Multi-Infra Curbs – New Model for Urban Infrastructure

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Abstract

Active now for over 20 years in the civil construction market we have always been aware of an enormous material waste which has generated large amounts of debris. Focusing on this fact we searched for alternative uses for this residue and began to study ways in which to incorporate the debris as a recycled aggregate in the concrete used to fabricate curbs and gutters for street right-of-ways, in accordance with NBR 15116/2004 regulations.

After we began to develop and analyze the utility of this new piece of urban equipment we realized the enormous potential of a novel way in which to use it. We are aware that curbs and gutters sit in parallel with all the utility networks necessary to supply our cities. It was along these lines that we developed a project for a curb able to double as a support for these distribution networks as presented below. We also became aware of the necessity for connections with the sewage system and concluded that these connections have to be adapted to the city's new necessities in improving the use of our water supply as well as that of collecting and reusing rainwater and reusable sewage waters, the concepts of which we will present here.

We are a private entity and as such always interested in the economic viability of our projects in order to attain to our objectives. To this end we have drafted a contract and cessation model for the distribution of these utilities, as well as processes for metering and charging for consumption, monitoring methods and distribution control, connectivity with consumer units and other innovations to be presented herein.

Keeping in mind that a solution such as this depends on high investments as well as the political will to implement them we are unable to present any effective projection of results of implementation. We do however believe that what we propose below will be easily understood and its benefits easily comprehended.

Keywords: *curb, precast, cogeneration, water, reuse, rainwater*

1. Introduction

As already mentioned in the summary our objective here is to present a new model of implementing the urban utility network intended to resolve a series of problems found in the models used today. It is not uncommon for us to hear of water leaks, floods, pipe ruptures on job sites because of lack of the adequate mapping or negligence of machine operators on the streets, among others. This is brought about by the completely disorganized manner used in locating distribution networks by means of faulty and imprecise placement maps which are rarely redrawn after interference or alterations in them are carried out.

As an example figure 1 below shows a model of San Francisco's sewage system were you can see for

yourselves the complexity of these collection and distribution networks, alongside a view of the system presented here.

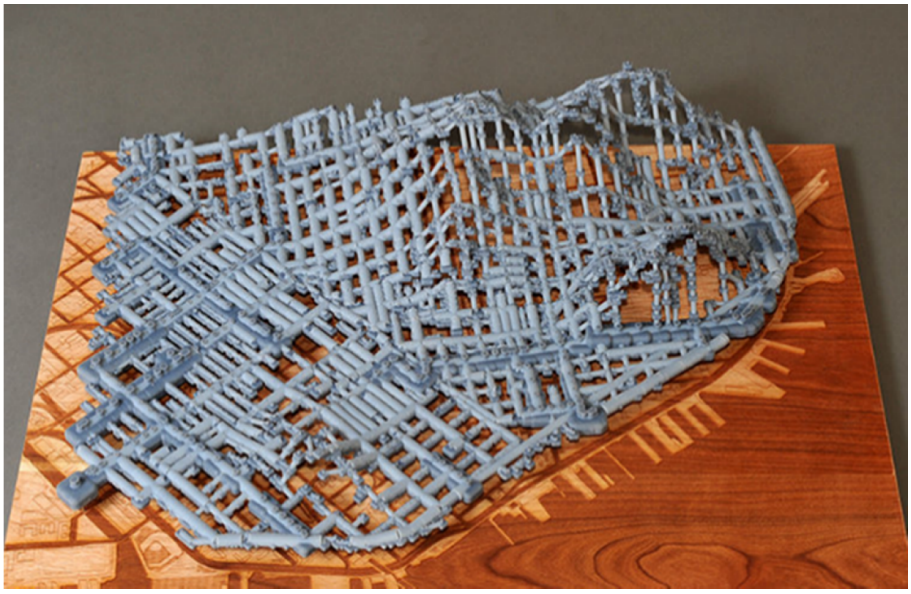


Fig.1 – Model of San Francisco's sewage system (USA) and the curb system.

2. Methods

Our solution is based on placing all networks within one standardized precast structural concrete element in which connection, collection and maintenance modules are interchangeable and able to be connected to the main fixture in any position. Presented here is a complete model (figure 2) including all the utility and collection networks although it is possible to reduce its vertical dimensions by removing any desired single network.

