RC.20120603.PN.0639 – Panama Canal

Country	Panama
Location	
Year	2012
Product	RoadCem
Project size	
Contact	PowerCem Technologies B.V.

Use of PowerCem Technologies in Panama Canal

Introduction

One of biggest projects in the world in 2012 is the capacity expansion of the Panama Canal. Substantial new infrastructure is required to enlarge the capacity of the canal. The construction of a new lock including new water basins, widening of the canal, strengthening of the embankments as well as new roads are part of the project. The Engineers responsible for the execution of the project have spotted the unique properties of the products of PowerCem Technologies, which have been successfully applied in other critical infrastructure constructions in various parts of the world. The successful track record of the technology has been the basis for working with PowerCem Technologies.

Figure 1: Impression of the construction works on the locks at the Atlantic Site, June 2012

One of the elements where PowerCem Technologies comes up as the preferred solution, is in the construction of an impermeable, strong and flexural slab that will be used in the water basin of the locks. The flexural strength from the PowerCem Technology provides for a better earth quake proof slab construction.
For every lock there is a basin of 30.000m^2.

The demands for this important part of the expansion of the Panama Canal project are:

- The constructions must be water impermeable.
- Improved resistance against Earthquakes.
- If damage should occur the construction should remain water impermeable.
- Ability to follow small deformations.
- There shall be no damage to the bottom of the basins when they are dredged.
- The building time should be as short as possible for reasons of project budget and time schedule of the project.
- The lifetime should be at least 100 year.

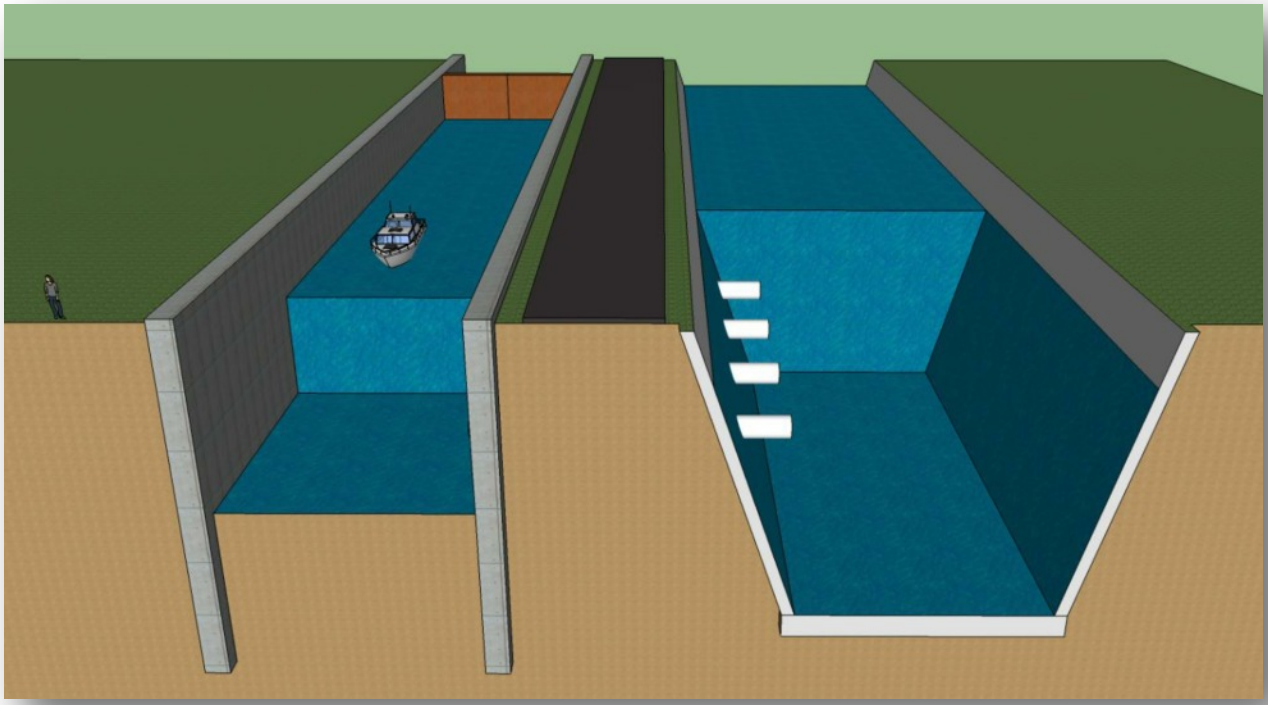


Figure 2: Lock system on the Panama Canal.

