



strength weaved grate design that R&S Grating has become known for.

DEVELOPING A NEW STANDARD

Following the initial incident on the Bolte Bridge in 2001, R&S Grating commenced developing a system of grating that could withstand the highly repetitive, dynamic loads that the failed grates had been subjected to.

Central to this development was the method of securing the grate to the frame. From assessing the failed bolts, it became apparent that the vibration experienced by the bolts from dynamic loading was severe. This was exacerbated by traditional bolting methods that used a bolting plate on the grate separated from the bolt down point on the frame. 8, 10 and 12mm bolts had all failed in these conditions. To address the vibration, R&S Grating developed a method of bolting the grate to the frame that eliminated this vibration in the bolt. The method used a bolting plate welded to the grate that sits flush on the frame. A threaded bolting block was then used on the frame to receive the bolt. This method ensured that the bolt did not carry any of the load or vibration being experienced by the grate.

In addition to the enhanced bolt down method, the anchoring of the frame was also addressed. A T-Section frame utilising stronger steel sections was developed to replace the traditional angle iron frames. The bolt down point was incorporated into the T-Section frame, further enhancing the security of the grate to the frame.

Finally, R&S Grating's weaved grate design was used for the grate. The weaved design uses a weaved bar intermittently joined to load bars with high strength welds. The design ensures a multitude of load paths, effectively and efficiently distributing any load.

A COMPREHENSIVE TEST

The ultimate test of R&S Grating's Freeway Grate design would come in what is arguably the most comprehensive test ever performed on a grate in Australia.

Vic Roads commissioned HRL Technologies to perform a real-world test of a Freeway Grate installed on the Steele Creek Bridge of the Western Ring Road (M80). With a lane closure, strain gauges were fitted to a load bar of the grate, as well as a gauge to measure axial forces in the bolts. Additionally, internal bolt strain gauges were fitted to the bolts, and two strain gauges were fitted to the studs anchoring the frame to the bridge deck. With the gauges fitted, a B-Double truck with 9 axles and a 62.5 tonne gross weight made four separate runs over the grate and frame at approximately 100 km/h.

The results showed that the dynamic forces in the bolt were less than 5% of what was preloaded in the bolt, proving the bolt down system to be more than adequate for large, dynamic loads. The strain gauges on the load bars of the grate recorded minimal stress, while the gauges on the studs tying the frame to the bridge deck also detected minimal strain.

The testing showed that all the critical elements of the structure had been achieved. The grate was successfully able to carry the high impact, repetitive load of the 9 axle vehicle with minimal stress, the bolts were successfully holding the grate to the frame with minimal axial stress and the redesigned frame was successfully anchoring the frame to the ground.

THE TEST OF TIME

In addition to the dynamic, real-world testing by HRL Technologies, another key indicator of the success of the design of the Freeway Grate is the track record of the Freeway Grates that are currently installed around

Melbourne. In the right hand, trafficable lane of the Bolte Bridge since 2002, R&S Grating's Freeway Grate has operated without incident. Additionally, the Freeway Grate is now in trafficable lanes of the Monash Freeway and CityLink networks and their presence continues to grow.

WIDENING HORIZONS

R&S Grating is supplying approximately 1000 Freeway Grates for the CityLink-Tulla Widening Project. With traffic predicted to steadily increase in the coming years, authorities are continuing to recognise the increasing risks of dislodging grates. Exposed pits not only present a danger for commuters, but also present difficulties for maintenance workers. Traditionally an afterthought in Freeway design, R&S Grating is proud to be supplying innovative grates that contribute to the healthy and efficient operation of Melbourne's major transport infrastructure.



A New Standard

R&S Grating have been contracted to supply a large number of grates for the CityLink-Tulla Widening project in Melbourne. The grates to be supplied are made to R&S Grating's "Freeway Standard", not only utilising high strength steel sections, but using R&S Grating's tried and tested weaved design to effectively distribute dynamic loads.

Critically, the design also features R&S Grating's dynamic loading bolt down method. Developed through rigorous analysis, the bolt down method is engineered to withstand repeated extra heavy duty dynamic loading in trafficable freeway lanes. Additionally, the frame anchoring method has been significantly redeveloped.

The installation of R&S Grating's Freeway Grates is the culmination of a long history of incidents on Melbourne's freeways and over a decade of calculated engineering and comprehensive testing.

A LONG HISTORY OF INCIDENTS

In 2001 R&S Grating was contacted to replace grates on CityLink's Bolte Bridge. A truck travelling in the right lane had caused a grate to dislodge, subsequently causing a vehicular accident. Maintenance personnel indicated that grates regularly showed signs of damage, such as broken bars or cross rods and damaged bolts, and were regularly being replaced with equivalent grates. Further inspections revealed extensive damage to trafficable grates.

The Bolte Bridge incident sparked the beginning of R&S Grating's development of the "Freeway Grate", however

it was not the only dislodgement to occur. Between 2001 and 2014 many incidents were documented where bolted down grates had dislodged from frames. These incidents occurred primarily on Melbourne's freeways, including the Monash freeway and parts of the CityLink network, however also included major urban highways and roads.

Prior to engaging R&S Grating, maintenance workers had tried a variety of techniques to secure grates to their frames. In some cases, this had included welding grates to their frames. In one instance, this resulted in both the grate and frame dislodging as one unit. As a result of this incident and other observations, R&S Grating worked with the relevant statutory authorities and other stakeholders to develop an improved method of anchoring frames.

One incident on Derrimut Road, Derrimut, highlighted the inadequacy of traditional "mesh" type grates in highly repetitive dynamic loading environments. As was regularly observed in such conditions, the cross rods of the grate failed. Videos of this particular grate in situ are available at the link below or by visiting R&S Grating's Projects page at www.grating.com.au/projects. The local council purchased the grate as a class D of AS3996 grate, demonstrating the inadequacy of traditional mesh grates under highly repetitive loading.

The repeated failure of grates and bolt down methods under highly repetitive, dynamic loading led to R&S Grating developing the Freeway Grate style of grate, incorporating a specialised bolt down method with the high



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To learn more about Freeway Grates, contact R&S Grating.

www.grating.com.au

