By any measure, road crashes represent an enormous public health challenge for India. Roads have an alarmingly high rate of death and injury nationally, and extremely high rates on particular stretches. This level of road trauma is not an inevitable outcome of rapid development - it is preventable.

As part of efforts to curb road deaths and serious injuries, the World Bank Global Road Safety Facility (GRSF) invited the International Road Assessment Programme (iRAP) to work with the Ministry of Road Transport and Highways (MoRTH), public works departments, research institutes, local engineering firms and motoring clubs to assess the safety of Indian road.

This report summarises the results for roads in Andhra Pradesh, Assam, Gujarat, Haryana, Karnataka, Kerala and Rajasthan. Most of the roads are rated just one- or two-stars for safety, and it is estimated that 28,000 deaths and serious injuries occur on the roads each year at cost of more than INR 55 billion (USD 885 million).

The reasons for this enormous level of trauma are clear and include the fact that 97% of the roads where pedestrians are likely to use the road have no formal footpaths. However, Safer Roads Investment Plans make the solutions equally clear. By giving people a safe place to walk for instance, new footpaths on 440km of roads in Kerala could prevent 4,600 deaths and serious injuries over 20 years and save INR 3.4 billion (USD 55 million) in crash costs. Much of this cost would otherwise be borne by an already stretched health sector.

The results contained in this report and the interactive online results (at http://vida.irap.org) help to demonstrate that by making targeted investments in priority roads, the social and economic burden on families, communities, workplaces and hospitals can be significantly reduced.











HOW SAFE ARE INDIA'S ROADS?
(AND HOW SAFE CAN THEY BE?)

GRSF Global Road Safety Facility
Bloomberg Philanthropies
FIA Foundation for the Automobile and Society
ROAD SAFETY FUND

iRAP

WE *CAN* MAKE ROADS SAFE

An estimated 632 people are killed on Indian roads every day

WHO, 2013

By any measure, road crashes represent an enormous public health challenge for India. On many of the nation's most important roads, school children, factory workers, farmers and people visiting markets vie for limited road space with high-speed trucks, buses and cars. The result is an alarmingly high rate of death and injury nationally, and extremely high rates on particular lengths of road. This level of road trauma is not an inevitable outcome of rapid development - it is preventable.

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As part of efforts to curb road deaths and serious injuries, the World Bank Global Road Safety Facility (GRSF) invited the International Road Assessment Programme (iRAP) to work with the Ministry of Road Transport and Highways (MoRTH), public works departments, research institutes, local engineering firms and motoring clubs to assess the safety of Indian roads. Since the first assessments were undertaken in 2010, almost 6,500km of roads in seven States have been assessed and more than 100 engineers have participated in training.

Importantly, investments to improve many of the roads have already been locked in. iRAP assessments are now being used in World Bank-financed projects worth more than USD 4 billion. To date, designs for around 25% of the roads assessed have been Star Rated, helping to ensure that safety is built-in to the plans prior to construction.

This report summarises the results for roads assessed in Andhra Pradesh, Assam, Gujarat, Haryana, Karnataka, Kerala and Rajasthan. Most of the roads are rated just one- or two-stars for safety, and it is estimated that 28,000 deaths and serious injuries occur on the roads each year at cost of more than INR 55 billion (USD 885 million).

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New footpaths on 440km of roads in Kerala could prevent 4,600 deaths and serious injuries over 20 years

The results contained in this report and the interactive online results (at http://vida.irap.org) help to demonstrate that by making targeted investments in priority roads, the social and economic burden on families, communities, workplaces and hospitals can be significantly reduced.

By committing to implemeting ambitious policies such as the elimination of one- and two-star roads by 2020, or a requirement that all new roads achieve three- or four-stars, India has the opportunity to create a legacy of safe roads for future generations.

