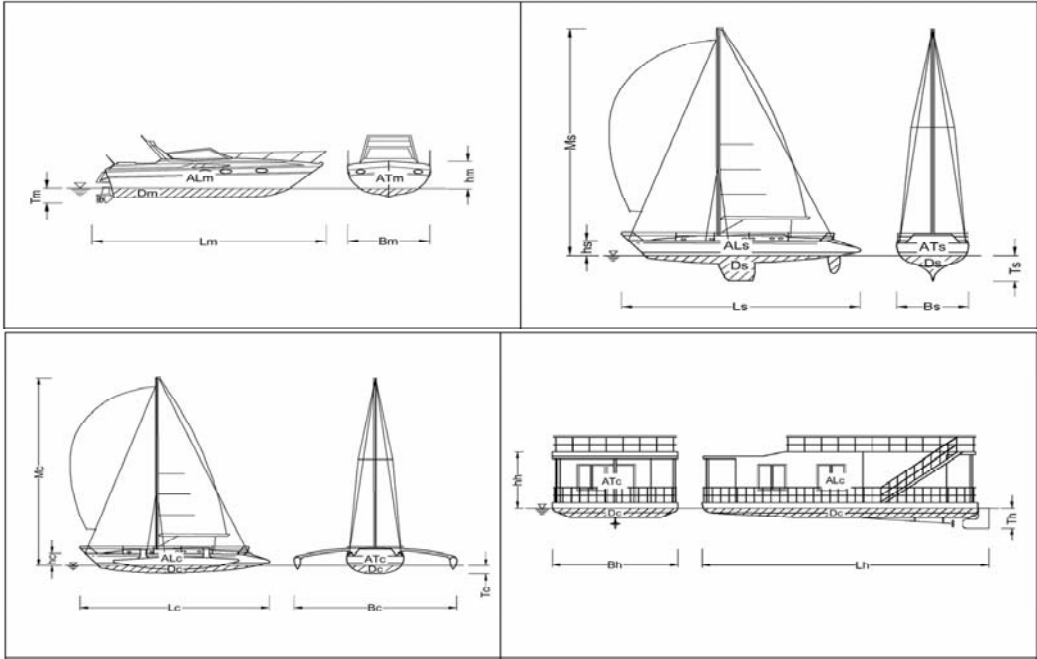


Figure 1 Definition sketch for dimensions of power and sail boat, catamaran and house boat. T[m]-draught; h[m]-stem height; L[m]-length; B[m]-width; D[m³]-displacement; AL[m²]-transverzal section area; AT[m²]-longitudinal section area; m-power boat; s-sail boat.

All defined data have just orientation purpose in dimensioning of marinas and acquire dimensions depend of specific situations and projects.

