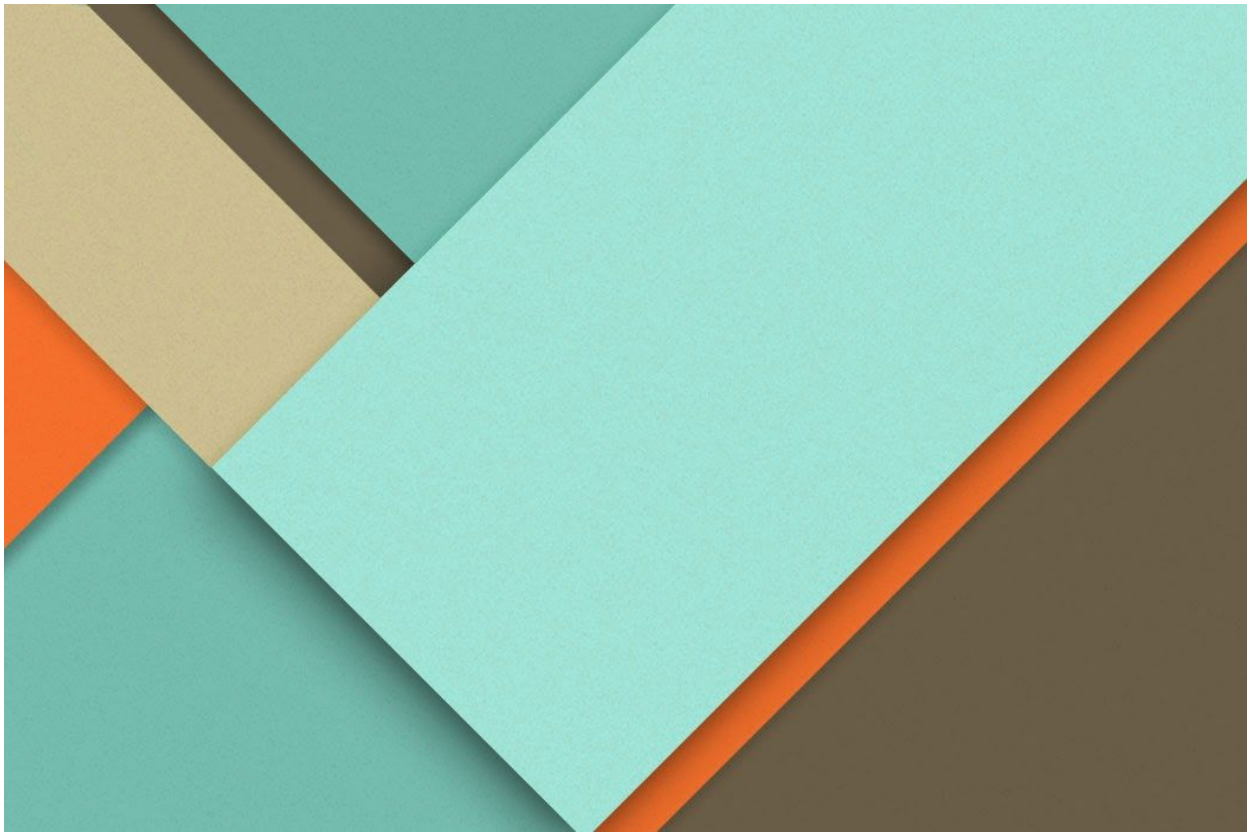


Feasibility study to mitigate the problem of congested utility lines within carriageway

An Engineering Science Project, in Collaboration with JTC Corporation

By Darryl Lim, Ethan Lim, Alex Pan and Tan Yu-fei, 2i1

Project Group 11-07

Abstract

Traffic jams have become an almost daily occurrence in our lives. However, many traffic jams are actually caused by road works for utility cables. In 2018 alone, there were 12,794 Road Opening Applications made to the Land Transport Authority, of which more than 60% was contributed by power and telecommunication cables, the focus of this project. The current practice of laying utility cables consists of the arduous process of excavation of the road, replacing or installing the lines before filling in the excavation site. There is also little to no cooperation between agencies and underground space is messy and unregulated, with cables arranged haphazardly and stacked messily on one another. This increases the amount of time and frequency of road openings. As such, a solution of cables being laid in a compartment next to the drain, flushed to ground level, was developed. A modular system of cables was also developed, making installation and replacement of cables easier and faster. Agencies, agencies and relevant authorities will cooperate to schedule works at the same time, preferably at night, while security of these amenities will be ensured through the use of CCTV cameras and strict laws.

