

Designing Coordinated Services Tunnels for Environmental Health and Safety

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Abstract

Many modern cities like Singapore are rapidly expanding their built environment and constantly working to expand their infrastructure network, building new and changes made to pipes and cables underground are common. With the current system of laying of pipes and cables underneath roads and road reserves, any modification to the pipes and cables would mean that the roads or the road reserves have to be dug up before work progress and then patched back after its completion. The proposed coordinated services tunnel (CST) will eliminate all environmental safety and health issues. Despite the large capital costs estimated to build coordinated services tunnel in Singapore, many great advantages in safety and health it will bring justify it. With better design and coordination, integrated service tunnels can be further applied to house not only the utilities services, but other drainage and sewer pipes and is a permanent solution to the conventional method of excavating grounds for modifying utilities services cables and pipes. Benefits of having this service tunnel are to reduce installation and maintenance costs in the long run, eliminating environmental impacts of safety and health, and increasing the life span of the utilities services housed in the tunnels.

Keywords

Coordinated services, tunnel, integrated, infrastructure, environmental health and safety.

INTRODUCTION

CURRENT SYSTEM USED IN SINGAPORE

Currently, all Singapore new towns have full range of public utilities such as telecom cables, power lines, and water pipes as well as provision for pneumatic refuse collection pipes linked up within the town itself. In the current new towns, these public utilities were buried in the space between buildings and the road edge (termed as the 'road reserve'; see upper picture in Figure 1), while others are embedded underneath the roads (see lower picture in Figure 1).

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Figure 1. Current Layout of Services

DISADVANTAGES OF CURRENT SYSTEM

Traffic Disruption

In order for the laying and maintenance of service pipes and cables, roads have to be dug up by contractors. This means that part of the roads have to be cordoned off to allow work to progress. This holds up traffic and poses safety and threats to the users of the roads (Figure 2).



Figure 2. Road Block

Unreliable Services

As most utility services are laid underneath roads or soil, utility supplies may sometimes be disrupted due to accidental hacking of existing cables and pipes. It is also difficult in inspecting and maintaining them regularly.

Inefficient Laying of Services

To lay new service pipes and cables under the road or road reserves take long period of time. This causes great inconveniences to the public and incurs high costs for the work.

Inflexible to Meet New Demands

Future changes in the demand for utility services by developments are difficult as large effort is required in the planning and design for a new pipe or cable layout as the changes may affect the pipes and cables of existing utility services. For example, contractors must check for existence of underground cables and pipes before the contractors can carry out the laying works.

Increase in Pollutions

Current dwellers in the new town will be subjected to noise and dust pollutions caused by road excavation for the laying of new services or repairing the damaged services.

Stagnation of Spaces

Spaces occupied by underground utility services can now be redeveloped into useful facilities. This was not possible before if the utility services buried underground posed potential safety threats.

Uneven Road surfaces after Works

The most common problem seen on the road surfaces after completed underground works by utility companies is the uneven road surfaces caused by improper execution of resurfacing the road. Such bumpy roads are safety hazards to road users especially motorcyclists (see Figure 3).



Figure 3. Uneven Road Surfaces

PROPOSED SOLUTION

It is recommended that all new towns have the CSTs installed for the hosting of utilities including electrical and telecommunication cables, water and potable water pipes, sewerage pipes, waste water pipes, gas pipes and pneumatic refuse conveyance system. Singapore has a wide network of roads coverage that includes expressways, major arterial roads, collector roads, and other local access roads. Excluding expressways, it is proposed to build the CSTs underneath this extensive network of roads. The exclusion of expressways is because most expressways are built either underground, overhead or are frequently linked to a flyover, and further digging is impractical and not practicable.

DESIGN COORDINATED SERVICES TUNNELS FOR NEW TOWNS

The dimensions of the main CST (generally for 3-lane roads) and branch CST (for 2-lane roads) will be similar to that in the Marina Bay. The width of 13.7m gives sufficient room for movement and work to be carried out in the main tunnel itself. The dimensions for branch tunnels are 8.7m width x 4.8m height. Vehicles and other equipment will also be able to enter the CSTs (main and branch).

