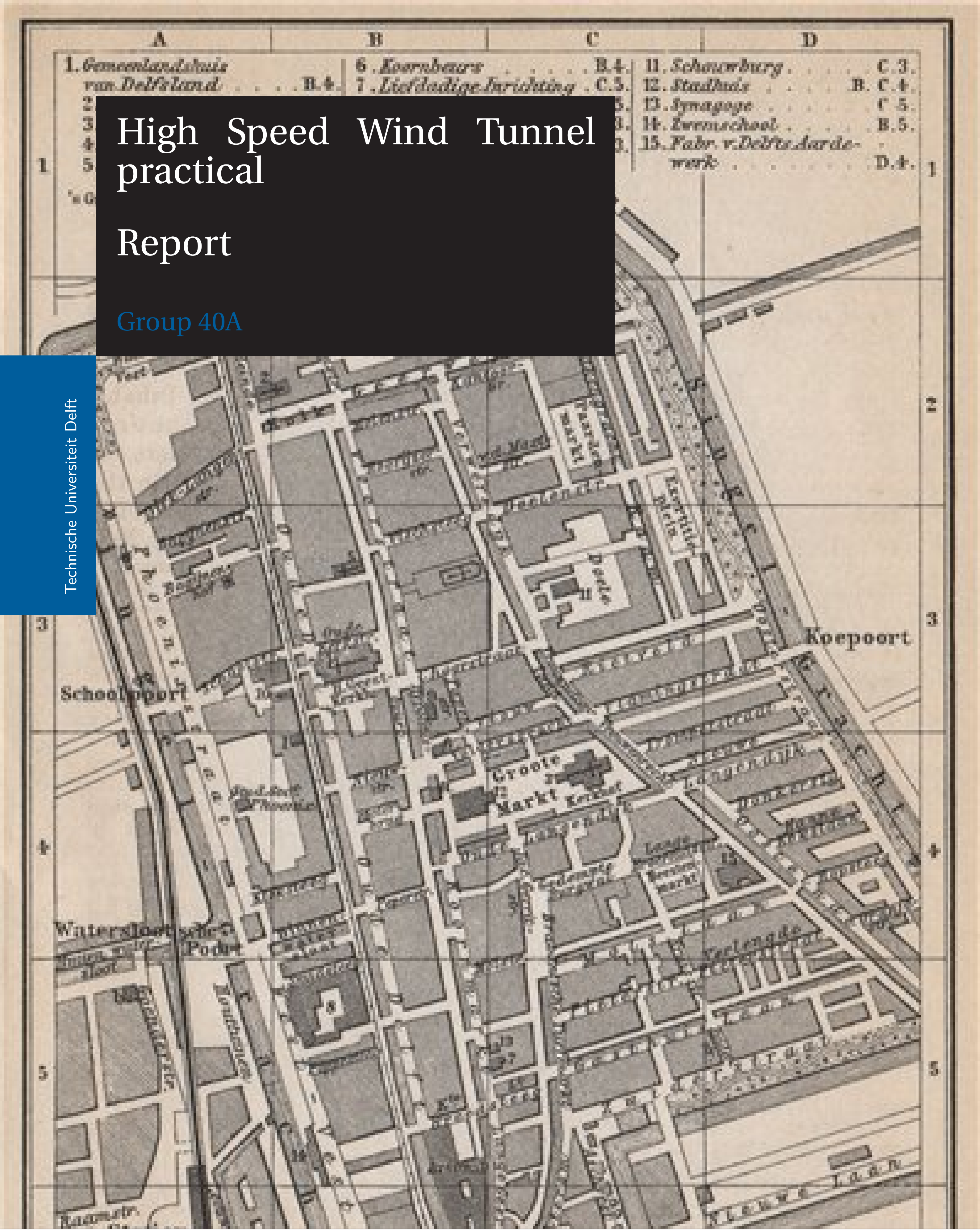

High Speed Wind Tunnel practical

Report

Group 40A

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Challenge the future

HIGH SPEED WIND TUNNEL PRACTICAL REPORT

by

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Cover image adapted from **?**]

1

Part 1

This section compares the theoretical calculation of Mach number and pressure ratio, with the results obtained from the first two measurements. For the first measurement, '1A' , meters 4 and 5 are set to 0 mm deviation and meter 6 was set to -5 mm. The second measurement, '2A', meter 4 was at 15 mm, meter 5 was at 0 mm and meter 6 was at -5 mm again.