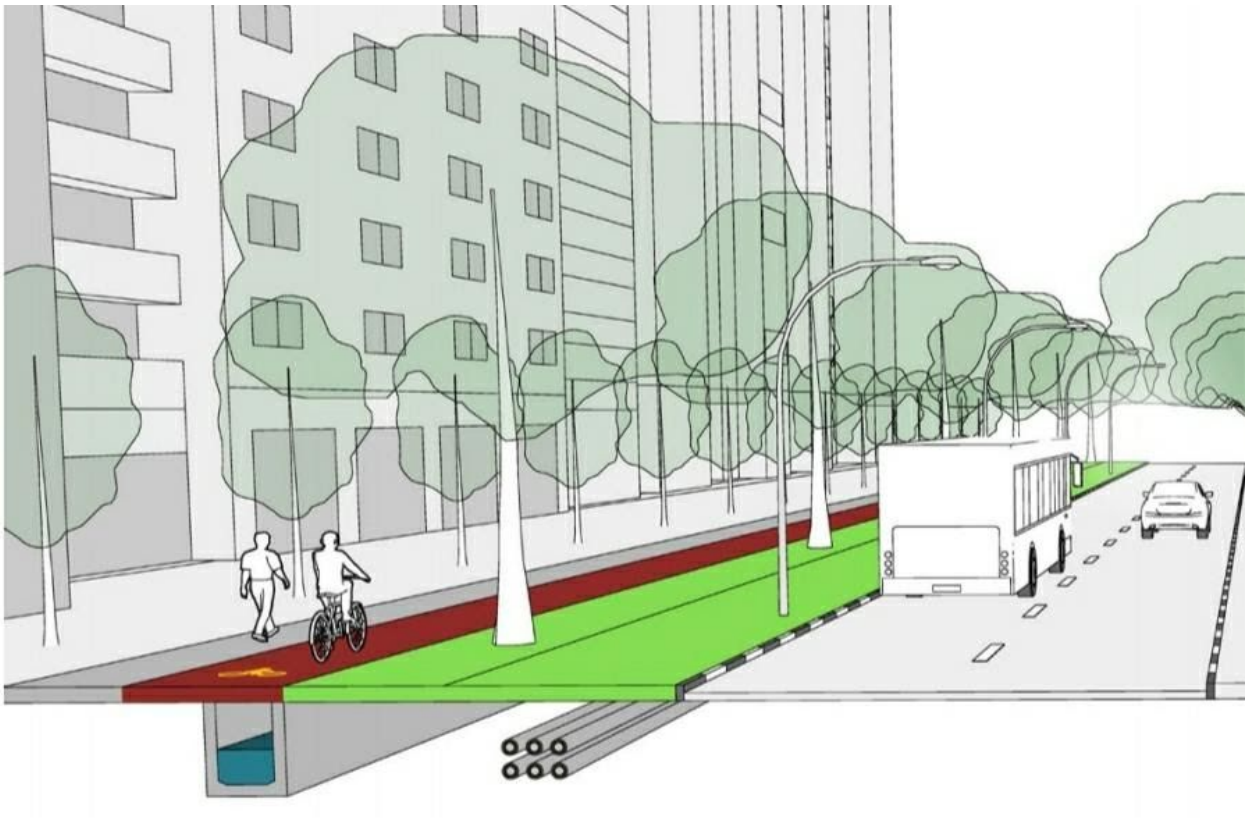
Introduction

Current Practice

Currently, the procedure for road works for electricity and telecommunication lines is very flawed. Firstly, there is no fixed schedule, no coordination between agencies, leading to more frequent road works as each agency does works for only itself. Excavation of the road is always necessary to access the cables for works, which lengthens duration required for road works. Underground space is unregulated and cables are haphazardly arranged and stacked on each other, complicating road works and leading to more time required for works. Such a messy arrangement also increases the chances of accidental damage to other cables during works, warranting yet another repair project, increasing the number of road works carried out.