The dimensions of the minor CST (for pedestrian walkway and 1-lane road) will be 4000mm by 4000mm. Generally, it will be split into two compartments; a pipe tunnel and a cable tunnel. The cable tunnel consists of Power Cables (Distribution), Power Cables (Transmission) and Telecom Cables.

The pipe tunnel will consist of a 600mm diameter Pneumatic Refuse Pipe, 1200mm diameter Water Pipe, 300mm diameter Water Pipe, 300mm diameter Recycled Waste Water Pipe. However, the 1500mm pipe for district cooling is not a necessity in residential estates. Thus, we recommend that it will be removed. A gas pipe will also be added on the top right hand corner as it is a necessity for residential estates.

The recommended layout of the CST (main tunnel) and CST (branch tunnel) are illustrated in Figure 4 and Figure 5 respectively. Figure 6 shows the layout of the minor CST.

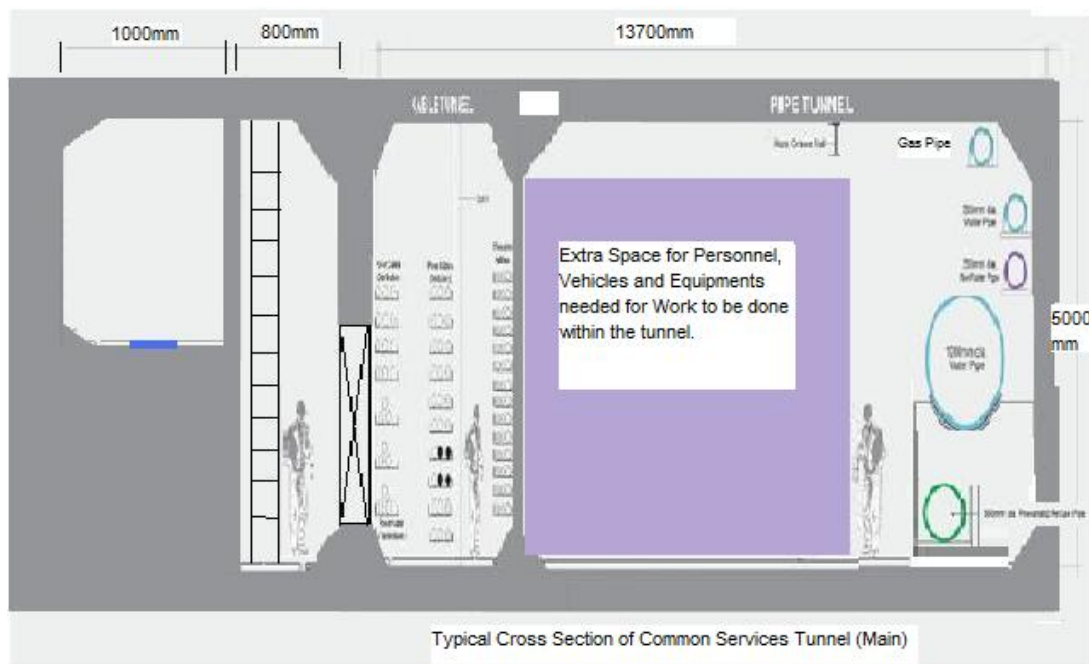


Figure 4. Coordinated Services Tunnel (main tunnel). *Edited from URA website.*

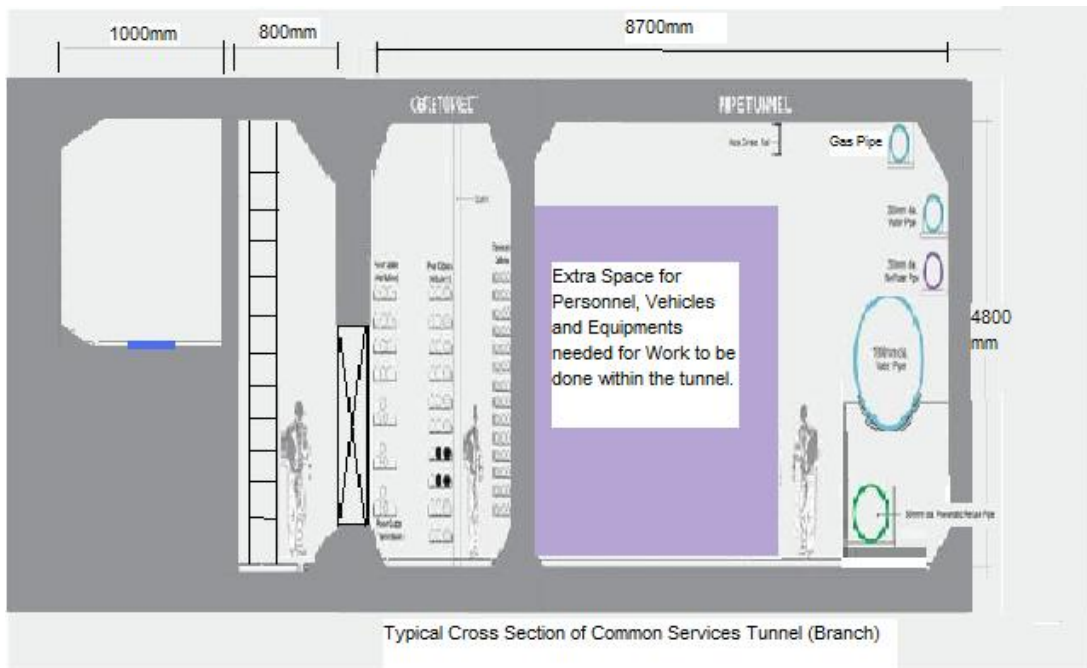


