Upgraded Mojets: more thrust, less carbon

Bruxelles Mobilité was the first authority to install third generation MoJets in its Montgomery Tunnel. Now it is investigating their installation in a second tunnel reports TJ.

On the 25 August 2021, Fathi Tarada received the first patent for his MoJet-3 tunnel fans. The patent came from Canada and should be the first of many, since applications have been made around the world.

MoJet technology modifies conventional jet fans so that they are more efficient, producing a greater thrust per fan. Angled end pieces on the inlet and outlet of the fan direct the air stream away from the surfaces of the tunnel, reducing friction between the air flow and the surface and hence delivering more thrust.

The latest iteration of the MoJet is more energy efficient than previous versions. This could mean that smaller diameter MoJets could replace larger conventional jet fans, leading to potential savings of between 30 and 50 percent in energy during operation, which would also significantly reduce carbon emissions over the 15-to-20-year life of a fan.

Having carried out live tests in its Montgomery Tunnel, which compared standard and MoJet fans of the same diameter, Bruxelles Mobilité is assessing whether MoJets could improve safety and energy performance in another of the city's road tunnel, the Rogier Tunnel. Mosen was commissioned to carry out extensive computational fluid dynamics (CFD) analysis.

"In the CFD study, we went to extreme detail to model the flow in the fans and in the tunnel, undertaking large simulations in a single model," says Tarada who is managing director of engineering consultancy Mosen. "We wanted to give the client – and ourselves – a very high degree of confidence that this technology would work."

Incremental innovation

Tarada first set out to improve jet fans back in 2008. "The initial idea was to combine the benefits of the conventional jet fan with a Saccardo nozzle – a convergent nozzle which is fed by a large axial fan, typically in the vicinity of portals," he explains.

He did just that, creating a fan with a convergent nozzle on the discharge side to give the air flow a boost and increase the thrust. But the price for more thrust was a higher power requirement.

The second version of the MoJet saw the addition of the shaped silencers that direct the flow away from the tunnel surfaces. "We achieved what we wanted to, deflecting the air away from the surface, but there was still a penalty in terms of power consumption," says Tarada.

Version three comes with no energy penalty: it delivers more thrust for the same power consumption. Its other big benefit compared to similar technologies which increase thrust – such as the Banana jet fan – is that it does not require more headroom, says Tarada. With limited space in most

tunnel cross sections, this can be an important detail.

Full scale tests in the Montgomery Tunnel in 2019 which compared three unidirectional 630mm ID MoJets with three conventional fans of the same size, showed a 100% boost in thrust for the same power. A further test in part of the Mersey Queensway Tunnel in Liverpool in 2020 during a standard closure, compared a reversible 1.25m ID MoJet with a conventional one demonstrating that the MoJet delivered 30% more thrust.

Modelling the Rogier

Constructed in 1957, the Rogier Tunnel in Brussels is a 608m-long road tunnel with two bores, each accommodating two lanes of traffic. Over the past few years, it has been undergoing a programme of phased refurbishment which will continue to 2023, involving the demolition and replacement of the concrete dividing wall, extensive concrete repairs, replacement of wall panels and ceiling panels, upgrade of power, lighting and mechanical and electrical equipment.

Currently the tunnel has 28 unidirectional jet fans, 14 in each bore. The benefit of switching these for reversible jet fans is that, in the case of a fire, the fans can be set to direct smoke away from the queuing cars, allowing people to escape and fire fighters to get it.

Mosen's study looked at the case of an LGV fire, modelling the situation where the fire had destroyed one fan and a further two fans were not operational due to maintenance issues. An earlier study by Mosen had identified the worse possible location for a fire and hence used this for the simulations and calculations.

"We have to assess the worst-case scenario and design the ventilation system accordingly," says Tarada.