Based on the above mentioned demands the engineers trust the excellent and unique properties of the PowerCem Technology for this part of the Canal.
In this paper the concept of the use of PowerCem for the water basins of the locks is described, based on a deterministic analyses of existing methods . To construct a layer as this there are 3 traditional methods:

1. Artificial Synthetic Foil construction.
2. Reinforced concrete construction.
3. Clay layer.

Basin soil cover with artificial synthetic Foil

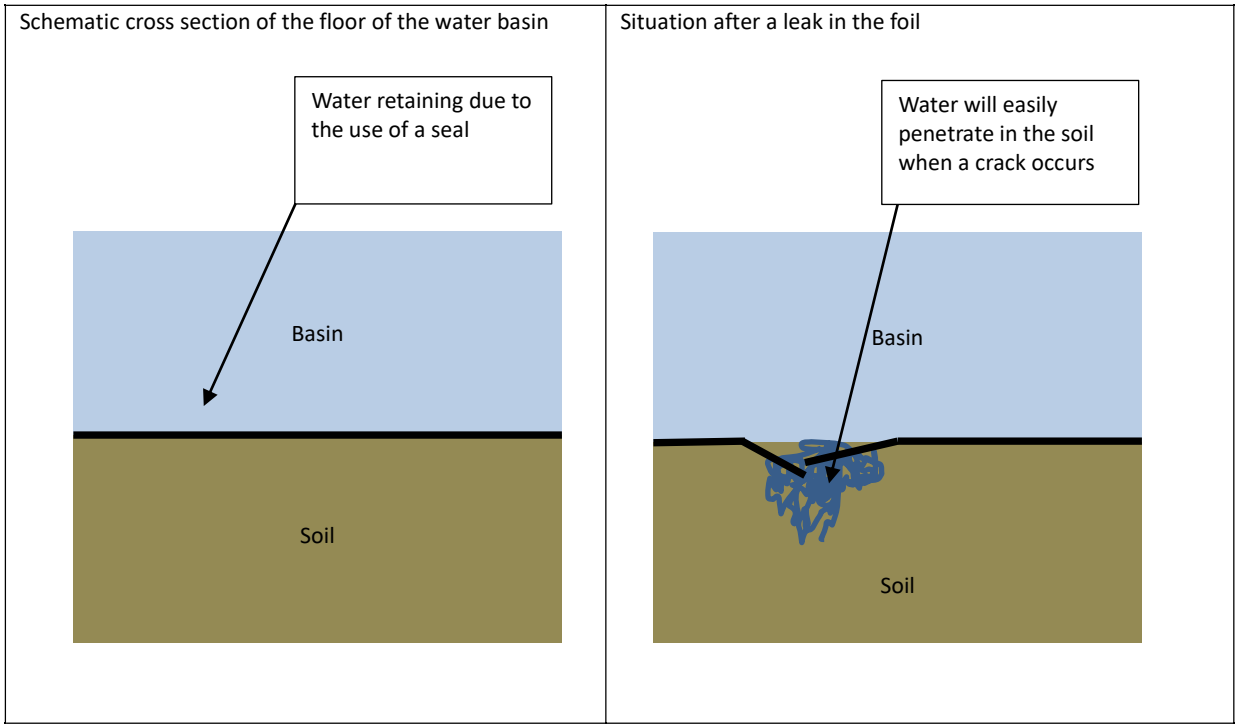


Figure 3: Effects on a Basin soil cover with artificial synthetic Foil

The strength and details of the construction must be calculated to last for a period of at least 100 years. Consequently there are serious doubts if a synthetic sealing has the capability to resist any occurrence of cracks during this long period. Although the impermeability is clear, the chance of cracks is present due to abrasion of the seal against the soil grains during earthquakes and settling deformations. For this long lifetimes it must be reviewed what will happen when a crack would occur.