Figure 5. Coordinated Services Tunnel (branch tunnel). *Edited from URA website.*

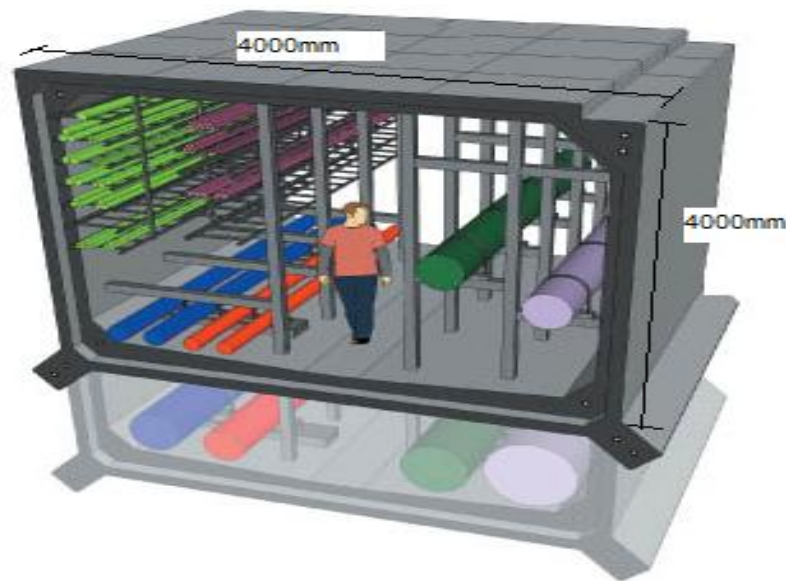


Figure 6. Coordinated Services Tunnel (minor)

Placement of Manhole

Manholes are needed for workers to enter and exit the coordinated services tunnel. Usually, the pavement for pedestrians (or walkway) along the roads are about 1m away from the side of the road, propose to have the manholes build in between the existing drainage and the CST, at every interval of 200m.

Size and Depth of Manhole

The size of the manhole shall be sufficient for most man to pass through. Extra allowance space must also be given as the user may have to bring equipment along, via the manhole. Thus, the manhole shall have the diameter of 800mm in size. The manhole shall be as deep as the CST's depth. It is estimated to be 6m in depth from the pavement level.

Depth of CSTs

As the CSTs are built under the roads, it would not be necessary for it to be deeper than a meter. Thus, the recommended depth from the top of the CST to the road surface is kept at 1 meter.