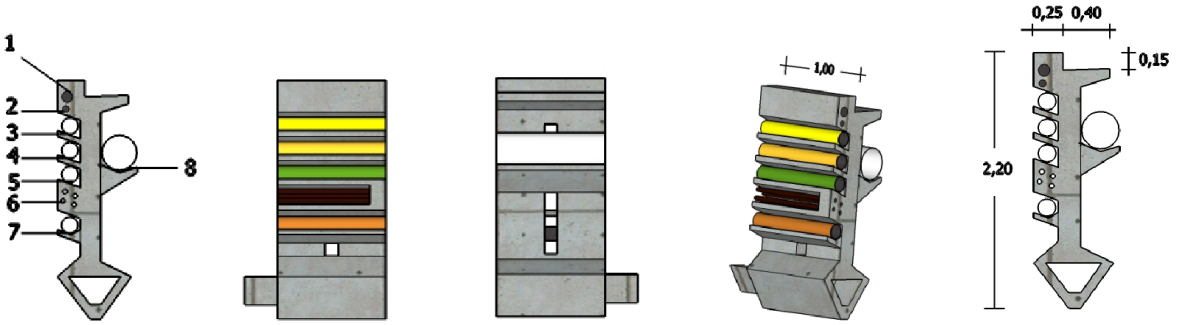


Fig. 2 –Layout, Dimensions, Section and View of Curb

Legend

1- Low tension electricity grid;

2- Data, voice and TV networks;

3- Gas network;

4- Drinking water pipes;

5- Reuse and Rainwater sewage pipes;

6- Medium tension electricity grid;

7- Sewage system

8- System for collecting rainwater

The Curb is made out of precast concrete and houses supports for fixed and movable pipes and tubes. The fixed pipes are for pressurized systems (water and gas) and cables and the movable ones for tubes operated by gravity such as sewage systems as they need an inclination. The concrete may use, as mentioned before, recycled aggregates as long as they are able to furnish adequate resistance, usually around 30 MPa. For the rainwater network we suggest using PVC tubing produced by a helicoid rolling process. In Brazil we have the RIB LOC model supplied by the Acque Engineering Company from Santa Catarina (www.acque.com.br) used due to its lightness and anti-deformation capacities.

Looking at the curb's bottom section you can see a structural interlocking male & female connection which after being put together creates a sort of grade beam footing as well as allowing for the perfect connection between the curbs. It can also be seen that the protuberance of the tooth changes the curb's gravity axis, favoring the connection and improving the piece's performance as well as facilitating its installation in the case the existing grade be unfavorable for the load. Instead of trying to substitute this grade we use wedge-shaped cement blocks resting on piles with the distance between each block dependant on the grading's characteristics as well as the loads on the grade beam in accordance to the quantity of modules used in any specific section.

Based on this solution we had to necessarily create a reservoir, figure 3 model able to adapt to the existing linear network which hinders minimum slope gradients, crossing intersections and the transposition of pipes. This system is also able to attend a demand in the public eye today – that of improving the use of our water supply and after learning more about Engineer Mauricio Santiago's idea concerning rainwater sewage networks published by PINI in the 13th edition of Urban Infrastructure magazine, we developed our own model for a rainwater gallery able to collect, retain and retard drainage not unlike the well-known *piscinões* (large pools). It also makes it possible to collect "gray sewage" (reusable water) in an efficient manner and direct it, for example, to industrial consumption areas which according to CIRRA – International Reference Center for the Reuse of water in Brazil, represents 20% of total consumption, or to less-expensive treatment centers.