Possible small damages ,of the limited thickness of an artificial Synthetic foil could have serious consequences as water would penetrate between the foil and the soil and thus into the soil, what leads to a lower bearing capacity of the soil. Due to this effect the cracks would become wider and wider. Immediate maintenance would be necessary because the damage would increase significantly and de-stabilize the construction.

Basin soil cover with Reinforced Concrete

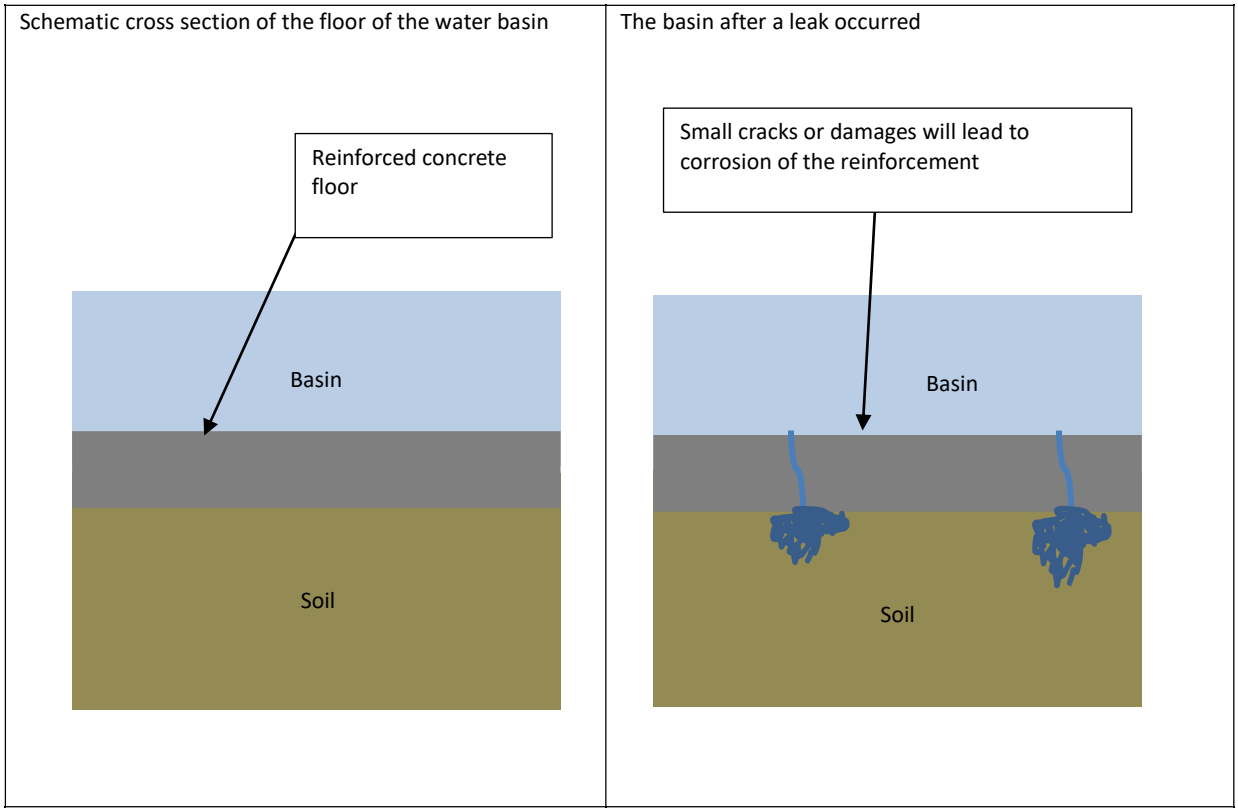


Figure 4 : Effects on a Basin soil cover with Concrete

The reinforced concrete slab will settle over time and will have to bear the dynamic forces resulting from earthquakes. This will lead to a significant chance of small cracks, due to the brittle properties of concrete. Water and sludge will penetrate into the concrete and the steel reinforcement will corrode. It is expected that the (salty) water will cause progressive damaging effects. The corrosion of the reinforcement will lead to more serious damages of the structure and the basin will start to leak.

