UNCONVENTIONAL APPLICATIONS IN UTILITY TUNNELS FOR URBAN AND INDUSTRIAL AREAS.

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Abstract

This paper is centered in discussing the use of bodily enter utility tunnels for unconventional applications. The use of multipurpose utility tunnels to integrate urban services has an enormous potential for our cities, in order to solve problems of congestion in the shallow underground. Unconventional utilities may be grouped into two categories: pressurized slurry lines and pressurized or vacuum pneumatic transport conduits. These services are not in common use at this time. But the future is always unpredictable, and just as this generation has benefited from nineteenth-century generosity in thinking, our society must provide forward thinking to meet the needs of our successors. If utility tunnels are too finely tuned to present needs alone, they will soon become outdated. Utility tunnels are potentially one of the most sustainable urban underground facilities, and must therefore be taken into account in urban planning, even though their design and operation risks might seem discouraging.

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1. INTRODUCTION.

Urban utilities are overcrowding subsurface space [Cerdá, 1867]. Future sustainable underground strategies will consist of the ability to lessen the use of traditional trenching [Cano, 1999]. There is an increasing interest in utility tunnels for urban areas
as a problem-solving technique to avoid congestion of the underground [Carmody, 1993]. One of the basic advantages of utility tunnels is the substantially lower environmental impact compared with trenching alternatives. Implementing these underground tunnels is retarded most by initial cost and management procedures [Sterling, 1983]. The habitual procedure is to meet problems as they arise in current practice. Sustainable strategies fail to confront the economic and political conflicts of interest [Curiel, 1998].

The use of utility tunnel for unconventional services is not common at this time. Paris sewer-utility tunnels present most of the experience in this matter. Unconventional utilities may be grouped in three categories. First, use of utility tunnel whole cross-section as combined sewer. Second, utilities using a pumped slurry system for picking of solid waste. And third, the pressurized pneumatic conduits for mailing. Installation of new utilities or services in utility tunnels can be performed without further excavation and with minimum inconvenience. The aim of this report is to discuss and to describe the requirements and problems associated with utilidors.

Figure 1. Walk-through utility tunnel cross-section. Utility tunnels that can be accessible by man all the way long.

2. UNCONVENTIONAL SERVICES IN UTILITY TUNNELS.

Unconventional services, which may be required in utilidors, include basically sewage, movement of solid wastes and transfer of mail or goods using pneumatic tubes. There are three different types of sewer systems: sanitary, storm and combined. Since the second half of the last century, sanitary and storm sewers are usually kept separate, due to the fact that sanitary drainage generally discharge to sewage treatment plants (Rainer
The first utility tunnels designed by Roman engineers were actually combined sewer systems, with a network of pipes for water supply in its top cross-section (e.g. “Cloaca Maxima”). During the XIX century, also French engineers used the whole cross-section as combined sewer system simultaneously. This configuration of utility tunnel is still working in many cities.

Pneumatic tubes are systems of air-driven containers in a network of tubes used for transporting physical objects. Hero of Alexandria used first pneumatic systems in the 1st century AD. In the XIX century, capsule pipelines was used to transmit telegraph messages to nearby buildings from telegraph stations. While they are commonly used for small parcels and documents, they were originally proposed in the early 1800s for transport of heavy freight. It was once envisioned that massive networks of these tubes might be used to transport people. Alfred Beach built a pneumatic train subway in New York, which ran for one block west of City Hall in 1870 (it was just 100 m long). It was also speculated that a system of tubes might deliver mail to every home. A major system in Paris was in use until 1983 when it was finally abandoned in favor of internet and telephone lines. Slurry pipelines are used to transport aggregate materials by embedding them in a fluid, usually water. At the end of the pipeline, the material is dehydrated, and the aggregate is thus available. However, the water that is removed may contain environmentally hazardous materials and create an environmental problem. Services described are not in common use at this time in utilidors and there is only limited experience.

Figure 2. Searchable utility tunnel. Utility tunnel that can be accessible in a selective form, but personnel displacement is not possible due to its reduced cross-section

3. REQUIREMENTS ASSOCIATED WITH UNCONVENTIONAL SERVICES IN UTILITY TUNNELS.
There are many workplace health problems related with the use of the utility tunnel's whole cross-section as combined sewage system [Cantó, 2001]. The atmosphere may suddenly and unpredictably become lethally hazardous (toxic, flammable or explosive) from causes beyond the control of the worker [Cantó, 2002]. Poor air quality can cause a decrease in work performance, general feelings of poor health, reduced ability to concentrate, or illness. Health problems are often associated with a lack of adequate fresh air, allowing low levels of a variety of contaminants to build up in the utility tunnel’s air supply. Circulating air must contain an adequate portion of fresh outside air. Otherwise it will only redistribute contaminants, not dilute them. In addition, there are certain health conditions that have been linked to microorganisms found in the sewer systems environment. The origin of this type of problem is usually a location where dirt or water has collected or high humidity is present, providing a good medium for the growth of microorganisms. Another problem in utility tunnels usage as sewers is flooding, not just for workers but also for urban services conduits.

Figure 3. Placing conduits on shelves minimizes workers injuries.

The use of a pumped slurry line for the conveyance of solid wastes presents requirements similar to those in water supply or pumped sewer conduits in utilidors [Curiel, 2002]. The leakage, which could flood the utility tunnel with slurry material, is the main hazard. Joint use of pneumatic transport conduits and gas yield a potential hazard. Since pneumatic lines are frequently operated so that the pressure in at least one tube is below atmospheric, the possibility exists of splaying any leaking gas into the tubes. This could result in an explosion at the terminals of the mail tubes. Gas detectors must be installed to shut the system down if a gas concentration over 1% is detected. The need to avoid sharp bends in the tubes may yield to excessive space requirements. Temperature rise due to heating lines in utilidors may be considered favorable for pneumatic tubes. Since condensation of water in the tubes is reduced and the possibility of icing is eliminated. However, a leakage in the heating conduits may produce a large change in tube temperature. Since the system used for the pneumatic collection of solid waste is similar in principle to pneumatic tube mail lines, the above observations, in general, apply. In addition there is the possibility that an explosion or fire could result from waste materials introduced into the system. This could jeopardize other utilities.
4. CONCLUSIONS

Design of urban services must take into account not only our present needs, but also future needs in utilities. Furthermore, we must reserve underground space for future advances in urban utility systems. When the first utility tunnels were constructed in the middle of the nineteenth century, electricity was not considered as an urban utility, but when this service was developed over the next years, utility tunnels were prepared to receive new cables. In order to achieve sustainable development of urban underground space for utilities, it is necessary to integrate urban services by using systems like utility tunnels and by trying to avoid trenching.

One of the advantages, utility tunnels can offer in front of traditional trenching, is that there appear to be a number of utilities which are not in common use at this time that could be installed when a demand arises. In a well-designed utilidor with adequate expansion space, most of these utilities could be installed. Avoidance of short radius bends might produce some problems in design of the tunnel but should not be too restrictive. Compatibility problems appear to be no more significant than those existing in a utility tunnel with current utilities.

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