

## Preliminary design of a Towing Tank for ESPOL, according to ITTC requirements

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### ABSTRACT

Ships accidents cause great human, economic losses and a great environmental impact, as has occurred throughout history. Carrying out a reliable naval design is essential to reduce the risk of accidents. Naval designs, having the sea as a factor, become complex because it is random and unpredictable. Therefore, it is essential to have a tool in the country that supports the design of reliable ships.



This thesis proposes to preliminary design a towing tank for ESPOL, following the ITTC requirements, given the need to have a laboratory that allows tests on naval designs, evaluating the seakeeping and its previous efficiency to its construction, to carry them out in a more efficient way, in order to avoid accidents, in existing structures and future projects, which cause human, economic and environmental damage.



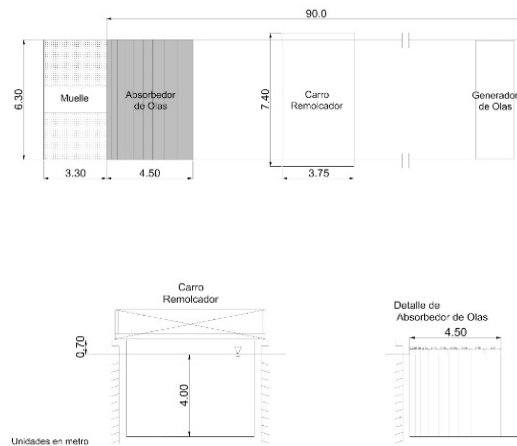
Design requirements were established based on the ITTC, database of ships in the region, linear regressions and other theories on ship speeds and shapes. The towing tank and its accessories were sized, and the economic viability of the project was evaluated for 15 years.

Table 1. Summary of the national vessels database

Ship Type	Typical Fn	Typical Cb	L <sub>w</sub> [m]	λ	V <sub>w</sub> [m/s]	V <sub>m</sub> [m/s]
Tankers	0,15	0,85	228	91	8,0	0,8

Ship Type	Typical Fn	Typical Cb	L <sub>w</sub> [m]	λ	V <sub>w</sub> [m/s]	V <sub>m</sub> [m/s]
Bulk carriers	0,19	0,8	38	15	4,2	1,0
Cargo Ships	0,24	0,68	105	42	9,1	1,4
Passengers	0,27	0,62	92	37	8,5	1,4
Fishing & Tugs	0,38	0,55	116	46	13,5	1,9
Patrol boats	0,70	N/A	50	20	15,4	3,5

The dimensions of the towing tank were calculated using restrictions to reduce the uncertainty generated by the interaction of the model-tank during the experiments and the accessories were properly sized for the characteristics of the channel, and this are: the carriage, wave generator and wave absorber.



An IRR of 9% and a NPV of \$ 282,372.25 were obtained, recovering the investment in 9 years, for a towing tank with the following dimensions 90x6,3x4 m, that will allow tests with models at a scale of 2.5 m at a maximum speed of 5 m / s (1.00 Fn), in calm waters or in waves, replicating the region's sea to a level 5 sea state.

Table 2. Summary of financial analysis by towing tank

Description	110	90	70
Initial Investment	\$ 1.144.542,27	\$ 986.595,66	\$ 836.279,34
NPV (5%)	\$ 49.387,56	\$ 282.544,92	\$ 416.468,26
IRR	6%	9%	11%
Recovery Year	11	9	8
Cost of operation	\$ 98.944,21	\$ 98.836,01	\$ 99.884,18

Description	110	90	70
Income	\$ 252.180,00	\$ 252.180,00	\$ 252.180,00

The preliminary design of the towing tank for ESPOL will help in the prevention of naval accidents, will allow the development of national designs, national security and the reliability of maritime engineering processes, therefore, it will be a beneficial tool that will contribute to the growth of the Ecuador and its inhabitants.

Looking for the automation of this laboratory, it is recommended to include a PLC control system so that all the equipment is synchronized in the test channel.

**Keywords:** Towing tank, carriage, wave absorber, wave generator, ITCC.

### Conclusions and Recommendations

The necessary dimensions for the towing tank (90x6.3x4 m) for ESPOL were determined following the guidelines of the International Test Tank Conference (ITTC). It will carry out experiments for 2.5-meter models and a maximum Froude (Fn) number of 1.00, which will be able to provide services to all vessels in the country.

An economic analysis of three infrastructure scenarios was carried out, choosing the 90-meter long canal that meets the existing requirements of current vessels. (cost benefit) As a next step, it is recommended to carry out a macroeconomic analysis of the project to quantify the social impact it will generate in the country.

Being this a preliminary design, a second spin to the design spiral is recommended, where a thorough structural analysis must be carried out to accurately determine the items corresponding to civil works; thus achieving a budget with less uncertainty.