A concrete floor has a significant impact on the costs and the limited construction time.

Basin soil cover with fine clay

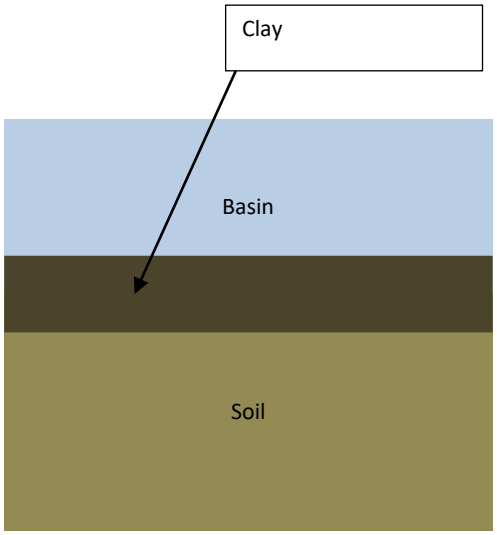
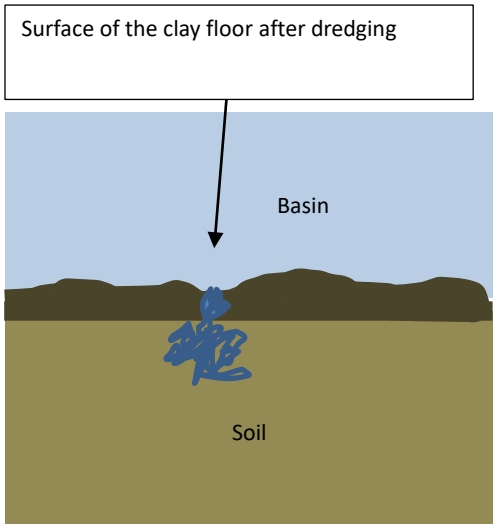
Schematic cross section of the floor of the water basin.	The clay layer can be damaged during dredging of the sludge that will occur at the bottom of the layer.
	

Figure 5 : Effects on a Basin soil cover with Clay

The clay on the floor and walls of the basin will make the basin less permeable but the floor of the basin will not be impermeable. During the lifetime of the construction regular dredging of the sludge will be necessary. Due to the deformation of the soil and eventually also of the less permeable clay layer, the chance that too much clay will be dredged out has a crucial negative impact.

Basin soil cover with RoadCem in-situ soil stabilisation by PowerCem Technologies

