

## **Innovative Solution Proposals for Infrastructure Problems of Istanbul**

**Ilknur Akiner, Muhammed Ernur Akiner**

Akdeniz University, Faculty of Fine Arts, Department of Architecture, 07070, Antalya.  
Harran University, Faculty of Engineering, Department of Environmental Engineering, 63190, Sanliurfa.  
ilknuraker@gmail.com; ernuraker@gmail.com

### **ABSTRACT**

As a result of rapid population growth and the lack of adequate controls unplanned construction has increased rapidly in Istanbul up to 1995. Since 1995, in order to prevent irregular urbanization rate, controls have been increased using technology and public housing constructions have been accelerated. Satellite cities with all kinds of planned infrastructure have been created in buildable areas of the city. Despite the acceleration of the establishment of satellite towns in recent years, unplanned construction from the past is existed in a large part of the province. Sustainable development is possible only with the minimization of the high infrastructure costs, urban planning and by having different institutions with infrastructure services that generate joint plans. However, it is a bit late for this goal since a large part of Istanbul completed the process of urbanization. First of all, the solution to the problems of the existing infrastructure should be realized from a headquarters. So, coordination between institutions those provide water and sewerage, electricity, telephone and gas infrastructure services and transportation services of municipalities from a headquarters. Transport infrastructure of the relevant municipalities should also be considered since infrastructures are usually built underneath the pavement and the roads. Concrete channel with a cover known as the Utility Tunnel is proposed for Istanbul as an innovative solution for infrastructure problems. This system provides the implementation of the water, electricity, gas and telephone as well as a combination of infrastructure systems in a single place where the repair and the renewal will be much easier. The ultimate goal of the proposed study is to create a center for the coordination of problems before they occur, and to create many scenarios about infrastructure problems, also to provide necessary prompt and long term innovative and economical solutions based on the infrastructure of the Istanbul.

**KEYWORDS:** Infrastructure; urban planning; sustainable development; urbanization; Utility Tunnel.

### **1 INTRODUCTION**

It is suggested that repair and renovation will be easier if concrete tunnels with manholes are built in Istanbul to install infrastructure systems such as water, electricity, gas and phone all together. This kind of systems has recently been used mainly by developed countries (Riera and Pasqual, 1992). Tunnels suggested for Istanbul should to be constructed in alignment with the sidewalks and roadsides symmetrically, not under the middle of the road, where the vehicle load is at maximum (see Figure 1 and Figure 2). A scaled cross-section of an example tunnel system is shown in Figure 3.

Benefits of this system:

- \* Low implementation cost.
- \* Performing the infrastructure communication at a single center for all services.
- \* More flexibility in equipment that require lots of connections at different times.
- \* More efficient, time-saving application.
- \* Less excavation.
- \* A healthy, safe and quality system.

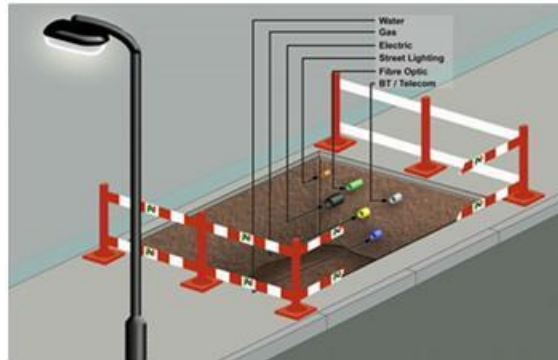


Figure 1: Infrastructure put in alignment with sidewalks and roadside



Figure 2: A combination of all infrastructure systems

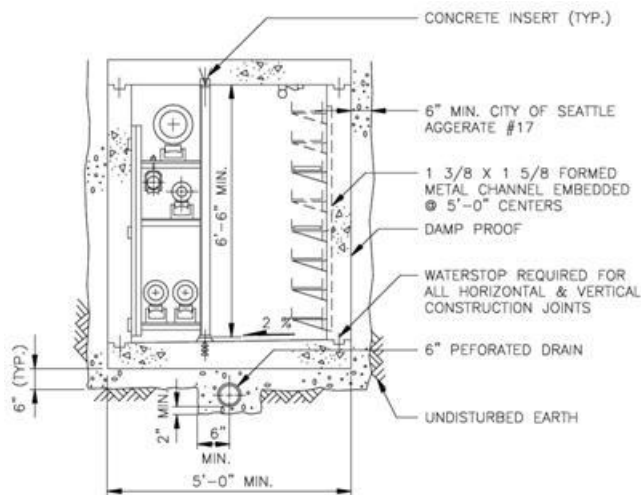


Figure 3: Concrete tunnel cross-section (University of Washington Civil Facilities Services, 2008)

## 2 PROPOSED INFRASTRUCTURE SYSTEM: UTILITY TUNNEL

These tunnels, which are also known as Utility Tunnels, should be sized in dimensions that enable one or a few people work comfortably (AbouRizk et al., 1999; Canto-Perello and Curiel-Esparza, 2001). As an example, the Utility Tunnel constructed for United States Capitol Visitor Center is shown in Figure 4. As a difference of the system planned for Istanbul, the reinforced concrete tunnel that will have a trapezoidal or rectangular cross-section will not have soil on top. It will be covered with reinforced concrete covers. An example entrance for the Utility Tunnel is shown in Figure 5.



Figure 4: Inner View of the Utility Tunnel of United States Capitol Visitor Center



Figure 5: Utility Tunnel entrance from Barcelona – Spain (Canto-Perello et al., 2009)

Precast infrastructure tunnels can be prepared in the factory and moved to the area for easy installation. This application reflects the practicality of the system.

