The information detailed in this Case Study has been provided by RSI ‘Panos Mylonas’.
The National Road 90 or North Road Axis of Crete (NRAC) is located on the island of Crete (South of Greece) and extends from one end of the island to the other (Kissamos to Sitia).

The NRAC belongs to the comprehensive TEN-T network, being also part of the European E75 corridor. The majority of the road is a single carriageway. It was constructed long ago and was considered as freeway but, due to the development of the island through the years, it is now being operated as an arterial.

The section of interest is located between CH.182+400 and CH.184+600, this being part of a wider route, connecting Selinari with Neapoli. This case study consists of an undivided road segment with one lane in each direction and paved shoulders with an Annual Average Daily Traffic (AADT) in 2017 of approximately 3,000 vehicles. Figure 1 and 2 show the location and an aerial view of the road section under consideration.

Figure 1. Location of the considered NR-90 road segment

Figure 2. Aerial view of the NR-90 road segment
Crash Data History

The road has a long history of crashes. On the road section between CH. 178+470 and 184+600, which includes the segment under design, nine crashes have been recorded during recent years (2012-2017), five of which led to fatalities. Therefore, the road section under consideration is regarded as one of the highest-risk segments along the entire road axis.

Road Assessment

The current road status has been assessed using the iRAP protocols. The Star Rating for the safety built into the road infrastructure for road users (vehicle occupants and, motorcyclists in this case) has been estimated as 1-star (Figure 3) in the course of the full investigation described in Figure 6.

Design of Countermeasures

The increased risk that road users face when travelling through the road section led the local authorities to form a proposal with an updated road layout containing a list of countermeasures that will help upgrade the road safety level along the route.

The designed countermeasures included:

- Resurfacing the pavement along the entire route
- Blocking off access to the existing intersection (CH. 184+230) and other minor property points in order to eliminate possible collisions
- Installing new guardrails in front of roadside hazards (i.e. sharp curves) according to the latest European standards for safety barriers (EN 1317)
- Improving the configuration of the existing bus shelters alongside the road
- Cutting back vegetation in order to improve the available sight distance
- Providing new road markings and signing.

The new design is shown in Figures 4 and 5.
Star Rating for Designs

Star Ratings are based on road inspection data and provide a simple and objective measure of level of safety which is ‘built-in’ to the road for vehicle occupants, motorcyclists, bicyclists and pedestrians. Five-star roads are the safest while one-star roads are the least safe. Improving the Star Rating by one star is generally associated with a halving in the crash costs per kilometre travelled for vehicle occupants and step-changes in safety benefits too for other road users.

The Star Ratings for Designs (SR4D) cloud app has been developed with the aim of enabling Star Rating to be easily incorporated into the road design process. The app empowers designers to assess the safety of a road design and improve its star rating before the road is constructed, thus saving lives and preventing serious injury from the outset. In this process, the road is rated as it is at present in order to provide a baseline Star Rating. The plans for the road are then examined to see which attributes of the coding will change. The coding can be changed for the entire subsection using the iRAP software platform ViDA, by using the SR4D app or by using the iRAP Demonstrator on particular parts of the sub-section to illustrate the process.

In the present case study the SR4D has been carried out at the design stage in order to assess what the safety performance of the road section under design would be after the implementation of the proposed countermeasures.

Therefore, Star Rating (the assessment of risk based upon 52 features known to influence crash likelihood and severity, where the higher the number of stars, the safer the road) has been provided for the entire road segment under design.

Before the application of the designed countermeasures, the overall road section fell into 1-star for both vehicle occupants and motorcyclists. No Star Rating has been provided for pedestrians and bicyclists since no such road users are generally found on this road section.

Table 1 shows the “before and after” list of road attributes that have been changed in the coding and the influence that these have had on various elements of the risk.

Examples are made for both a typical mid-block cross section (CH.182+450) and the intersection (CH. 184+230), the access to which is blocked according to the updated design of the road.
Case Study

(Please note that in the “before” situation the vehicle occupant and motorcyclist StarRating Scores are beyond the upper limit of the chart scale and so do not fully convey the risk and potentially omit some of the elements of that risk.)

![Figure 8. Risk in “before” situation and from new design (mid-block cross section CH. 182+450)](image)

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Coding in “before” situation</th>
<th>Coding from new design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadside severity – driver side object</td>
<td>Tree &gt;= 10cm dia. within 5m</td>
<td>Safety barrier - metal</td>
</tr>
<tr>
<td>Roadside severity – passenger side object</td>
<td>Tree &gt;= 10cm dia. within 5m</td>
<td>Safety barrier - metal</td>
</tr>
<tr>
<td>Road condition</td>
<td>Medium</td>
<td>Good</td>
</tr>
<tr>
<td>Skid resistance / grip</td>
<td>Sealed – medium</td>
<td>Sealed - adequate</td>
</tr>
<tr>
<td>Delineation</td>
<td>Poor</td>
<td>Adequate</td>
</tr>
<tr>
<td>Intersection type</td>
<td>3-leg (unsignalised) with no protected turn lane</td>
<td>None</td>
</tr>
<tr>
<td>Intersection road volume</td>
<td>100 to 1,000 vehicles</td>
<td>None</td>
</tr>
<tr>
<td>Intersection quality</td>
<td>Poor</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

Table 2. Attributes coding in “before” situation and from new design (intersection CH. 184+230)

(Again, please note that in the “before” situation the vehicle occupant and motorcyclist Star Rating Scores are beyond the upper limit of the chart scale and so do not fully convey the risk and potentially omit some of the elements of that risk.)

![Figure 9. Star Rating Score in “before” situation and from new design (intersection CH. 184+230)](image)
After the completion of the new road design, the Star Rating was increased for all road users (3 stars for vehicle occupants and 2 stars for motorcyclists).

The following figures demonstrate the Star Rating for vehicle occupants and motorcyclists, with an updated design of the road segment.

Figure 10. Risk in “before” situation and from new design (intersection CH. 184+230)

Figure 11. Star Rating for Vehicle Occupants: NR-90 CH.182+400 – CH.184+600 (according to the design)

Figure 12. Star Rating for Motorcyclists: NR-90 CH.182+400 – CH 184+600 (according to the design)
Conclusions

In this case study, the Star Rating for Designs is used to illustrate how the safety performance of a specific road section can be assessed when countermeasures are proposed at the design stage. It is also proved that it is not mandatory to rely upon crash data to demonstrate a potential safety improvement.

The SR4D carried out improved the infrastructure road safety substantially and the Star Ratings were increased by between one and three stars in the examples shown. Thus, the proposed countermeasures for the road segment under design are considered very effective.

In addition, it is concluded that Star Rating for Designs strengthens the road safety audit process, complementing it with an objective and repeatable quantification of road user risk (without the need for a high level of experience), and supports the wider potential of Star Ratings as a safety performance metric.

Therefore, any suitably trained engineer or road safety practitioner is able to carry out a design Star Rating, ensuring improved safety at the design phase of new road builds worldwide and maximized safety in road infrastructure investment.