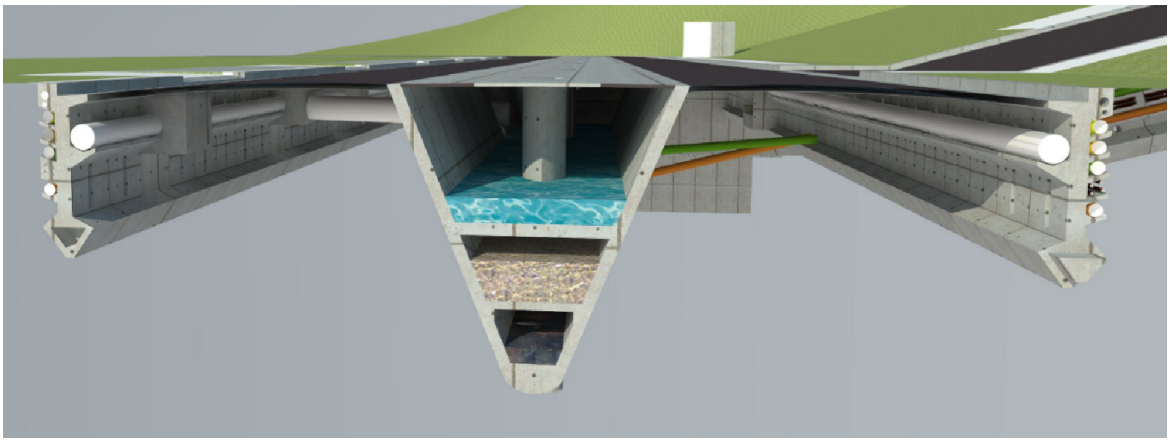


Fig. 3 – Cross section of gallery

Based on our experience with on-site labor management we know just how hard it is to train work crews for implementing and maintaining utility networks, one of the reasons we isolated each of the lines as independently as possible. We believe this issue is seen as being more managerial and logistical than technical by utility companies and operators who have consequently implemented solutions damaging to the environment, standard of living and high consumer costs. An example of this is the manner in which

electricity is distributed in the city via light posts. We ask ourselves - how can such a vital utility as our power supply be left exposed to so many risks.

This exposure can be seen in the form of a mere tree branch falling down on the lines and causing blackouts throughout an entire region for hours, as well as lightning storms, cable theft, clandestine connections and even car crashes colliding with the posts themselves. All these incidents represent large financial losses to be repaired and maintained which each utility company/operator passes on to consumers.

To maintain the networks isolated we developed modules (figure 4) that restrict the access of maintenance crews to only those lines they are responsible for. But then, we soon came up with another better solution which if implemented would generate innumerous benefits: we are aware of an enormous amount of juxtaposing and duplicity of services and loads in the model being used today to distribute utilities. Grouping these lines together and putting only one company in charge of distributing and maintaining them in urban areas would generate diminished operational costs, the money of which could be used to improve existing conditions or cut meter expenses for consumers.

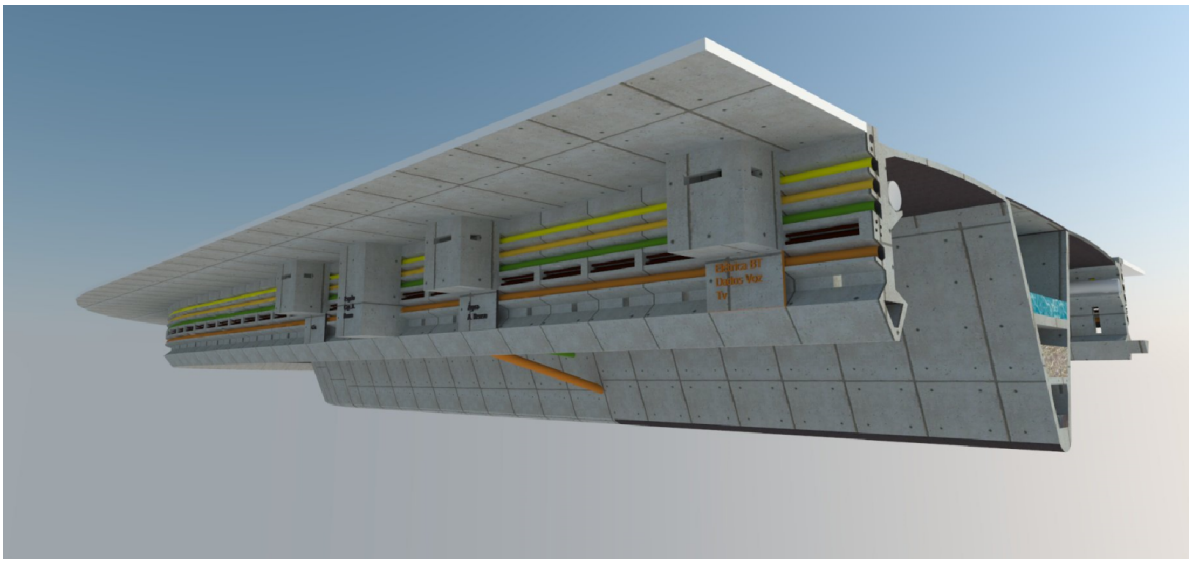


Fig. 4 – Installation and Maintenance Modules

The main problem here would be to train professionals in this area. But still, we do not see any great obstacle in training an electrician who today works exclusively with electric connections to learn how to install a telephone, cable TV or an internet line. Today, in the individualistic system being used, each company has their own fleet of vehicles with drivers, helpers, attendants, distribution centers, stocks, call centers of their own or outsourced. Hardly ever do they work SHARING responsibilities.