These factors result in slower and more frequent road works, and thus unnecessarily lengthy and high occurrence of traffic congestions caused by these road works. It is obvious that an innovative and effective solution is needed to improve these current practices and minimise traffic congestions caused by these inadequate processes.

Messy arrangement of utility cables



Designated area for cables according to LTA guidelines. Cables are placed under green section, accessed by excavation of road.

Considerations

A few points have been taken into consideration while developing a solution. Firstly, utility cables have to run along or under roads as this will ensure that the cables lead to all consumers since roads lead everywhere. Also, the branching of cables is similar to the branching of roads. The space containing the cables should have a 1.2m wide working space for a person to carry out works.

Solution Design

Proposals

Five proposals were developed to solve this problem:

1: Installing utility lines under footpath

2: Joint excavation projects

3: Modular arrangement of utility lines

4: Stricter rules to prohibit installation of lines under road

5: Installing cables under the centre divider of the road.

Then, a decision making matrix was used to choose the best solution with the help of an external mentor from JTC, using the following criteria provided by JTC to rank the solutions:

- Ease of maintenance
- Security of the amenities
- Cost of installation and maintenance
- Total time required for planning and implementation
- Effectiveness at minimising traffic congestion

	Effectiveness at reducing congestion	Total time required	Cost of installation	Security of the cables	Ease of maintenance	Total Score
Importance	5	4	3	2	1	
Utility lines under footpath	5	3	1	5	5	55
Joint Excavation Projects	1	1	5	3	1	31
Modular Arrangement	2	1	4	3	4	36
Stricter Rules and Penalties	4	3	3	3	2	49
Utility Lines under centre divider	3	3	2	3	3	42

Solution 1 was chosen as the best solution. However, it was found that Solutions 2 and 3 could be merged to Solution 1 for a more effective multi-pronged solution. Hence, an action plan was developed.

Action Plan

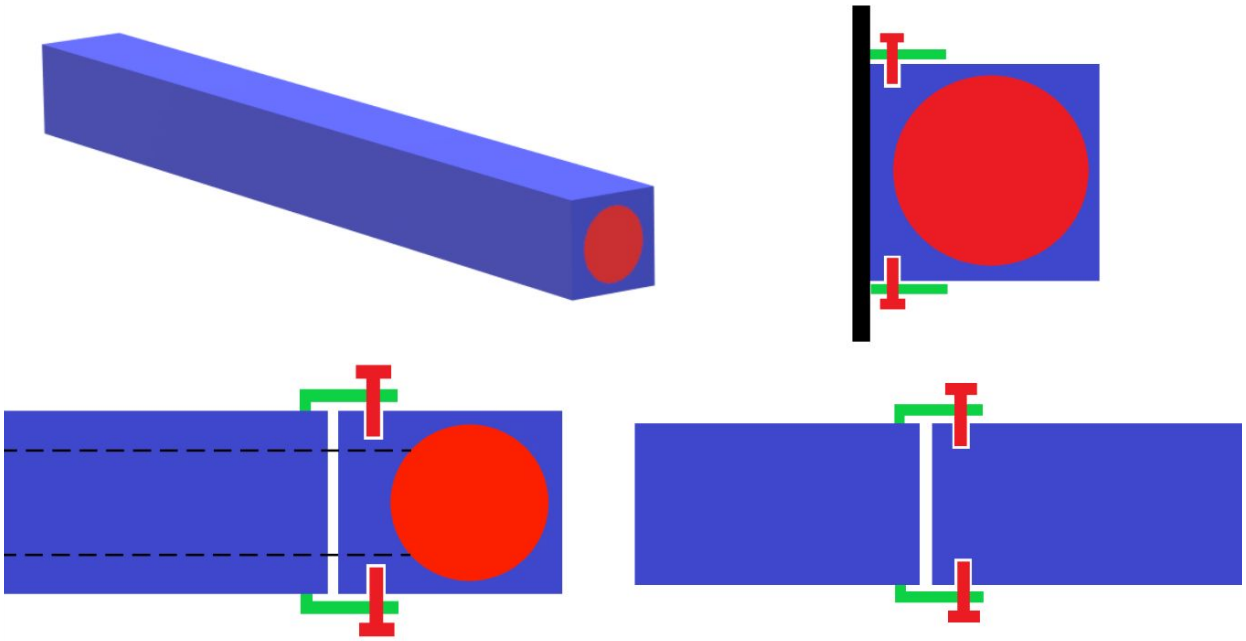
Part 1 of Action Plan: Cables placed under footpath