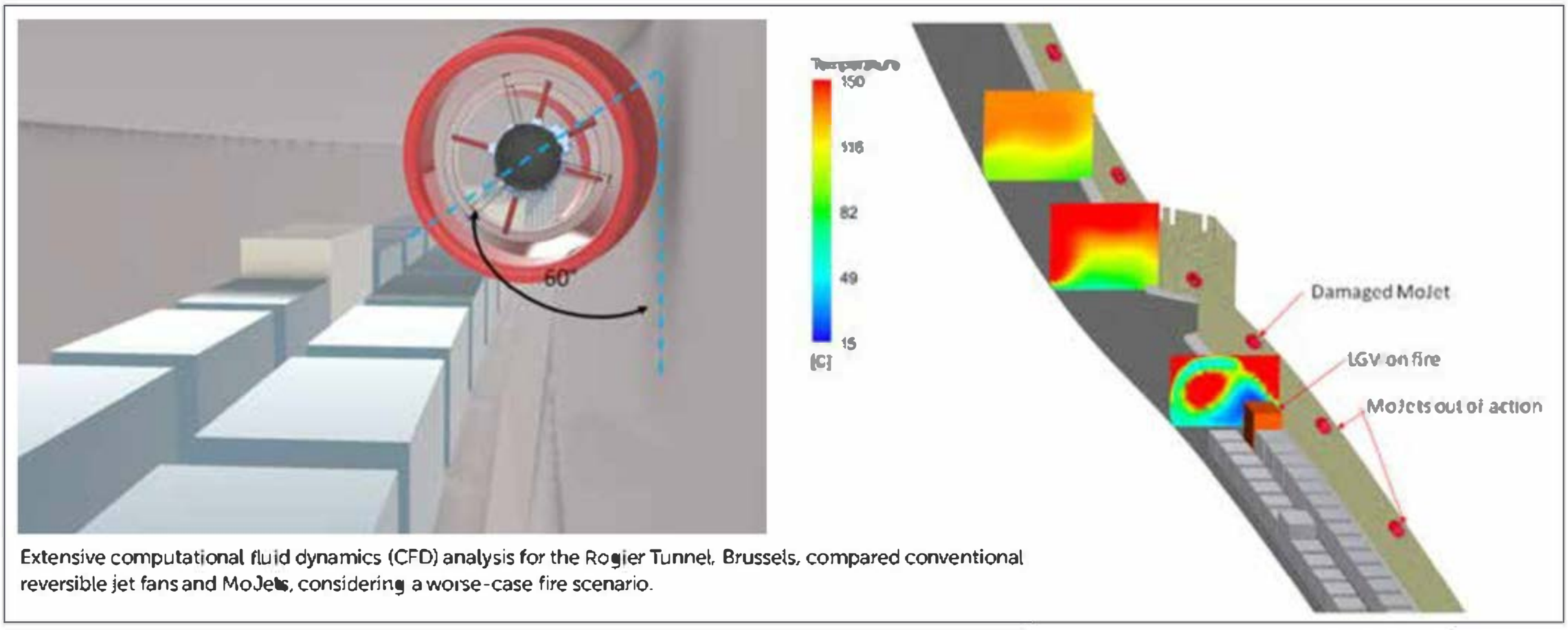
There is a critical velocity that fans must achieve to ensure that the smoke can't flow out over the stationary traffic known as backlayering. Mosen's calculations showed that the MoJets deliver sufficient airflow to avoid backlayering – although conventional reversible fans of a similar diameter couldn't do that.

Even with MoJet's superior thrust – and its potential to save energy and carbon – it is challenging to convince specifiers that they are a good solution, says Tarada: "The mechanical engineering industry is incredibly conservative," says Tarada. "However, our two successful tests, at the Montgomery Tunnel in Brussels and in the Mersey Queensway Tunnel in Liverpool, should convince any doubters."

According to Tarada, MoJets should be no more expensive than a conventional jet fan. However, currently only two companies are licensed to manufacture them: TLT-Turbo, Germany and Woods Air Movement, UK.

Although earlier versions of the MoJet have been installed in tunnels in Norway, Denmark and Sicily, the Montgomery Tunnel in Brussels was the first to have MoJet-3s installed. Bruxelles Mobilité have yet to decide whether the Rogier Tunnel will become the second.

Mosen's Mo Jet has tapered inlets and outlets that direct the airstreams away from the tunnel soffit and walls, delivering more thrust for the same power input. This photo and computational fluid dynamics (CFD) comparison are from tests in the Mersey Queensway Tunnel in Liverpool



Extensive computational fluid dynamics (CFD) analysis for the Rogier Tunnel, Brussels, compared conventional reversible jet fans and MoJets, considering a worse-case fire scenario.