For this system using only one company for the entire network we have developed a general connection, figure 5, module in which one compartment concentrates from 16 up to 20 connection points. These points allow to open or block consumption, as needed, for example, when bills are not paid, and are monitored by volume sensors and meters. This would allow for a set of extremely valuable statistics to better manage the network.

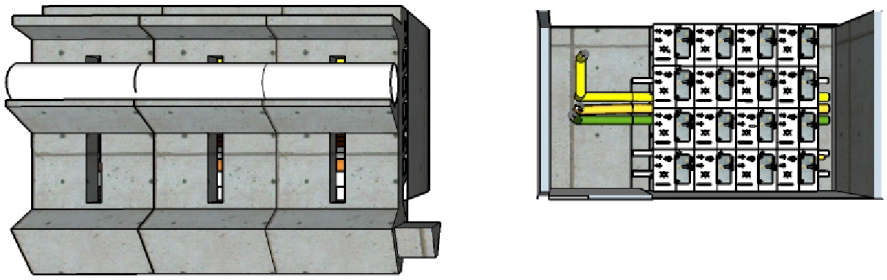


Fig. 5 – General Connection Module – A frontal view of connection panel

For example, by measuring the volume of drinking water sent to any specific "concentration point" (CP) and comparing this to that metered by consumers connected to it the values should be equivalent. If not it is easy to see that there is a problem in the network either between the CP and the consumers or inside the consumer's home if there is a distortion in the metering of average historical use. The consumers would thus be informed to repair their installations. If nothing is found in the consumers' homes we would then conclude to have a leak or a clandestine connection in the pipe and take the proper action to repair it. Being able to verify consumption on an individual level would be a great benefit for all involved.

In search of a sustainable ecological and financial model we also realized that the old system does not use a great amount of potential energy created by the movement of high-pressure water in the distribution pipes as well as that of the sewage system used to collect rainwater and the flux of reusable water. We are thus in the final phase of developing two alternatives for generating energy through water flow in our pressurized system – a Hydro Turbine (figure 6) channeled through the MOGEARP – Module for Generating Energy through the use of Rainwater and Reusable water (figure 7). The energy produced in both cases will be directed to a CETRACO – Treatment and Co-generation Distribution Center (figure 8).