HUMAN IMPACT

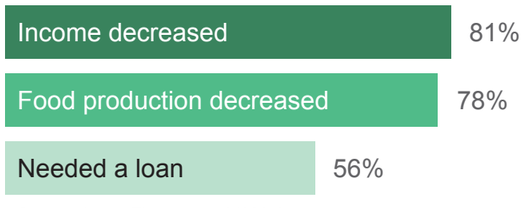
A staggering 142,485 people were reprtedly killed in road crashes in India in 2011, although the World Health Organisation estimates the number could be even higher, totalling 231,027 (WHO, 2013). Today, some 2 million people in India are living with disabilities caused by road traffic injuries (Watkins, 2009).

There is strong evidence of a link between road crashes and poverty in India. Nationally, road crashes are reported to cost the economy around INR 3,300 billion (USD 59 billion) per year (WHO, 2013). Males in the prime of their life are the people most commonly killed, and they very often provide the majority of the household income. Hence, road deaths are often the trigger for a household to slip into poverty (Aeron-Thomas et al, 2004). By systematically improving the safety of India's roads, so that the risk of crashes is minimised and those that do occur are not severe, governments and development banks can help alleviate poverty and suffering.

For the iRAP assessments carried out in India, it was estimated that an average of 4.3 deaths and serious injuries occur on each kilometre of road each year. About three-quarters of these are thought to have been vulnerable road users: motorcyclists, pedestrians or bicyclists.

While reducing poverty is a global priority, road crashes make this task more difficult as many non-poor households become poor after a road crash. The large majority of households in Bangalore, India suffering a road death also suffer serious financial impacts. Often households need to borrow money, sell an asset, give up study or take on extra work just to survive.

Households impacted by a road death



Source: Aeron-Thomas et al (2004)

12% India alone accounts for more than a tenth of the world's road traffic fatalities (Watkins, K, 2009).

38% The Ministry of Road Transport and Highways reports that more than a third of crash victims are under the age of 25 (MoRTH, 2012).

32% A third of people killed are riders of motorised two- or three-wheelers (WHO, 2013).

Detailed crash scene investigations undertaken during the iRAP assessments revealed alarming trauma rates. On a 53km stretch of the SH17 in Karnataka for example, crashes resulting in nine deaths and 17 serious injuries were investigated during a 45 day period (J P Research, 2012).

Road traffic injuries place an immense burden on health-care systems, diverting financial and human resources from other priorities, including the treatment of infectious diseases and chronic health problems. In India road traffic injury patients account for 10-30% of hospital admissions.

Dr Kevin Watkins, 2009

ROAD ASSESSMENT

1

ROAD INSPECTIONS

Detailed safety inspections were carried out on 6,241.7km of roads in seven States. The inspections used a vehicle equipped with GPS, video cameras, distance measurement devices and survey software, which analysts used to record around 50 different road design attributes that are known to influence the likelihood of a crash and its severity on each 100 metre segment of road. These attributes include intersection design, road cross-section and markings, roadside hazards, footpaths and bicycle lanes. The data collection was led by local firm Indian Road Survey and Management (IRSM) and Public Works Department (PWD) staff. Detailed crash investigation studies were also carried out by J P Research to so that the true nature of crashes on the roads could be fully understood.

2

STAR RATINGS

Vehicle occupant, motorcyclist, pedestrian and bicyclist Star Ratings were produced for each road. Star Ratings are an objective measure of the likelihood of a crash occurring and its severity. They draw on the road safety inspection data and the extensive research on real-world relationships between road attributes and crash rates. Research shows that a person's risk of death or serious injury is highest on a one-star road and lowest on a five-star road.

3

SOLUTIONS

More than 90 road improvement options were considered while generating affordable and economically sound Safer Road Investment Plans (SRIP) that can save lives. Options range from low-cost road markings and pedestrian refuges to higher-cost intersection upgrades and full highway duplication. The Star Rating and SRIP analyses were undertaken using iRAP's online software, ViDA (http://vida.irap.org). Full password-protected interactive results are available to stakeholders in ViDA.

MEASURING RISK

By measuring the risk associated with road attributes, Star Ratings can provide a better indicator of the influence of the road on risk than crash numbers alone. This image, a typical scene in India, lists the attributes that influence the most common and severe types of crashes for vehicle occupants, motorcyclists, pedestrians and bicyclists, and which underpin the Star Ratings.