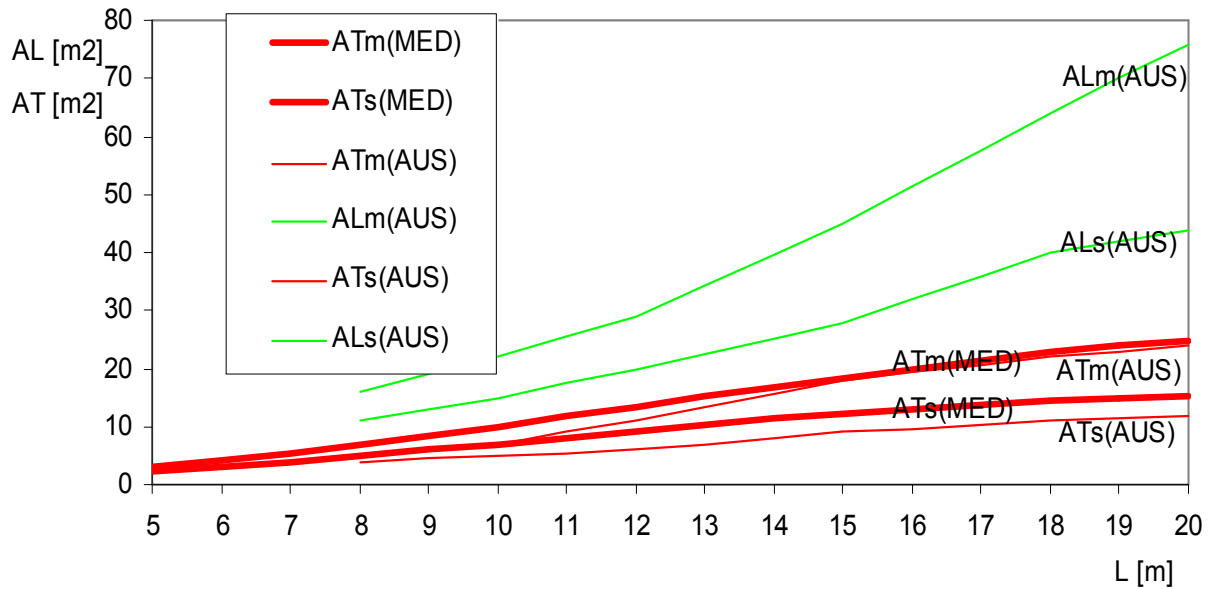


Figure 2 Hull cross sections in relation with length of boat; $AL_m[m^2]$, $AL_s[m^2]$, $AT_m[m^2]$, $AT_s[m^2]$; m-power boat, s-sail boat; MED-Mediterranean, AUS-Australia.

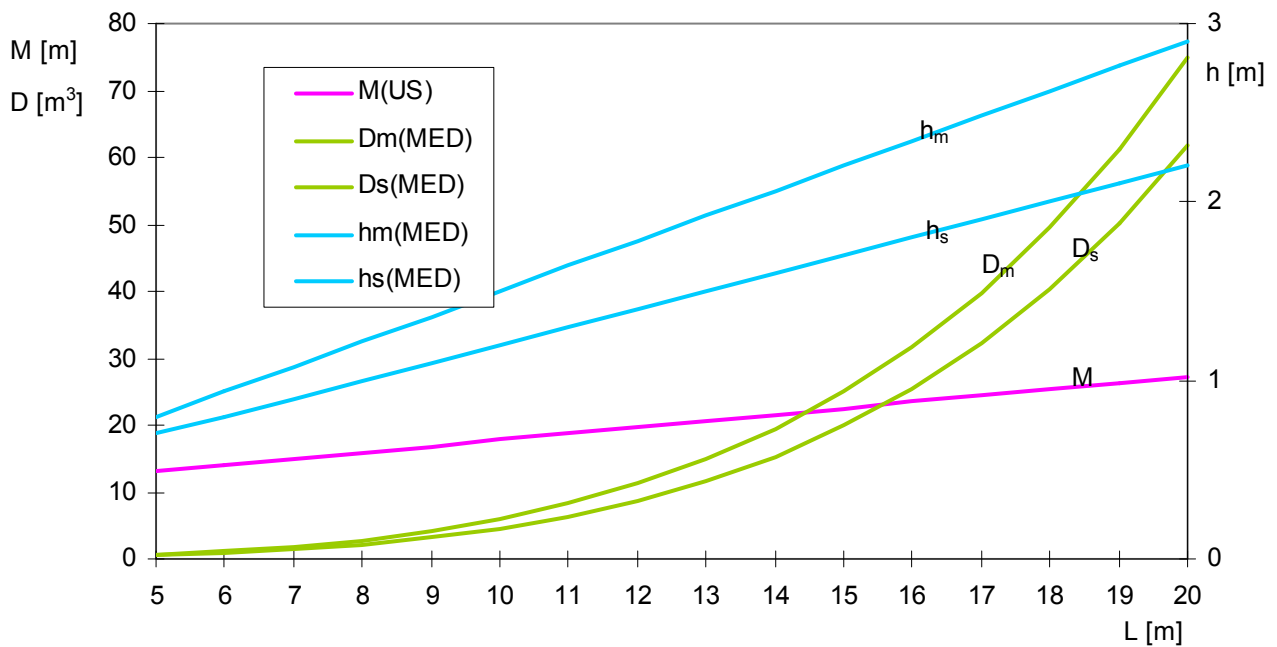


Figure 3 Displacement $D [m^3]$, mast height $M[m]$, stem height $h[m]$; m-power boat, s-sail boat; MED-Mediterranean, US-United States.