The first part of the solution is to place the cables closer to ground level. Cables will be placed in a compartment next to the drain, with the top of the compartment flushed to the ground. Access to the cables will be through manholes spaced 100m apart. Larger-scale works may require the top of the compartment to be excavated. The top of the compartment will be used as a footpath or park connector, optimizing use of land space. There will be clear distinction of assets between agencies such that agencies will not interfere with other cables not related to them. Although the compartment being closer to the ground and the presence of manholes may make unwanted intrusion upon the compartment easier, there are current laws which prohibit

installing cables which are not approved by the relevant authorities and prohibit tampering or damaging telecommunications and electricity cables, which carry hefty fines and jail terms. There will also be CCTV cameras located in the compartment to ensure the security of the cables.

Part 2 of Action Plan: Modular System

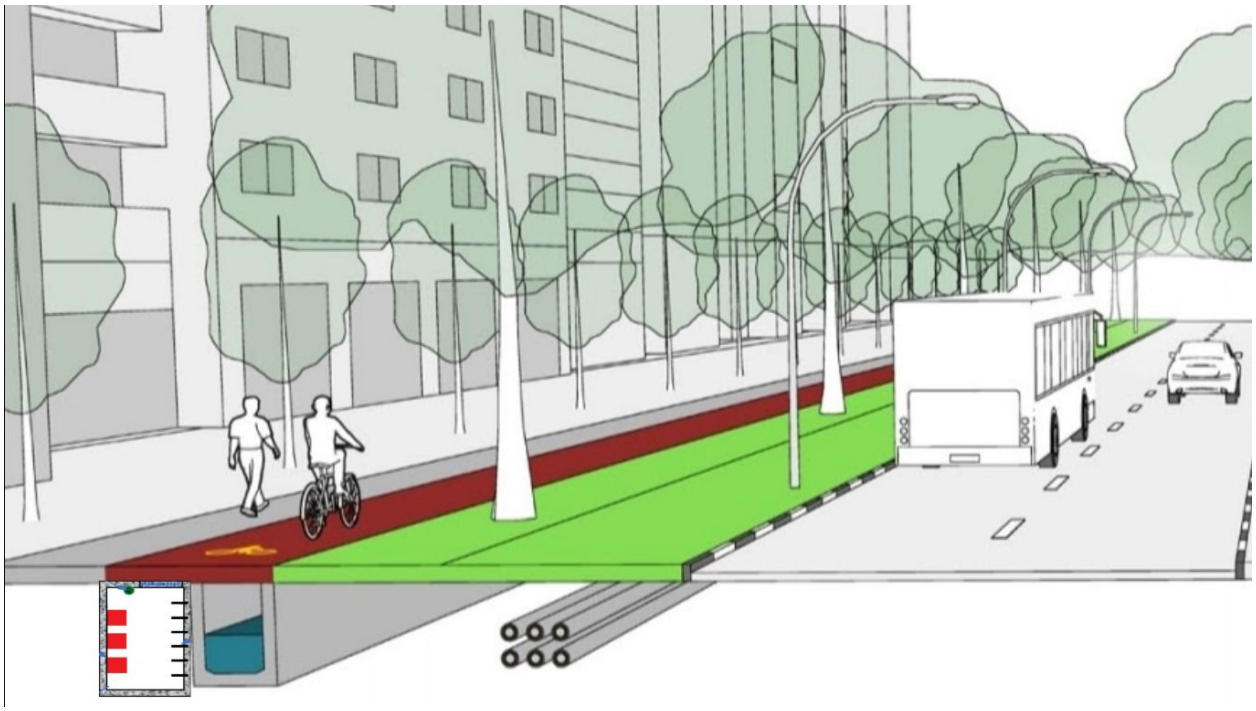
The second part of the solution is a modular system of cables. Cables will be embedded inside concrete blocks 8 metres long (can fit on trailer trucks) which can be joined and branched with a "bolt-and-socket" system. The cables and blocks will be manufactured off-site by agencies and only installation can be done on-site. In the case of damage to cables, only affected areas need to be replaced as opposed to whole cables having to be replaced with the current system. Current laws also prohibit the installation of cables not approved by the relevant authorities. This means that agencies will have to use this system of cables if this becomes the default system in Singapore and agencies will not revert to their original messy and haphazard arrangement of cables.