Speed

The risk of death or serious injuries increases significantly with speed. If a pedestrian is struck by a car travelling at 60km/h, they face a 90% chance of being killed.

Lighting

Visibility is an important factor in creating a safe environment, particularly at intersections and where vulnerable road users are present.

Roadsides

Roadside hazards (like this pole) increase the risk of death and serious injury when a vehicle runs off the road.

Intersections

Intersection crashes are one of the most common types of crash problem, particularly in urban areas. In rural areas, or where vehicle speeds are high, the consequence of collisions at intersections can be particularly severe.

Delineation

Centre and edge delineation treatments (not present here) help drivers judge their position on the road, and provide advice about conditions ahead.

Bicyclists

Bicyclists (and people using non-motorised vehicles) are amongst the most vulnerable of all road users. Bicyclists are safest when they have paths and do not need to mix with fast-moving traffic.

Pavement

Poor road surfaces, such as those with holes, standing water and debris, mean it is more likely that vehicles will swerve out of their lane. Furthermore, in an emergency, vehicles can stop faster on skid-resistant pavements.

Geometry

The number of lanes, width of lanes, curves, dips, crests and slopes all effect the risk of crashes.

Median

Medians physically separate opposing traffic streams and help stop vehicles travelling into opposing traffic lanes. They can also help pedestrians cross the road or restrict their access at unsafe places.

Footpaths

Without unobstructed footpaths (as is the case here) it is more likely that pedestrians will walk on the road, especially when it is raining or when visibility is poor.

Crossings

Most pedestrian deaths occur while the pedestrian is attempting to cross the road. Pedestrian crossings (present here, but poorly designed), including signalised crossings, refuge islands, bridges, and traffic calming treatments, have the potential to reduce risk.

Shoulders

When a driver accidentally travels onto the road shoulder (not present here) the risk of crashing will be less if the vehicles can either stop on the shoulder or safely travel back into the traffic lane. Shoulders can also provide space for slower-moving non-motorised vehicles.

Traffic mix

Mixing fast moving cars, trucks and buses and slow moving auto-rickshaws and tractors increases the risk of crashes, especially head-on and rear-end crashes.

STAR RATINGS

The Star Ratings help to explain why roads in India experience such high rates of death and serious injury. Significant proportions of the roads assessed are rated in the highest-risk one- and two-star bands for vehicle occupants, motorcyclists, pedestrians and bicyclists.

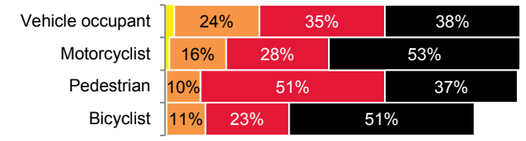
The assessments found that many of the roads lack the most basic engineering safety features such as footpaths, safety barriers, paved shoulders and safe intersection design. The risk factors on the next page play a significant role in the Star Rating results and provide a basis for planning life-saving treatments.

Nevertheless, short sections of road were rated four- and five-stars, indicating that with the application of safe-system principles in design and adequate investment, the construction of low risk roads is possible in India.

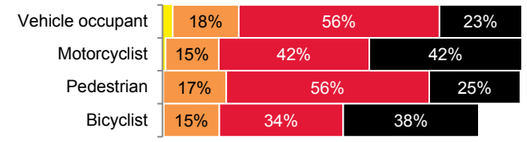
Star Ratings for each State and road user type

★★★★★ (lowest risk)
★★★★
★★★
★★
★ (highest risk)

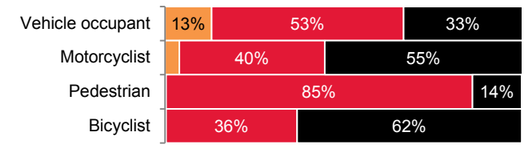
All roads (6421.7km)



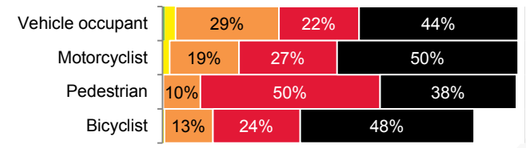
Andhra Pradesh (589.3km)