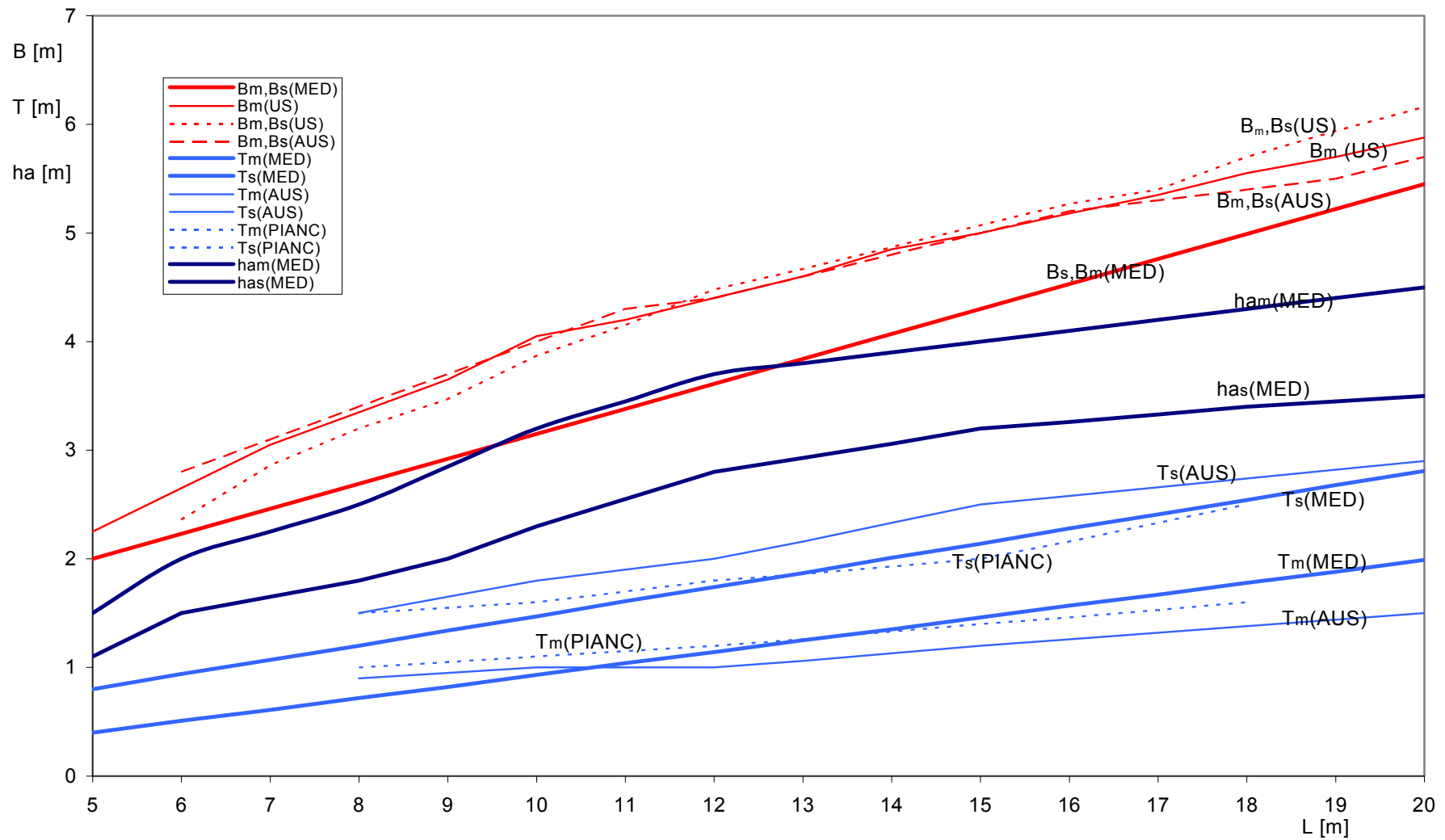


Figure 4 Hull geometry; B_m [m], B_s [m], T_m [m], T_s [m], ha_m [m], ha_s [m]; m-power boat, s-sail boat; MED- Mediteranian, US-United States, AUS-Australia.

Basic types of marinas

Basic berth types are:

1. Mediteranian type (med)
2. Finger piers type (f)

Which type will be selected depend on tradition of building but also on technical and economic aspects of project.

Generally finger type is more expensive variant of berth configuration because it requires more space but providing safely maneouvring and mooring boats. On the other side Mediteranian type provides better usability of space and allows possibilities of mooring greater boats longitudinal to the pier. Weakness of this type is slimness of berth space which desire greater agility of yachtman.

