Alternative conceptual design of Pacific and Atlantic Post-Panamax Locks - 3x2 Water Savings Basins

Diseño conceptual alternativo de Esclusas Pospanamax del Pacífico y Atlántico - Tinas de ahorro de agua de 3x2

CONSORCIO POST PANAMAX

13 de julio de 2005

Contrato No. 150551

Resumen Ejecutivo

0 Executive summary

This hydraulics report deals with an alternative to the Pacific side Actualization and Atlantic side Harmonization studies performed previously under contract SAA-143351. It follows the logic of these studies, where three water saving basins per lock were used.
This alternative concerns the same configuration on both sides of the Panama Canal, a triple lift lock system, but in this case using **two water saving basins** per lock.

Following the recommendations, choices and Terms of Reference of the ACP, a system with three lock chambers, each equipped with 2 water saving basins, allowing to **save nearly 83 %** [1] **of the total water required to lock 1 ship** (semi convoy mode), has been retained.

The levels of chambers and water saving basins have been set up using the same software as used in previous studies. This software calculates minimum and maximum water levels in the chambers and the 6 basins and also provides figures for water usage and the water saving rate for each lockage, as well as to the daily number of up and down lockages.

Based on the results of former concept design studies, the emptying and filling system retained for this alternative is **a sidewall culvert & ports filling and emptying system.**

The system has been modeled and pre-designed using Flowmaster™ hydraulic calculation software.

The new calculations were undertaken with the same hydraulic system (i.e. culvert, conduit & port size, valve opening times, etc.) as the ones designed which were obtained in the study with 3x3 water saving basins.

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1 *The three-step lock system saves 2/3 of the volume of a **single lock** chamber.*

Moreover, the water saving basins save: $e = \frac{n}{n+2}$ *= 50 % of the 1/3 remained (with the same area for WSB and lock chamber : m= WSB area / lock area = 1), where n= 2 is the number of water saving basins per lock*

So, the total water saving rate is e':

$$e' = \frac{2}{3} + \frac{1}{3}e = \frac{3n+4}{3n+6}$$

For n=2, e' = 0.83, i.e. 83 %

It is reminded that because of the smaller tidal amplitude in the Atlantic Ocean than in the Pacific Ocean, the maximum head between lock chambers and water saving basins is also smaller at the Atlantic side and thus the size of the WSB conduits has been reduced.
On the other hand, as the average head between Gatun Lake and the Ocean is nearly the same at both sides, and as the maximum head between two lock chambers remain nearly unchanged, the dimensions of the main longitudinal culverts have been kept unchanged

The calculated filling and emptying times are within those required by design values and/or guidelines. The velocities reached in culverts, conduits and ports are acceptable, taking into account that the maximum velocities could be reduced by firstly adapting the forms of the circuits' components (especially ports) and secondly by changing the opening and closing rates of the valves.

The system provides, after optimization, quite a uniform flow distribution and a balanced upstream-downstream / east-west filling. The remaining dissymmetry that could cause strain levels on the hawsers to exceed acceptable levels has been examined during the Pacific side actualization study. Due to the increased F/E times, the hydraulic conditions remain comparable in these 2-WSB configurations. A new hawser forces analysis has therefore not been run in this alternative.

Nevertheless, solutions to reduce these forces would be identical as those proposed for the Pacific side actualization study for 3 water saving basins per lock chamber:

- Modifying the valve opening diagram;
- Modifying the dimensions of the ports.
- Concentrating the ports along the 'centre of gravity' of the lock chamber

The next stage, defined as the preliminary filling and emptying system design phase, should mainly be aimed at:

- Optimizing the culvert, conduit and port dimensions, shape and number of ports;
- Optimizing the valve opening/closing timings;
- Defining the distribution of ports along the lock chamber, their position and orientation;
- Accurately evaluating the expected hawser forces.

This stage will require a detailed study using Flowmaster™ in conjunction with the 2D/3D Delft numerical model and finally studies using a physical scale model.

This conceptual design is set up for locks using Water Saving Basins, according to the TOR. If these WSBs are not used, the E/F times may have to be increased, or the E/F system may need to be adapted / modified to take into consideration the fact that under certain configurations the head will be much greater.