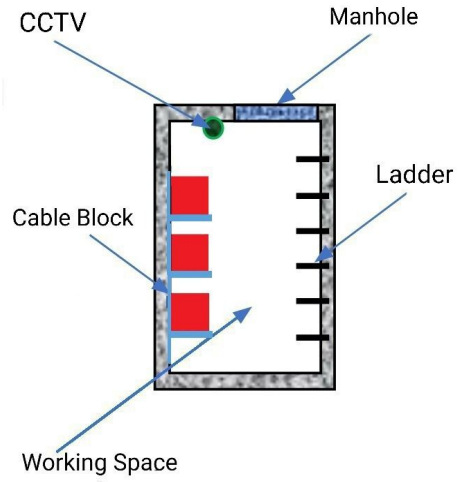
Cable Blocks

Part 3 of Action Plan: Joint Projects

Companies, agencies, and relevant authorities will work together to schedule works such that projects are carried out at the same time. Works should be scheduled at night when there is less foot traffic to minimise disruption to pedestrians. Works by different agencies outsourced to the same third-party contractor will be scheduled such that these contractors can carry out works for multiple agencies at the same time, maximising the efficiency of each road opening.



Proposed location of compartment



Compartment for housing cable blocks

A 3D model was made in Minecraft for a better representation of the solution. A video of the model can be found here: https://youtu.be/lmz5Rm2BFNo

Results and Discussion

Effectiveness of Solution

A comparison of the current procedure and a 3D model of the solution will be carried out to determine the solution's effectiveness.

The current arrangement of cables underground is messy and unregulated, with cables placed in on a first-come-first-serve basis and haphazardly stacked on each other. Cables are installed according to individual agency guidelines without cooperation between agencies which leads to road works being more complicated, resulting in longer and more frequent road works. To solve this problem, the new system will see a standardised system of modular cable blocks, to improve the arrangement of cables and make installation and maintenance of cables faster. Cables and blocks will be made off-site and only installation will be made on-site. The new compartment will contain designated ledges for the cable blocks, improving the ease of access to the cables and a neater arrangement. Ledges will be assigned to different agencies so that there is clear distinction of assets.

The current system involves excavation to be carried out on roads to access the cables, and filling up of the excavation site after works are completed, a long and arduous process which creates disruption to traffic by taking up one or more lanes of the road. The new process will see the cables moved underneath the footpaths which run along roads, such that any work carried out will not require any road openings and hence eliminate traffic congestion caused by these works. Access to these cables will be through manholes spaced 100m apart, and very large-scale works will warrant the excavation of the top of the compartment The compartment is also closer to ground level, thus making any excavations easier, speeding up works.

As with any new project, this new system may be met with criticism. In this case, the main concern from the public may be that footpath traffic will be disrupted during works. However, with the manholes, minor projects can be carried out without the need for excavation. In addition, works will be joint projects scheduled at night where possible, reducing the disruption to foot traffic and also lowering the number of works carried out.