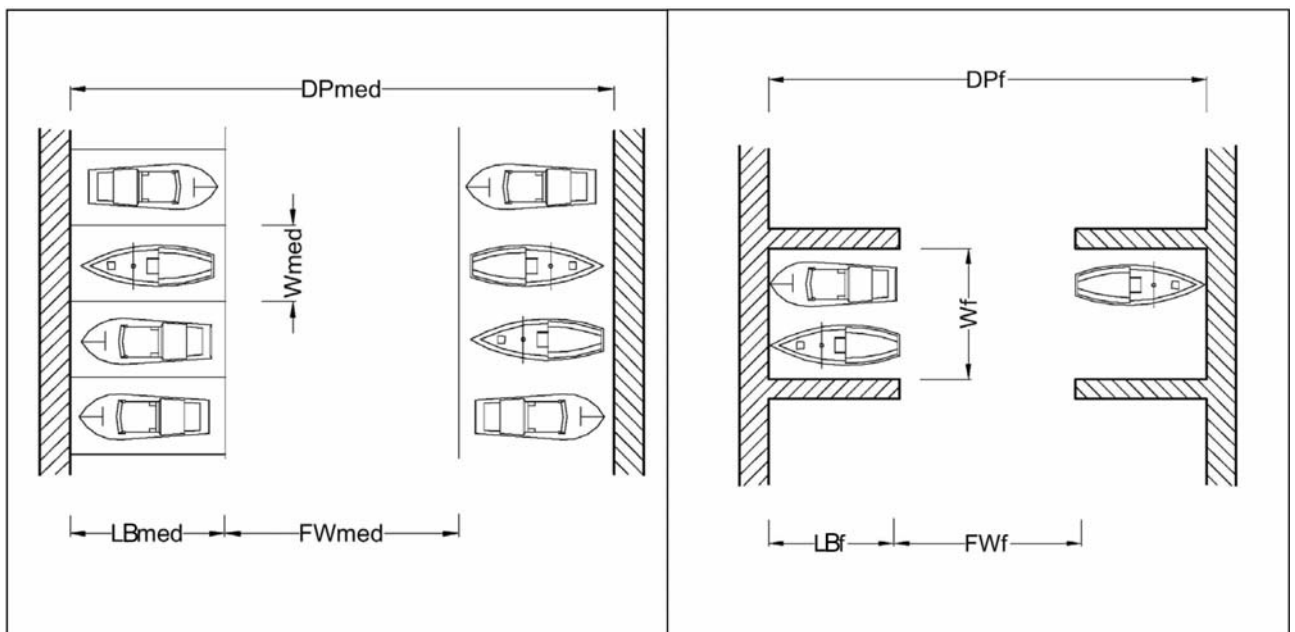


Figure 5 Definition sketch for Mediteranian type and finger type

DP	[m]	space between piers
W	[m]	berth width
LB	[m]	berth length
FW	[m]	fairway between berths
d	[m]	draught
med-mediteranian type; f-finger type		