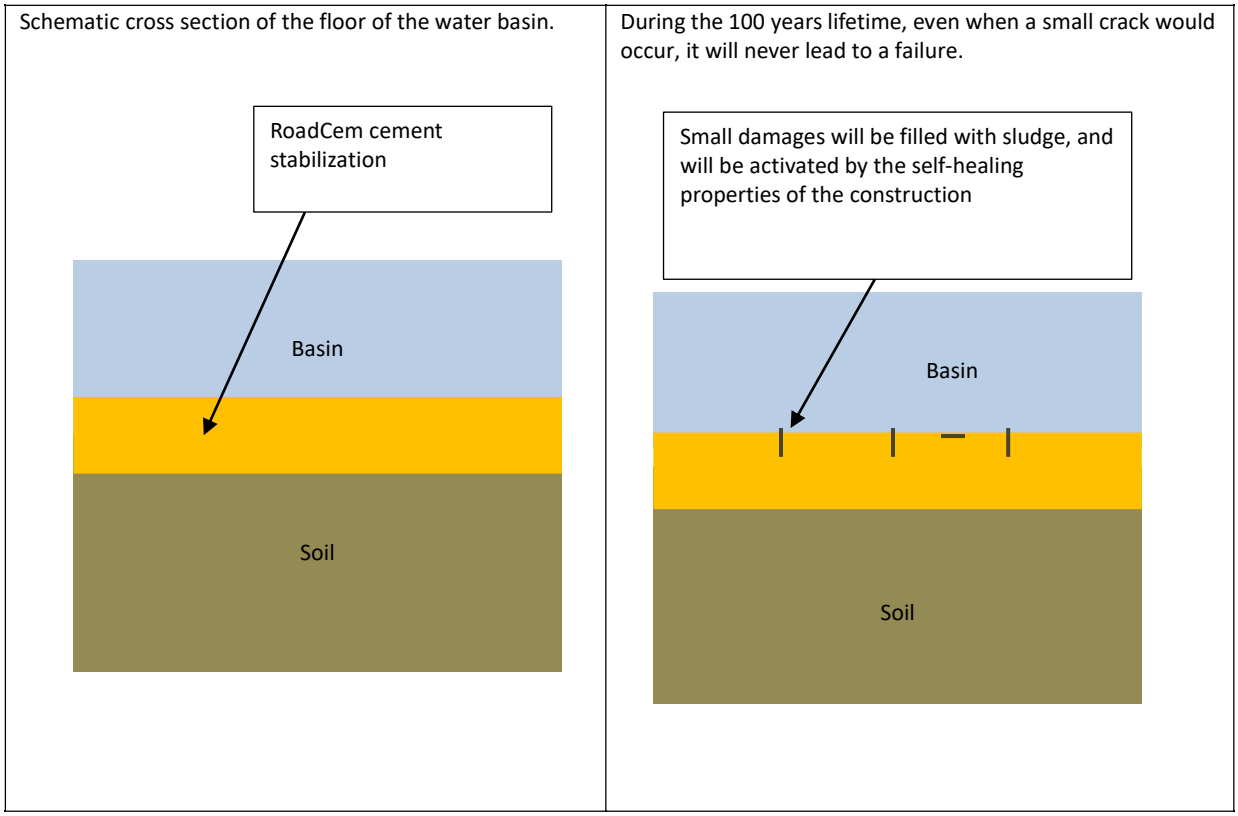


Figure 6 : Effects on a Basin soil cover with PowerCem Technologies

RoadCem is an additive based on the PowerCem Technology. This technology makes it is possible to transform all types of soil into a flexural concrete material. This means that also the in-situ soil at the bottom of the water basin can be mixed with RoadCem and Cement to make an impermeable, flexural layer.

The impermeable elastic material that is created with the in-situ soil, RoadCem and Cement is able to absorb vibrations that occur during an earthquake.

If for one or the other reason a crack might occur, the crack will be sealed with the sludge and the cracks will be closed. With a layer thickness of the RoadCem layer, the sludge will now be part of the self-healing properties and thus small cracks will be sufficiently self sealed.

This method is the only method that does not cause failure of the construction after exceptional situations. In the philosophy of delivering a lifetime of 100 years it was considered the most effective option. Also by using the existing soil, an economic, environmental and technical optimal solution is possible.

Conclusion

Based on the above mentioned deterministic analysis of potential constructions a table is presented where the advantages of the different construction methods are presented to fulfill the demands for the floor of the basins.

Demand	Artificial Synthetic foil	Reinforced Concrete	Clay	PowerCem Technologies
Water impermeability	+++	+++	+	+++
High resistance against Earth quakes	+	+	+	++
If hair cracks occurs it does not lead to damage	---	---	/	+++
Resistance against deformations	----	+++	---	++
Resistance against Damage due to dredging	-	+++	---	+++
Economic (Cost reduction)	+	---	+++	++
Ecological parameter	-	---	++	+++

Table 1: Analyses of the demands of the floor of the basin.

Inspection by Head Engineer Ir. Ing. Christophe Egyed MSc BSc of PowerCem Technologies B.V.

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