## 3 METHODOLOGY FOR THE PROPOSED SYSTEM

Obviously, the initial cost will be greater when considering traditional practices. At this point, we need to think about the measure to reduce costs. For example, special machines that can perform faster excavation can be used in order to reduce machinery rent and the working hours, and since the cross-section is known, excavation costs can be reduced by performing standard type excavations. In places that have high population densities, the rehabilitation of infrastructure system can be performed by integration of the existing systems to the new system in the first place. During the excavations made for the new system in crowded places, damage in the old system will lead to disruptions in public needs such as water, electricity and gas. In order to ensure continuity of service and avoid damaging during the excavation, all the existing infrastructure maps should be gathered together and examined in detail.

The proposed infrastructure tunnels are planned in alignment with the sidewalk. Another proposal to reduce the cost is to cast the precast concrete covers with patterns. Examples of patterned concrete pavement applications are widely seen in the world, a concrete surface that have a cobblestone appearance will decrease the cost, as well as avoiding any loss in aesthetic sense (see Figure 6).



Figure 6: Concrete pavements with pattern

Isolation may be required in some of the pipes due to reasons such as freezing of material passing through the pipe, possible gas leak, interact with electrical wiring. Maintenance and repair work of the insulation materials that may constitute a potential hazard in case of a deformation should not be neglected.

Cable racks are mounted on walls, in order to facilitate accessibility. Dense clutter of cables may cause fire since the temperature cannot be dissipated in environments lacking an air circulation. The cable rack system will prevent this danger. Infrastructure tunnels should be sized based on certain standards and several factors. There are many example geometries in the literature, made by considering many factors such as creating a comfortable and healthy environment for workers, lining up cables and pipes as to prevent interaction, ensuring a spacious environment to facilitate assembly and disassembly.

Adequate space must be provided between racks as to not hinder a worker's operation. A worker should be able to reach the top rack with ease and be able to repair the fault. It is necessary to pay attention to this fact, during the plans for sizing. It is recommended that the depth of the racks at the level in between shoulder and waist does not exceed 60 cm. The depth of the racks should not be excessive; otherwise there will be difficulties in reaching the cables and repair.

The depth of the racks at a level under navel should not exceed 45 cm. It is important to ensure that a worker may be able to perform repairs in an ergonomic, without leaning forward. If possible, racks should not be put below the waist level. Thus, the horizontal footprint of the workers will not be much, and it will be easy to operate in a limited space.

The weight limits, calculated by NIOSH (The National Institute for Occupational Safety and Health) lifting equation (Waters et al., 2007), are recommended for different rack widths according to the vertical position of the racks (see Eq. (1)).

$$RWL = \frac{500}{20+S} \cdot \left(0.82 + \frac{4.5}{V}\right) \quad (1)$$

Where; RWL is recommended weight limits (in kp (~100 kg/m<sup>2</sup>), S is the rack width, V refers to the vertical position of the racks.

The health of workers and technical staff comes first. In this sense, tunnel interiors should be illuminated, ventilated and signs, visible even in the dark to facilitate escaping in case of a danger, phone and firefighting equipment should be placed at standard, regular intervals into the tunnels (see Figure 7).



Figure 7: Fire detector and ventilation system (Curiel-Esparza and Canto-Perello, 2005)

One other important issue is the security. This type of infrastructure tunnels has concrete covers that can be opened by ill-intentioned people. In case of any sabotage, the tunnel may be filled with water, and the aftermath may be catastrophic if there are any workers throughout the tunnel, as seen in Figure 8. Therefore, these tunnels must be secure in a serious manner. The tunnels should be checked regularly, and the reports on the security situation should be prepared on a regular basis. Gas and smoke detectors, an alarm system that alerts the control center and the closest first responders in case of opening a cover must be standard practices in order to establish security (Canto-Perello et al., 2013). Also the structure of the Utility Tunnel should be tested against natural disasters including earthquake (Chen et al., 2010; Yang and Wang, 2013).



Figure 8: An infrastructure tunnel with destroyed top-cover and filled with water (Canto-Perello and Curiel-Esparza, 2006)

#### 4 CONCLUSION

The innovative infrastructure system project, designed by an academic group, can be successful by the interactive joint research and application practices between the project team and municipality.

The project to be performed will be a design of the reinforced concrete structure to gather all infrastructures together in order to prevent complexity in the infrastructure of Istanbul, as well as the establishment of an innovative management in water and sewage system for the whole city, particularly newer residential areas. A similar study was performed in a study by Mendoza-Espinosa et al. (2006) for the gray water, and the planning team has developed a system model to simulate gray water and recycled water applications with different scenarios. STELLA, developed by the ISEE Systems, was selected as the simulator. This study can inspire us for the efficient use of the water resources by recycling the gray water, at this point; it is suggested with a reference to the Karahan (2009) that 50% of the water consumed can be obtained through the gray water system, by using in garden irrigation, toilet cisterns, cleaning, etc. after treatment.

In this case, the volume needed for pipes to be used to drain recycled water should also be considered in the infrastructure system to be designed, if this will be implemented in the future or in the

near term. In other words, adequate space should be designed by taking account of the possibility of future expansion in the cross-section. If the proposed infrastructure system is considered for Istanbul, basic costs, operational costs, productivity, construction time, use of supports and resources will be the priority issues to be determined for the innovative infrastructure project.

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