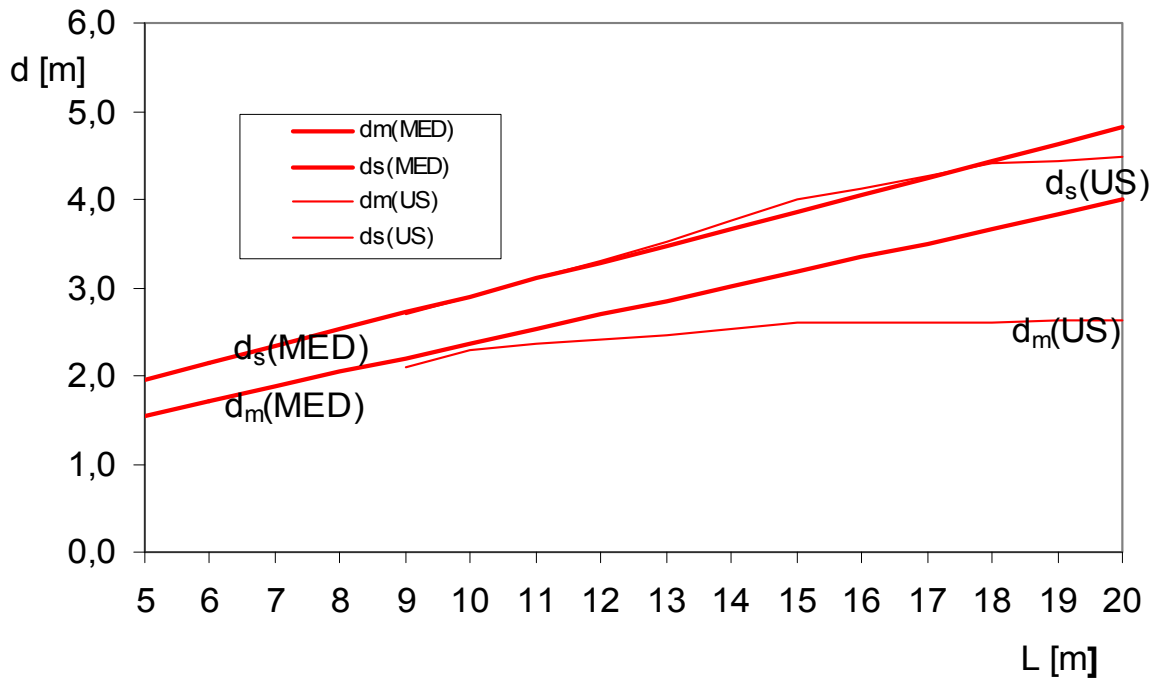


Figure 6 Draught; d_m [m], d_s [m]; m-power boat, s-sail boat; MED-Mediterranean, US-United States

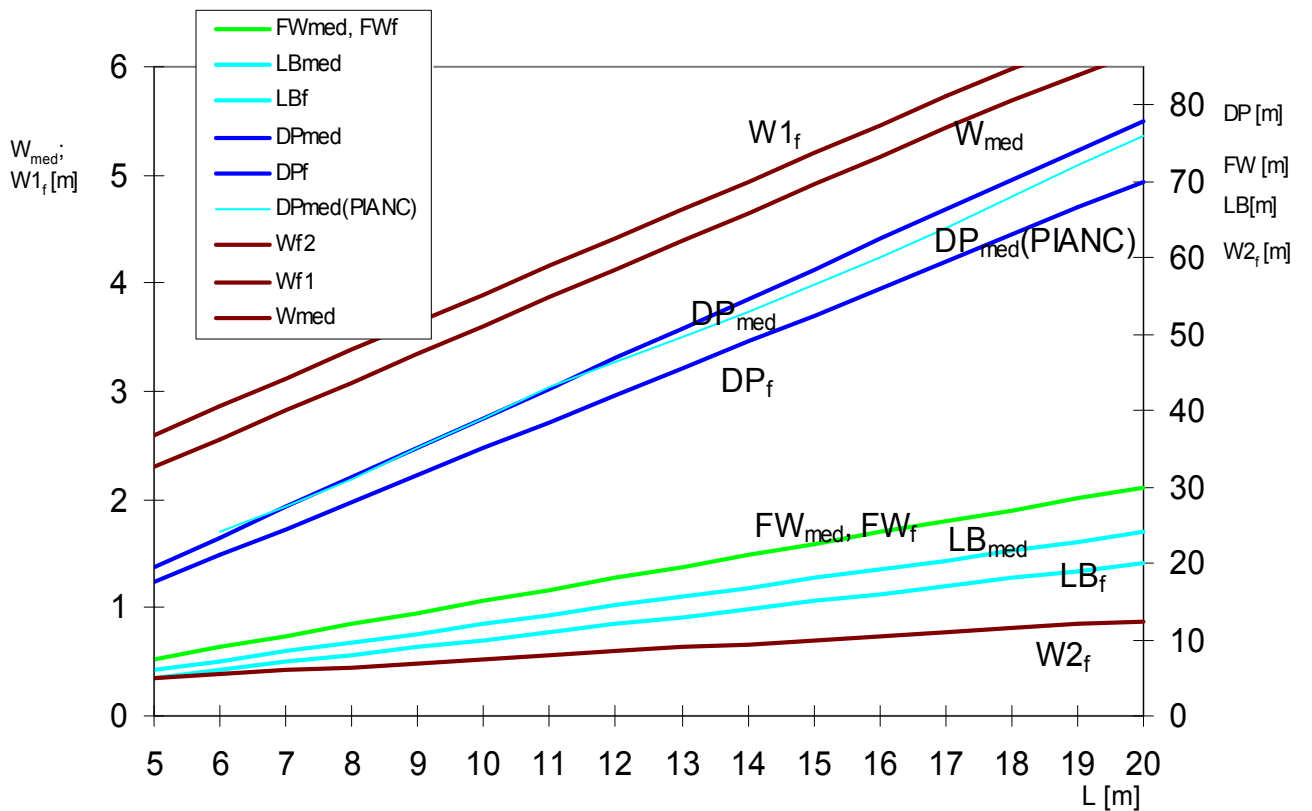


Figure 7 Geometric characteristic of berths; W1, W2-single and double berth [m], FW[m], LB[m], DP[m; med-Mediterranean type; f- finger type.

