Vehicle occupants sustain injuries in one of three main configurations – head-on crashes, run-off-the-road and intersection collisions. If one of those risks can be reduced substantially, the threat to life and injury comes down accordingly. Reducing the risk of head-on collisions on inter-urban roads is commonly achieved by providing median separation, often in the form of safety fencing or a barrier. Single-carriageway roads generally demonstrate higher risk than dual-carriageways. This can be because there are typically only painted lines on the road to separate opposing vehicles, it can be too that roadsides and intersections are more hazardous.

Sweden has been instrumental in introducing innovative protection on single-carriageways with the concept of a 2+1 design with median protection. Many existing single-carriageway road sections in Sweden (Figure 1) have been provided with a wire rope safety fence to separate opposing vehicles, thereby effectively making them dual-carriageways, mostly within the existing road space required for a single-carriageway.

**Treatment Potential**

Figures 1 and 2 show a typical “before and after” scenario of a Swedish 2+1, together with mapping of the location where this design has been installed. Lanes alternate, with either 2 lanes or 1 lane in each direction, transitioning alternately after a prescribed distance in order to provide overtaking opportunities in both directions. This 2.4km road section near Vanneberga in southern Sweden (see [https://goo.gl/maps/i4J7X4SSW6GyV6NA8](https://goo.gl/maps/i4J7X4SSW6GyV6NA8)) is carrying approximately 14,700 vehicles per day. A typical cross-section of the 2+1 design is shown in Figure 3.
Case Study

Road Crash Data – Assessment when 2+1 Implemented

Because of small crash numbers, the Swedish approach does not rely upon crash data for individual sites. Rather, it has demonstrated the aggregated benefit at several hundred sites. Here, that benefit is complemented by an iRAP assessment.

Studies by Carlsson (2009) and Vadeby (2016) instigated by the Swedish authorities have demonstrated the life-saving value of these designs. Vadeby commented that: “the total number of fatalities and seriously injured decreased by 50% and the total number of personal injury crashes decreased by 21%” and that “the number of fatalities and seriously injured decreased by 63% and the personal injury crashes by 28%. Correcting for regression to the mean gave very similar results.”.

Carlsson showed that “the reduction in FSI (fatal and serious injury)-rate (with a 110km/h speed limit) and Alt-4L 110 (Alternative 4-lane) is 56–58%. For other types of crash it can be mentioned that the observed FSI-rate for vulnerable road-users on MLV has been reduced by about 90%.”.

Risk Assessment – 2+1 with Median Barrier

In a country such as Sweden where crash numbers are relatively low, recent crash histories at a location are not a good predictor of long-term risk. At Vanneberga, the 2+1 with median was introduced as part of a large-scale and widespread implementation policy. It was known that over time such action would reduce potential collisions. The implementation was not simply a response to recent crashes.

Independently of this implementation and as an illustration of the safety rating, iRAP has used its model to assess the safety of the Vanneberga case study. It provides a Star Rating for both before and after the installation of the 2+1 with median barrier:

- **Before** the upgrading the road was rated (Figures 4 and 5) as 2-star throughout its length. There were risk spikes at three intersections and smaller risk rises away from these intersections, the latter caused by variation in the safety of the roadside.

- **After**the upgrading, the road is rated (Figures 6 and 7) on average at 3-star and as a good 4-star away from the intersections. This improvement is observed despite the speed limit on the road being increased from 90 to 100km/h. Figures 8 and 9 show that the risk of head-on collisions (the yellow in the bar) has of course declined. The roadside risk was reduced in this example by improving the safety of the roadside, for example, by installing safety fencing. Changes were also made to the location and design of intersections.

Figure 3. Typical 2+1 cross-section designs (Trafikverket, 2020)

Figure 4. “Before” – an average of 2-star

Figure 5. “Before” Raised risk at intersections and variation in risk on roadsides
Conclusions

The introduction of the 2+1 median barrier on Road 21 near Vanneberga has resulted in a reduction in risk as illustrated by the iRAP model and an increase in rating from 2- to 3-star. Studies in Sweden have shown that if it follows the pattern of other roads it will show a decrease in fatal and serious injuries of 50%.

References


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The European Road Assessment Programme (EuroRAP) is an international not-for-profit association set up in 1999 and registered in Belgium that is dedicated to saving lives through safer roads.

The programme aims to reduce death and serious injury through a programme of systematic improvement of roads, identifying the major shortcomings that can be addressed by practical road improvement measures. It forges partnerships between those responsible for a safe road system – civil society, motoring organisations, vehicle manufacturers and road authorities – and aims to ensure that assessment of risks is at the heart of strategic decisions on route improvements, crash protection and standards of route management.