

SINGAPORE, SINGAPORE

# Flood Mitigation at Tanjong Pagar





## Case Study

<b>Project:</b>	Flood Mitigation on Tanjong Pagar Road
<b>Year Completion:</b>	2021
<b>Design:</b>	Steel Pipe, Type 3 Drainage
<b>Designer &amp; Installer:</b>	Hocklim Engineering Pte Ltd

### The Challenge

Due to its geographical location, Singapore's climate is characterized by high humidity and abundant rainfall. During a heavy rainfall, flash floods often occur along Tanjong Pagar road especially at the junction of Craig Road and Tanjong Pagar Road where many F&B outlets are located. This often results in rainwater flooding into F&B outlets and affecting traffic along the road.



Figure 1: Flash Flood along Tanjong Pagar road - Craig road junction

## The Solution

To prevent further occurrence of flash floods along Tanjong Pagar road, Hocklim Engineering was tasked to alleviate the situation along the area. After surveying, Hocklim Engineering and PUB were able to identify the drainage section at the junction of Craig Road and Tanjong Pagar Road as the bottleneck for the flash floods.

During a heavy rainfall event, rainwater will flow downwards from Craig road towards Tanjong Pagar road, intersecting with another drain along Tanjong Pagar road. This will cause a clash in the water flow affecting the smooth flow of water towards the drainage across Tanjong Pagar road. This results in the build up of water, taxing the capacity of the drain as water accumulates at a faster rate than the rate of water draining off efficiently leading to flash flooding around the area.

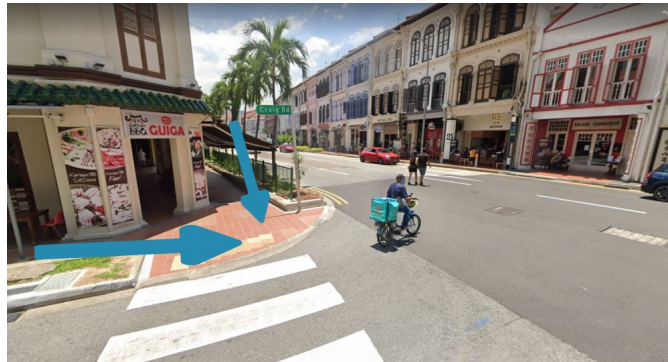


Figure 2: The blue arrows indicate the flow of water from the 2 drainages that intersects at the junction of Craig Road and Tanjong Pagar Road

Hocklim Engineering's solution was to install steel pipes across Tanjong Pagar Road, linking the existing drains along Craig Road and Tanjong Pagar road separately to the drainage across Tanjong Pagar road. This will improve the flow of water towards the under utilized drain across Tanjong Pagar road during heavy rainfall.

### Trail trenches along Tanjong Pagar Road

Before the steel pipes can be laid, Hocklim had to ensure that the area had to be cleared of any electrical cables or water pipes. Firstly, trial trenches had to be dug on a trial and error basis to check on the presence of any existing cables underneath.



Figure 3: Setting up safety road measures before commencing work

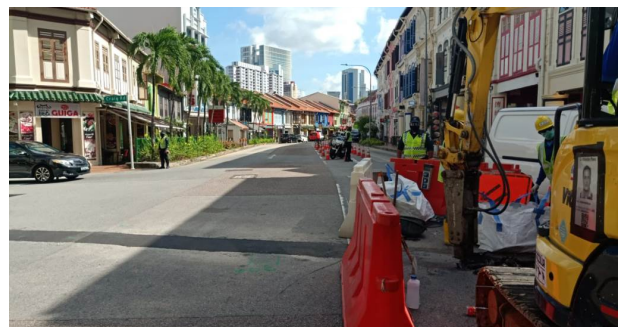


Figure 4: Ensuring that traffic is not affected while working



Figure 5: Manual Excavation to avoid damaging any existing cables or pipes.

Before the work commenced, we had to ensure that traffic was unaffected throughout the whole project. Our safety road measures were to close lane by lane when conducting trial trenches on each lane.

Once the safety measures were in place, we started the excavation of the trial trenches. A diamond cutter was used to cut the road surface as its ease of use and efficiency will greatly reduce the time needed to break the road surface.

Manual excavation was then carried out up to 1 meter deep to ensure that no cables were damaged. Once any cables were discovered, Hocklim will backfill and compact the excavated materials and reinstate with premix of existing thickness before moving on to another spot, repeating the same procedure until an area cleared of cables is found.



Figure 6: Existing Pipes that were discovered when digging the trial trenches.



Figure 7: Backfilling the trial trenches

After much trial and error, Hocklim identified 2 areas to be cleared of any cables and water pipes to install the steel pipes. With the approval of PUB, Hocklim Engineering proceeded to install the steel pipes in the 2 areas along Tanjong Pagar road.