Fig. 6 – Hidro Turbina

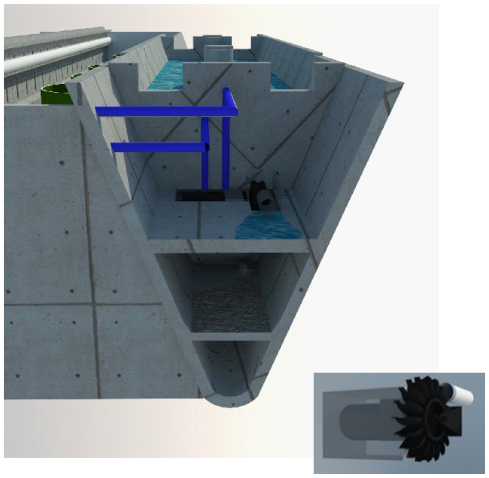


Fig. 7 – MOGEARP

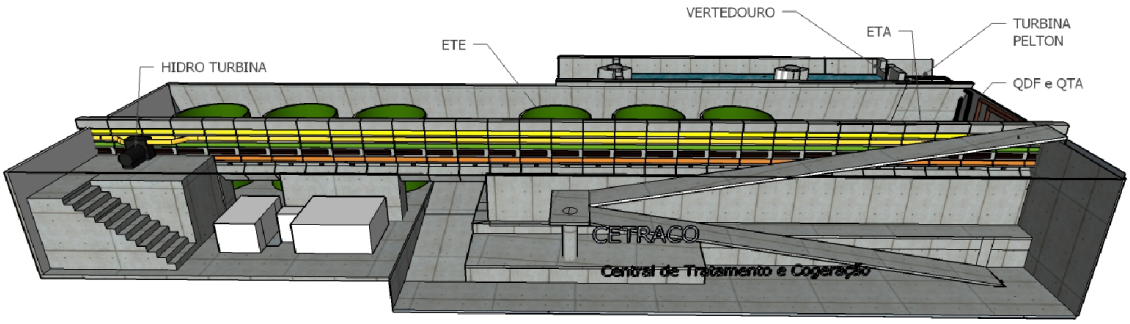


Fig. 8 - CETRACO

The Hydro Turbine works on the same principle as that used by aircraft turbines where the flow of water passing through continuous propellers with alternate rotations generates potential energy greater than that received. In this manner we attain to a delta energy reactance which can be used, for example, if it is connected by an axle with conical gears to an alternator to produce electricity, or to pressurize the water network as a booster working without any external energy source. This pressure can be directed as well to any cooling system in office and apartment buildings, fabrication units among many others.

The MOGERAP consists in installing generation modules at the same level of the rainwater and reusable water galleries. Inside this module we would connect an alternator to a Pelton-type turbine which is activated by water flow coming from a pipe with a diameter smaller than that used on the pipes which supply the gallery which through the use of walls dividing the gallery into sections creates water reservoirs which accumulate water and then by draining it produces energy. We have also built, on the upper portion of this wall, spillways with enough diameter to allow the water to flow off when the reservoirs attain to their maximum capacity, useful to better control flooding. In this manner we are able to use the same volume of water as many times as we want by merely inserting one more section into the rainwater gallery. It is worth mentioning that in this way we will always have enough volume for consumption in the units extending down the street except whenever there is a peak in consumption greater than the capacity to accumulate rainwater. Whenever this occurs the system can automatically divert drinking water to the reuse water system to avoid shortage in the systems supplied by it. The module is able to identify this diversion both when it is activated and then upon its return, making it feasible to meter the difference in consumption of rainwater and drinking water.

A CETRACO will hold two compact stations, one being the ETA (Water Treatment Station) for reuse and rainwater, with a capacity of 5,000 L/H and a ETE (Sewage Treatment Station) which transoms sewage into reuse water with a maximum capacity of 128,000 L per day. We are able to collect water from the gallery by gravity and insert it into the system, treat it and then send it out for consumption.

To be able to use rainwater without pressure pumps in the network we have created a device which connected to the axle of a Pelton turbine installed anywhere on the sewage system would rotate gears, at one end, connected to an eccentric bi-articulated arm and a piston on the other. This device would be inserted in a hermetically sealed capsule with two check valves located on the lower part of its base for admission and exit. The piston operating in one direction would generate suction, forcing water into the capsule, in the other direction it would compress the water creating pressure on the exit valve. This continuous motion would result in pressurizing the rainwater sewage system making it possible to supply higher reservoirs along the line. We emphasize here that the conception of this pressure system counted on the invaluable collaboration of Mr Valdeci de Oliveira. As an alternative manner for mechanically pressurizing the system we have used a series of pumps using energy coming from CETRACO which would automatically transfer all load to the electric energy company supplying the region.

Our projects are invariably designed for the continuous uninterrupted distribution of utilities both during maintenance of the systems as well as in the event of accidents. To this end we have installed a backup pipe (figure 9) on the opposite side of the support with dimensions and manufacturing characteristics allowing for the passage of any of the fluids to be distributed. We also have installed, at the center of the module, at any desired interval, a pipe connecting the three networks on one side and the backup pipe on

the other which, through the use of automatic valves, are able to create bypasses in the network. These bypasses may be individualized to supply vital units such as hospitals, for example. These "bridges" will enable us to connect with networks on the other side of the street. This same concept is applicable as well in energy networks where, through the use of interconnected static switches we are able to bypass and direct electricity using the same network on the other side of the street or via the next CETRACO.