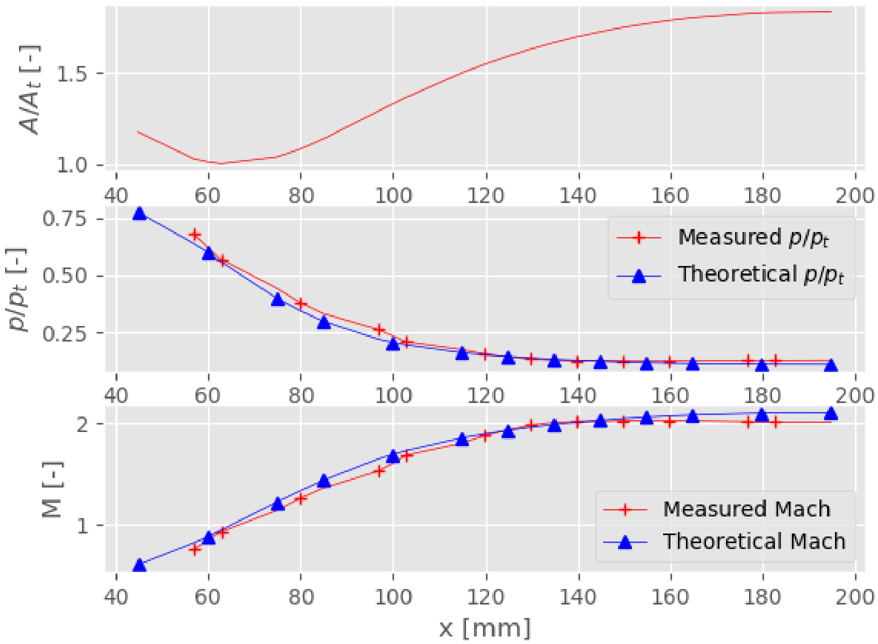

Figure 1.1: Experimental versus numerical values for 1A

In this set-up the sub-sonic flow speed before the throat was accelerated to super sonic after the throat. After the throat the mach number continues to increase, whilst the pressure ratio decreases. Since the theoretical calculations neglect viscous forces and the effect of the boundary layer, the actual mach number measurements are a little lower than the estimated values. This is because the boundary layer and viscous forces take energy out of the flow. This results in a lower speed and therefore lower pressure drop.

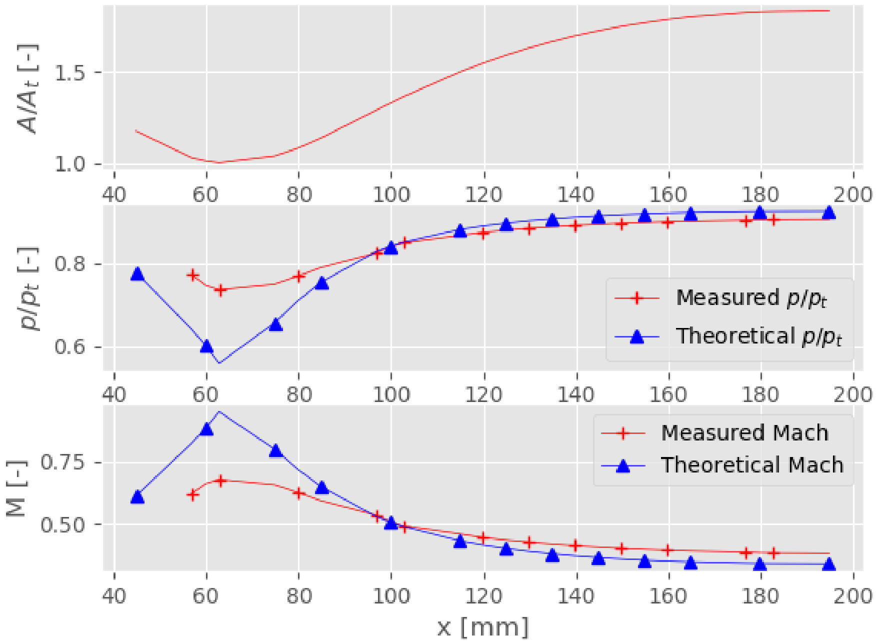

Figure 1.2: Experimental versus numerical values for 2A

; The second experiment is purely subsonic following a converging-diverging duct. The Mach number increases upstream of the throat and then decreases again downstream of the throat. The pressure ratio is the other way around, decreasing before the throat and then increasing. The first notable difference is that the theoretical pressure ratio assumes a back pressure equal to $p_{e,3}$, which gives out a mach number of 1 at the throat. It can be seen from the graph that the measured mach number does not reach 1. This is because the pressure difference between the inlet and the outlet was not large enough to create sonic flow. Additionally the measured change in pressure is smooth and continuous as compared to the kink that can be seen in the theoretical results.