Another possible concern is that with the compartment being closer to ground and with manholes, safety of the cables may be compromised. However, this has also been taken into consideration, with CCTVs installed near manholes, with manholes locked at all times. There are also current laws which prohibit tampering with cables. These should be adequate to ensure the security of the cables.

Further Implementation

This solution can also be employed for the piped gas system of Singapore. The compartment for gas pipes can be located under the centre divider of roads, separated from electricity cables to lower the chance of sparks causing ignition. A larger but similar system, located deeper underground, can be used for sewage and water systems, although the sewage system in singapore is unlikely to be changed anytime soon, with the Deep Tunnel Sewage System being relatively new.

Conclusion

In conclusion, the solution will be very effective as the cables are placed under the footpath or park connector, which means that no road opening is required. The modular system of cables, coupled with the cables being nearer to ground level, will allow for easier and faster installation and maintenance as no excavation or rearrangement is needed. In the event of damage to cables, only the affected blocks need to be replaced. Security of the cables will also be ensured with the strict laws and CCTVs. Hence, the goal of improving the organisation of utility cables, reducing the number of road openings and minimising road congestion, has been achieved, while the trade-off of foot traffic being disrupted is decreased by scheduling works at night.

Despite this solution being very effective, the main difficulty in its implementation is the time required and cost. To implement this solution will require the compartments to be dug along all roads in Singapore, followed by the installation of the manholes and ladders under manholes, as well as the fixing of CCTVs in the compartment. This is a process requiring at least 30 years, with Singapore having more than 3500 km of roads. This will cause long term disruption to footpath or park connector traffic on each stretch of road as the works move around Singapore. However, the silver lining might be that the cables currently under the roads will not need to be extracted and they can be left where they are. Cement can be used to fill up the current area containing the cables, ensuring structural integrity. Brand new cables will be installed in the new

system. Once the project is completed, Singapore will reap the rewards for many decades to come, which will more than make the original time and money used worth it.

References

AsiaNews.it. (n.d.). Singapore, stop new car traffic from February 2018. Retrieved March 28, 2020, from http://www.asianews.it/news-en/Singapore,-stop-new-car-traffic-from-February-2018-42133.html

SP Group. (n.d.). Retrieved March 28, 2020, from https://www.spgroup.com.sg/cable-tunnel/Benefits.html

JTC. (2018, November). PDF. Singapore, Walking and Cycling Design Guide

Land Transport Authority. (2019, April). PDF. Singapore, Code Of Practice: Street Work Proposals Relating to Developmental Works

Land Transport Authority. (n.d.). PDF. Singapore, LTA Safeguarding of Road Reserves

Straits Times. (2017, December 19). What will happen to Singapore's ageing cables, and how the cable tunnel serves the future. Retrieved April 3, 2020, from https://www.straitstimes.com/singapore/what-will-happen-to-singapores-ageing-cables-and-how-the-cable-tunnel-serves-the-future

Government of Singapore. (2019, May 03). Electricity Act. Retrieved May 13, 2020, from https://sso.agc.gov.sg/Act/EA2001?ProvIds=P1X-#pr85-

Government of Singapore. (2020, January 01). Telecommunications Act. Retrieved May 13, 2020, from https://sso.agc.gov.sg/Act/TA1999?ProvIds=P1II-#pr9-

Government of Singapore. (1992, March 25). Public Utilities (Electricity) Regulations. Retrieved May 13, 2020, from https://sso.agc.gov.sg/SL-Rev/261-RG2/Published/19920325?DocDate=19920325& ProvIds=P1II-#pr3-

Government of Singapore. (2018, April 6). Length of Roads Maintained by LTA. Retrieved June 4, 2020, from https://data.gov.sg/dataset/length-of-road-maintained-by-lta

Minecraft, Mojang. (2019, December 10). TLauncher Minecraft Release 1.15. Retrieved 1 June, 2020, from https://tlauncher.org/en/

Aternos. (2019, December 10). Multiplayer Creative Server on Minecraft Release 1.15. Retrieved 1 June, 2020, from https://aternos.org/