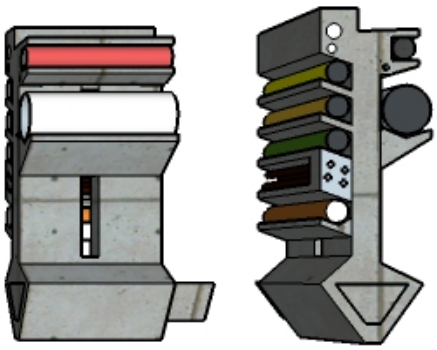


Fig. 9 Backup Module

To prevent accidents and natural disasters we suggest regular inspections using radiology in order to reduce blackout risks to a minimum. But still, the greatest advantage of grouping together all the utility lines is that of reducing global costs of managing each system with the money possibly being reinvested into the monitoring and efficiency of the system. This would provide an overall view of what is occurring on the system at all times, making it possible for quicker action to be taken against any eventual problems.

We have also developed constructive modules (figure 10) used to adapt intersections and access to consumer units not unlike the lowered curbs and for collecting sewage.

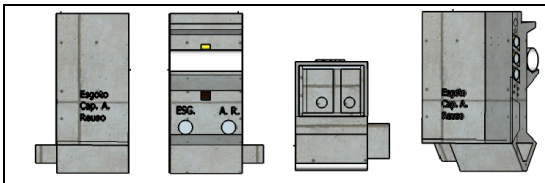
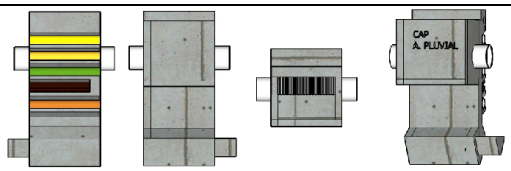
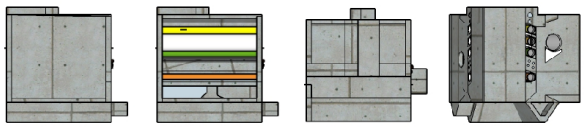
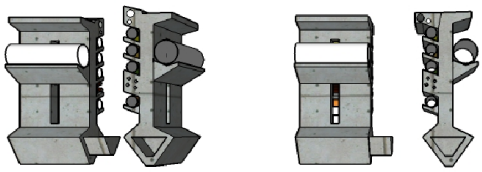
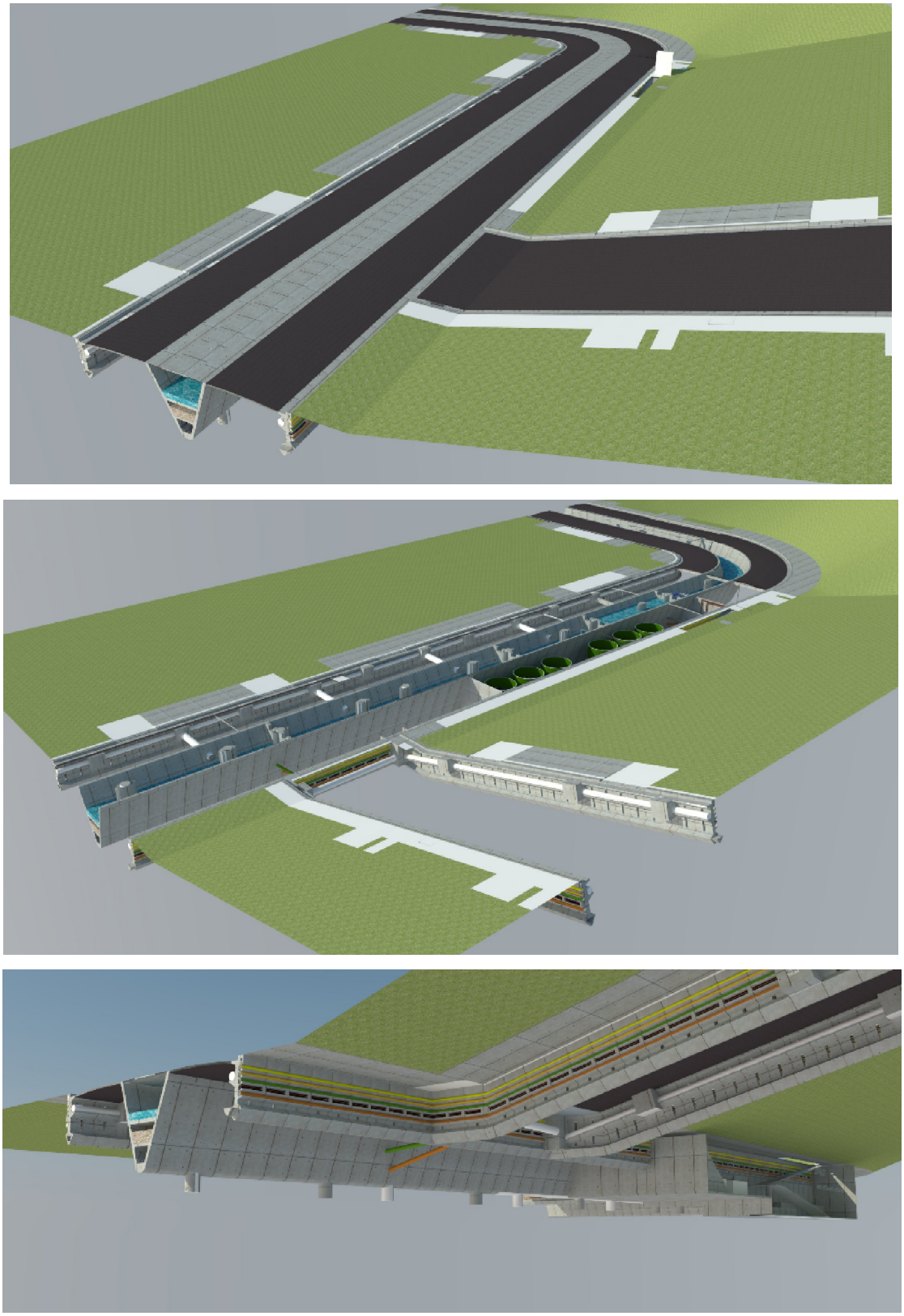
	**Sewage and Reuse Water Collection**: module subdivided into two compartments each with another two separating solids from water which is being sent through independent connections to collection networks.
	**Collection of rainwater**: gutter drain type module, able to be connected or not to the collection gallery or be used as a mere secondary collection point.
	**"Corner"** – Module on the main network used to interconnect with secondary network at intersections.
	**Lowered Curbs** – module permitting access for vehicles and the transposition of the network at intersections.