$$U_{30s}(3m) = 1,33 \cdot \overline{U_{3600}(3m)} \quad c_{3600}^G(z = 3m \text{ or less}, 30s) = 1,33$$

Design wind velocity

Australian Standard[2] recommends hourly average wind velocity for design velocity which must be multiplied with gust factor. In that sense for yachts and ships in marinas is required design velocity of 30 seconds duration on 3 meters above terrain:

- $U_{30s}(3m) = c_{3600}^G(z = 3m, 30s) \cdot \overline{U_{3600}(3m)}$

$$c_{3600}^G(z = 3m, 30s) = 1,33 \quad \text{gust factor}$$

$$\overline{U_{3600}(3m)} \quad \text{average hourly wind velocity 3 m above terrain.}$$

British Code [3] suggests using 50-year average wind velocity with duration between 1 and 5 minutes. There are no data about height above terrain.

According to Eurocode (1991) calculations of wind loads can be made with 50-year wind velocity with duration of 1 second. Gust factor 10 m above terrain for average velocity of 10 min. duration is $c_{600}^G(z = 10m, 1s) = 1,39$, and for hourly average velocity is $c_{3600}^G(z = 10m, 1s) = 1,54$, which gives:

- $U_{1s}(10m) = 1,39 \cdot \overline{U_{600}(10m)}$,
- $U_{1s}(10m) = 1,54 \cdot \overline{U_{3600}(10m)}$

where:

$$\overline{U_{600}(10m)} \quad \text{average 10 min. velocity, 10 m above terrain}$$

$$\overline{U_{3600}(10m)} \quad \text{hourly average velocity, 10 m above terrain.}$$

Drag factor

Table I Drag coefficient comparison for unshielded boat[5].

	angle of wind blowing	0°	90°	180°
boat type	power boat	0,75	1	0,95
	house boat	0,75	0,9	0,75
	sail boat	0,35	0,9	0,45
standards	AS3962-1991	1,10-1,20	1,30-1,60	1,60-2,00
	PIANC-British Notes	0,20-0,75 (0,45)	1	0,2-0,75 (0,45)
	PIANC-ASCE	0,50-1,20	0,80-1,50	0,50-1,20

Experimental values of drag factor (C_D) [5] for sail boat, power boat and house boat in comparison to Australs, British and USA standards are given in next table.

Angle of wind blowing in table represent: bow to wind (0°), beam to wind (90°) and stern to wind (180°).

Table I Drag coefficient comparison for unshielded boat[5].

Where boats are moored next to each other or on both sides of a pier it is generally accepted that the leeward boats will each attract a reduced wind load because of the shielding effect of windward boats. Recommendation of American Society of Civil Engineers [5] is to use reduction factor for shielded boats ranging from 0,1 to 0,5 of the force on an unshielded boat.

Summary

The design of marina requires careful attention to design parameters to maximize benefit, provide functional use and insure safely berths for yachts. The marina must provide suitable yacht capacity for the defined nautical fleet, provide adequate access from the sea and allow safe maneuvering of yachts inside of marina.

References:

- [1] PIANC; "Final Report of the International Commission for Sport and Pleasure Navigation"; Anex to Bulletin No 25 (Vol III/1976), Permanent International Association of Navigation Congresses.
- [2] "Guidelines for design of marinas"; Australian Standard; Standards Australia Committee AS 3962-1991; Second edition 2001.
- [3] PIANC; "Special Report of the International Commission for Sport and Pleasure Navigation"; Supplement to Bulletin No 93 (January 1997), Review of selected standards for floating dock designs.
- [4] "Marinas: Design and Operation"; W.R. Blain; N.B. Webber, Proceedings of the international Conference on Marinas, Southampton, UK, September 1989.
- [5] -Allan Uhlmann: "Wind Loading on Small Craft for Marina Design" PIANC; Bulletin, No.103-2000.