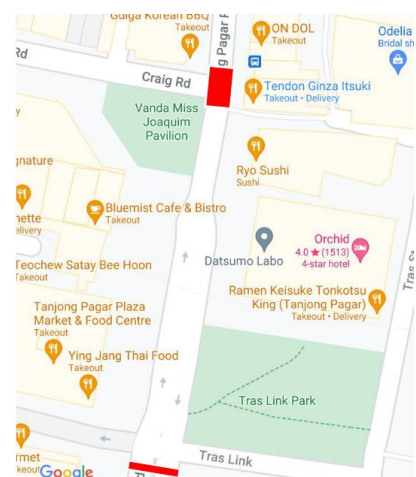


Figure 8: PUB approved areas highlighted in red.

## Installation of Steel Pipes

Following the same format when excavating for the trail trench, Hocklim Engineering proceeded to excavate to a depth of 1.6m before installing Bakau piles to 3000mm deep with 300mm spacing apart to reinforce the foundation of the soil. After the Bakau piling, a 200mm thick hardcore base was laid before adding a 50mm thick G15 lean concrete creating a firm and level working base onto which heavy load-bearing surfaces can be laid. Following which, 2 layers of B10 mesh was laid before casting a slab of 100mm thick G35 concrete.



Figure 9: Bakau piling



Figure 10: Laying 2 layers of B10 mesh on the steel pipes

After curing of the concrete base, 6 pieces of 8m x 114.3mm x 8.56mm thick steel pipe was laid in the area near Tras link while 8 pieces of 8m x 141.3mm x 9.52mm thick steel pipe was laid near Craig Road before repeating the process of laying 2 layers of B10 mesh and casting a slab of 100mm thick G35 concrete on top.



Figure 11: Pouring the cement onto the B10 mesh and pipes



Figure 12: Floating the concrete before applying the Tack coat



Figure 13: Applying Tack coat on the cement

After the concrete has cured, tack coat was applied before covering with the premix. This is to ensure the asphalt layer and concrete layer binds together to prevent any sliding or slippage failures that may occur between the 2 layers, thereby improving the durability of the road. After the tack coat is applied, the premix is then reinstated.



Figure 14: Premix reinstatement

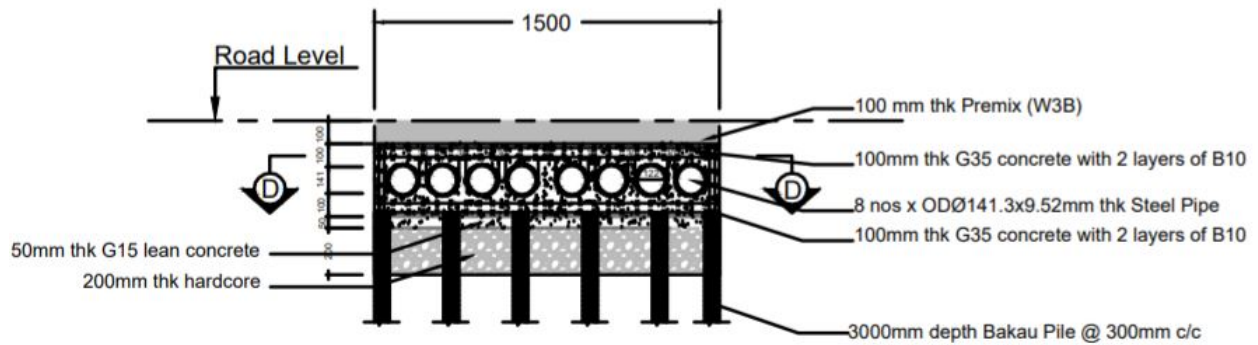


Figure 15: Cross section of the layers

### Measure taken to ensure traffic is not affected

Since the proposed works are near a road junction, Auxiliary Police officers were engaged to assist with the traffic control as part of LTA road closure requirement.



Figure 16: Auxiliary Police officers controlling traffic

Hocklim also ensured that the work does not affect the daily traffic flow by closing lane by lane when excavating work has to be done across lanes.

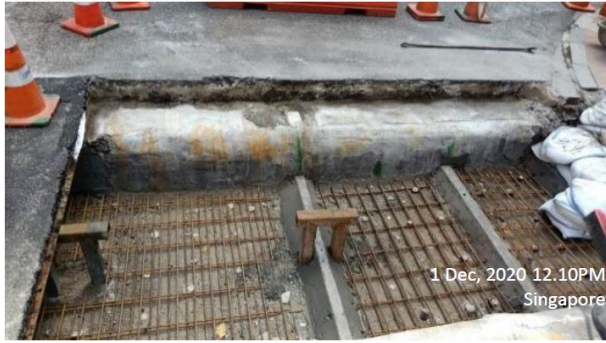


Figure 17: To provide more stability to the steel plates, the SHS sections were used as support for the steel plates



Figure 18: Laying the steel plates with 50mm thick premix and covering the trenches to allow traffic to operate.