2
Part 2

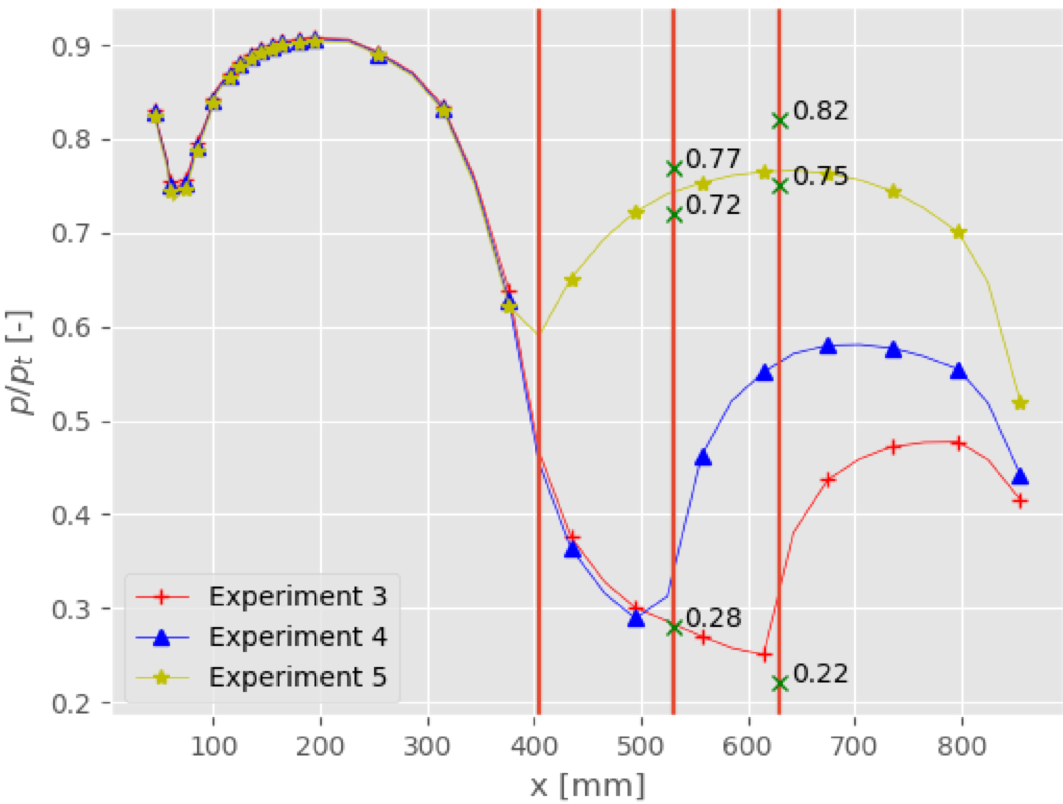

Figure 2.1: Caption

This graph shows the measurements for experiments 3A, 4A and 5A. In these measurements, the flow between the first and the second throat is subsonic, the flow at the second throat is sonic, while after the second throat, the flow is supersonic. The maximum pressure ratios at the location of the two shockwaves ($p/p_{t,3}$) are the points located at 0.77 and 0.82. The minimum pressure ratios for supersonic flow through the nozzle ($p/p_{t,6}$) are located at 0.28 and 0.22 for the 630 and 530 mm shockwaves. Finally, pressure ratios right after a normal shock take values at 0.72 and 0.75 for the first and the second shockwaves. Compared to the theory, the normal shockwaves in the experiment do not occur at the end of the wind tunnel. If the flow was perfectly expanded the line corresponding to experiment three would level off, however the exit pressure is not low enough to facilitate this, so the flow shocks which allows for a higher exit pressure. Therefore the value corresponding to 0.22, as the minimum pressure, can not be reached even by the red line.