Vehicle Entrance to CSTs

Vehicles Entrance to the main and branch CSTs can be built at strategic locations near the Town Centre. The vehicles transporting the equipment and pipes can enter the CSTs via these entrances after passing the security clearance. The town council of each new town will do conducting of security clearance and the coordinating of the usage of the CSTs.

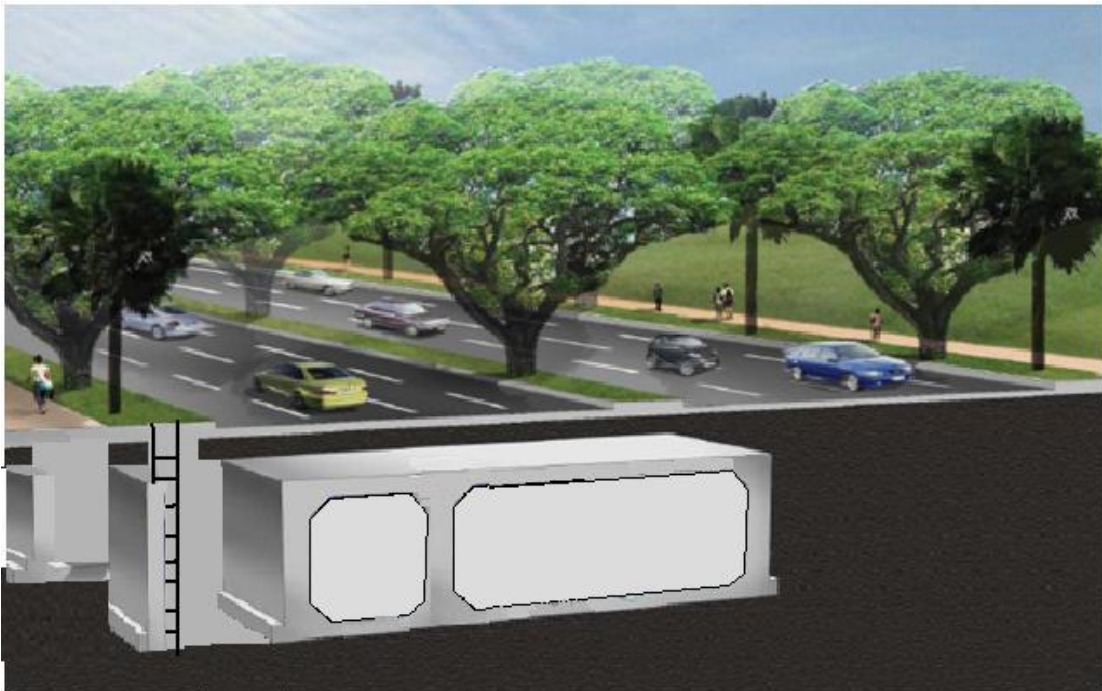


Figure 7. Illustration of Coordinated Services Tunnel (main) underneath main road

INTERFERENCE WITH OTHER INFRASTRUCTURES

It is not advisable for the CST to be built across other built underground infrastructures such as underground walkways, underground Mass Rapid Transit track. However, as it is common to find underground walkways and MRT tracks underground, it will be an inevitable problem. Thus, should the need arise, the arrangement should be such that the CST is above the pedestrian underpass, which may require relevant reconstruction adjustment works, followed by the underground MRT tracks being below (as they are usually located at an average depth of 14.7m below ground level (Urban Rail website)).

IMPLEMENTATION STRATEGY

In order to build CSTs into current new towns, we must remove all current pipes and cables underneath the road and road reserves and then shift them into a built CST. This is impractical and almost impossible to implement. Thus, I will recommend the CSTs to be first implemented in new building project, and subsequently at older estates undergoing

redevelopment. In 10 years' time, the building of the CSTs will be fully implemented in Singapore.

ESTIMATED OVERALL COST

The completed phase 1 comprising of 1.4km of common service tunnel in Marina Bay is about \$81 million. The estimated costs of phase 2, a 1.6km will cost about \$137 million.

Thus, the average costs of building a CST is \$72.66 million/km.

Singapore has about 3000km of road. Total length of expressways are about 150km; Total length of Major Arterial Roads about 575km; Total length of Collector Roads are about 405km; Total length of Local Access roads are about 2014km (KSDB website).