Fig. 10 Constructive Modules

Figure 11 presents a general view of the system.



We would like to emphasize that we have endeavored to cover all norms and regulations that are applicable today in implementing these networks. But, keeping in mind that nothing like this has ever been done before (according to our research) a few questions and documents must be revaluated when thinking of the networks' applicability on a whole.

3. Results

As we stated in the introduction, the more evident results of using this network have been revealed herein. But we are able to list various other advantages as well:

With less movement of earth in opening ditches we decrease the transportation of material to streams, rivers and lakes.

Due to the support structure there is no need to remove grading when it does not attain to the necessary resistance.

The networks sit on rigid and interconnected supports creating a solid foundation with high safety factors and avoids the sedimentation and slipping of earth which is one of the biggest causers of leaks.

The enormous ease of carrying out repairs on the network, since the position of all components are known. There is no need for usually imprecise mapping which leads to unnecessary costs and accidents.

Decreased cost of execution and installation as all networks must be necessarily installed at the same time in the same ditch. This means sharing costs between the diverse utility companies using the present system.

As already mentioned, changing the light post system to an underground one is costly in function of the cable and transformer specifications demanded by Brazilian norms and standards. Our system could use different standards as our pipes are encapsulated. But even with the present norms and standards our system would significantly decrease maintenance costs and losses due to accidents caused by exposed networks over a medium term. A centralized model would allow for short term gains. This same principle would apply to other cable networks as well.

The effective use of rainwater and reuse water, as shown here to generate energy reduces the collection of water from traditional sources, reduces the volume of water that has to be treated, and reduces the cost for consumers as well as for industrial units.

As we treat the effluents nearer to the consumers, we are able to avoid large work sites to transport all this material to treatment centers. This cost reduction would allow to improve the sanitation in the poorer parts of town.

With our system of retaining rainwater in galleries we reduce flooding and the consequent damage they cause.

An added visual quality in all areas by removing light posts and overhead cables and their equipment.

Using the backup system we are able to guarantee vital units such as hospitals, police stations, and many others. This additional safety factor would help decrease investments needed to continue services in the present system and lead to better services being furnished to the population in general

As we use debris as a concrete aggregate to fabricate the modules, we do not have to throw this waste into the landfills.

4. References

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