In the event that Hocklim was unable to backfill and reinstate a trail trench in time on that day or if LTA requires road to be open urgently, Hocklim will provide 25mm thick steel plates that has 50mm thick W3B premix to meet skid-resistance requirements by LTA. These plates were used to cover the trenches allowing work to continue while traffic is unhindered.

### Steel Pipe connection to existing drainage - Junction of Craig Rd & Tanjong Pagar Rd

The next step was to connect the steel pipes to the existing drainage system. Hocklim had to hack the pavement in front of the shophouse to connect the existing drainage to the steel pipes. In addition, Hocklim will construct a type 3 drainage along Craig Road to further improve the rainwater flow into the drainage system.

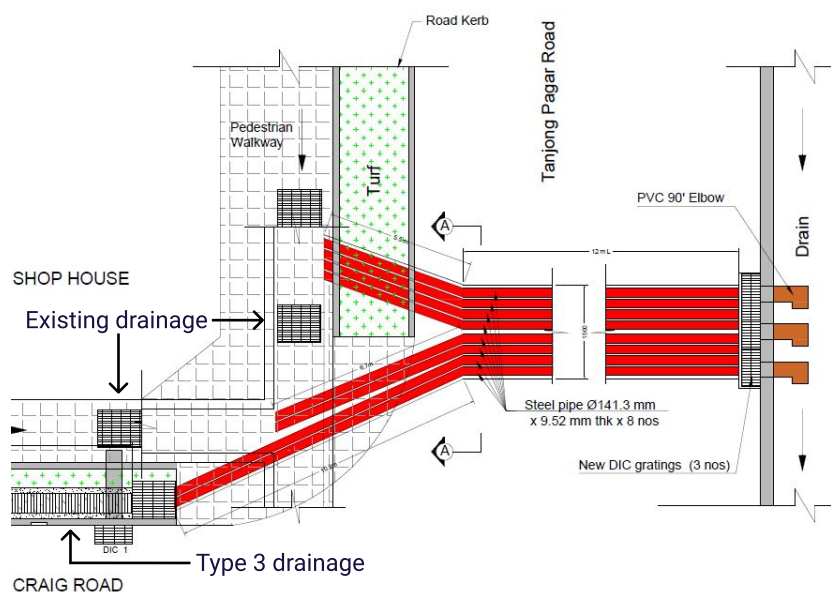


Figure 19: View plan for the steel pipe connection to the drainage system at Tanjong Pagar Rd - Craig Rd junction



Figure 20: Connecting the Steel pipes to the drainage

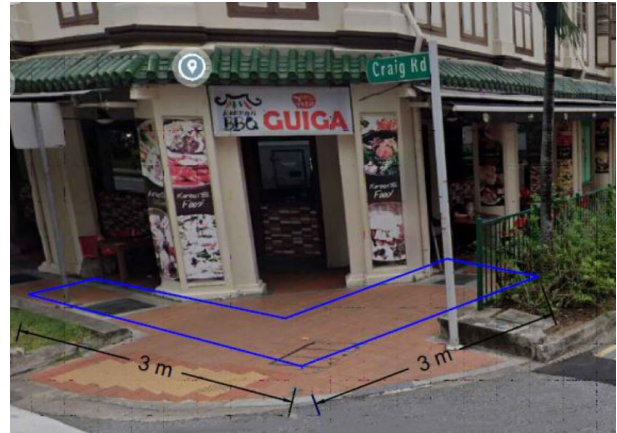


Figure 21: Pavement to be hacked (in purple) to connect the steel pipes to the existing drain

After the hacking and excavation was completed, the steel pipes were then connected to the respective drainage. Once connected, the formwork was constructed. Cement was then casted to the drainage original height.

Following which the rebar slab was laid before casting a layer of Grade 35 concrete on top.



Figure 22: Formwork for type 3 drainage



Figure 23: Casting of the concrete wall connecting the steel pipes to the drain



Figure 24: Laying of the Rebar slab





*Figure 25: Retiling of the pavement*



*Figure 26: Type 3 drainage completed*

After the cement layer was laid, Hocklim proceeded to retille the pavement to its' original state and with the installing of the type 3 gratings along craig road, the amount of rainwater can flow through the DIC grating into the drainage system more efficiently, due to the increase in drainage capacity of the type 3 drain, thereby alleviating any flash flood along the Craig road- Tanjong Pagar road junction.

In this project, the intersecting drains at the Craig road and Tanjong Pagar road junction causes the the build up of rainwater level in the area due to the inefficient water flow towards the drainage system across Tanjong Pagar road. The installation of the steel pipes connecting to the drainage on Tanjong Pagar road and Craig road respectively rectifies the existing bottleneck issue. This ensures that the rainwater is being drain off more efficiently and effectively to the drainage across Tanjong Pagar road, mitigating the flash flood around the area.



*Figure 27: Steel pipes installed along Craig rd - Tanjong Pagar rd junction*