Total residential area: 2.06km²

Total area of Singapore: 667km²

Fraction of residential area/total area is about one-third (1/3).

Estimated total length of major arterial roads, collector roads and Local Access roads connecting to new towns: 2994km x 1/3 = 998km

Therefore, total estimated costs is 998km x \$72.66million = \$72,514.86 million

CONCLUSION

Many modern cities like Singapore are rapidly expanding their built environment and constantly working to expand their infrastructure network, building new and changes made to pipes and cables underground are common. With the current system of laying of pipes and cables underneath roads and road reserves, any modification to the pipes and cables would mean that the roads or the road reserves have to be dug up before work progress and then patched back after its completion. The companies laying the pipes and cables do not coordinate the time when such underground works are being carried out. Thus, it is possible that a particular road has been dug and re-dug several times in a month, only for works to be carried out by different contractors and for different purposes. Resources and time have been wasted for such repetitive works, these works account for numerous worker injuries and posing safety threats to the road users and pollutions to the environment. The proposed coordinated services tunnel (CST) will finally eliminate all these environmental safety and health. The checking of utilities will also be simplified with the CST. Trenches will not need to be dug in order to find the sources of leaks in utilities. Similarly, because of the placement of utilities near roadways, the CST will avoid traveler inconveniences as every trench that would otherwise have to be dug would compromise drivers safety and the safety of flaggers.

Also, as the current underground of roads and road reserves are not visible to the public, it is common for the individual pipes and cables to be placed in a disorganized fashion, often in the way of one another. Works for any of the cables or pipes will be delayed as contractors have to study the plans and drawings, and dig to find the cable or pipe. They also need to avoid disrupting any other pipes or cables that do not belong to them, laid nearby.

Having a coordinated services tunnel will solve the problems faced by having an organized, shared and well-maintained specially-built tunnel underneath the ground for all the cables and pipes. Contractors will know where exactly their pipes or cables are and they will be rest assured that their work will not disrupt or damage the other services in the vicinity.

Despite large costs estimated to build coordinated services tunnel in Singapore, the many great advantages in safety and health it will bring. Indirect savings in the costs of digging

and re-patching roads, and the possible earnings from the redevelopment of the lands that are free up upon the completion of the common services tunnels, will further justify the large initial costs spent.

Coordinated services tunnels are purpose-built concrete underground structures for housing utility services such as electrical cables, communication cables, and water pipes, cooling systems, gas pipes and pneumatic refuse collection pipes etc.

In year 2006, Singapore has successfully implemented a pilot coordinated service tunnel system in the construction of Singapore's first Integrated Resort in Marina Bay. This success will path the way for building a complete city scale network of purpose-built tunnels island wide that house and distribute various utility services.



Figure 8. Design of the Common Services Tunnel in Marina Bay

Figure 8 shows the design of the common services tunnel in Marina Bay, Singapore. It is generally 13.7m in length and 5m in height. With a height of 5m, it is sufficient for any personnel to go into and work comfortably in the CST. The width of 13.7m gives sufficient room for movement and work to be carried out in the main tunnel itself. The dimensions for branch tunnels are 8.7m width x 4.8m height.

However with better design and coordination, integrated service tunnels can be further applied to house not only the utilities services, but other drainage and sewer pipes and is a better solution to the conventional method of excavating grounds for modifying utilities services cables and pipes. Benefits of having this service tunnel are to reduce installation and maintenance costs in the longrun, eliminating environmental impacts of safety and health, and increasing the life span of the utilities services cables and pipes.

The wide network of CSTs may also be considered for other national safety usage. As they are underground and are linked throughout Singapore, it can also act as an underground Singapore Civil Defense Force (SCDF) bomb shelter and can be used by the Singapore Armed Forces for defense purposes. These alternative usages of the CSTs will further support the building of a widespread network of CSTs in Singapore.

The implementation of coordinated service tunnels on macro scale reflects the ambition of Singapore to be a top class first world nation. With the ability of the Government and the strong finances of the country, it is possible for Singapore to afford the coordinated services tunnels for the entire Singapore city. With such advance infrastructure in place, Singapore will become one of the top urban cities to live in.

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