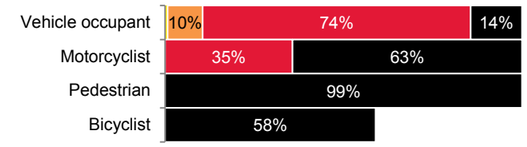
Assam (449.2km)



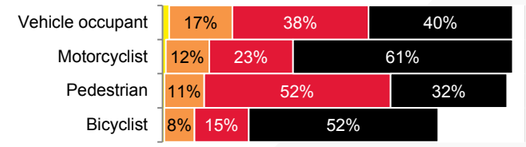
Gujarat (2,260.2km)



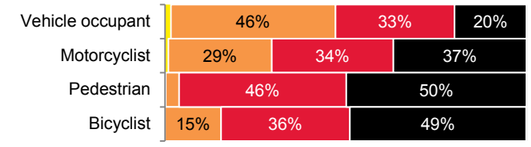
Haryana (119.1km)



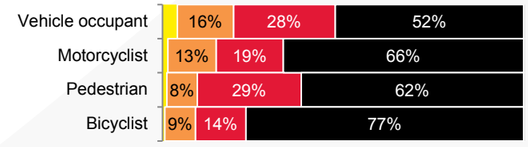
Karnataka (2,041.3km)



Kerala (622.5km)



Rajasthan (340.1km)



Pedestrian risk

Pedestrians are present on the majority of rural and urban roads, yet 97% of these roads have no formal footpaths.

Run-off risk

84% of roads have hazardous roadside objects, such as trees, poles and steep embankments. This is especially critical on curved sections, which account for about 22% of the network.

Head-on risk

88% of roads are single lane carriageways with no physical median. Many of the roads carry a mix of slow moving and faster moving vehicles, creating high overtaking demand.

Intersection risk

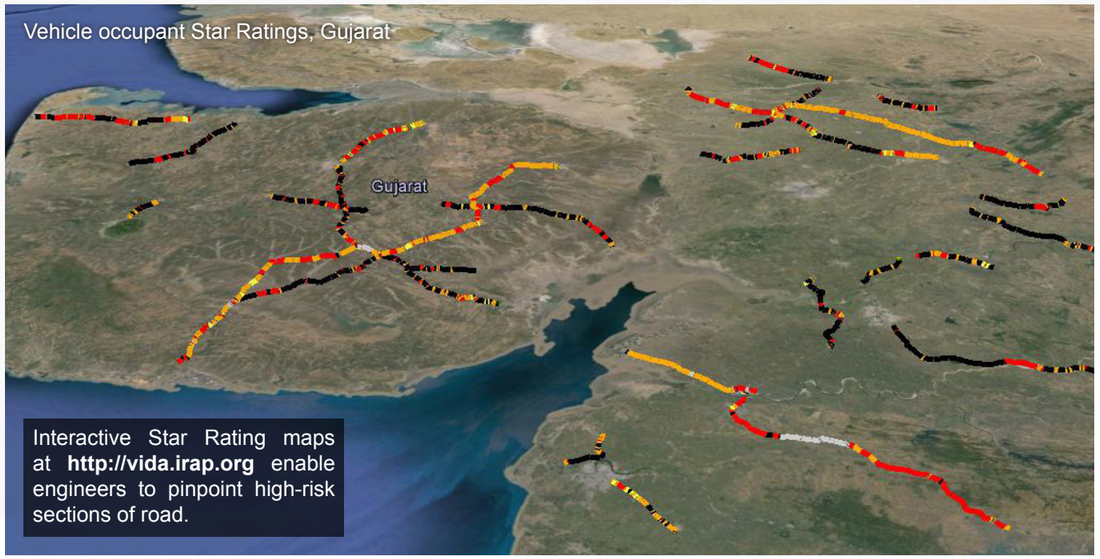
More than 7,800 intersections were recorded (an average of 1.2 per km). 86% of these are unsignalised 3-leg or 4-leg intersections with no protected turn lanes.

Bicyclists risk

Although bicyclists and non-motorised vehicle users are present across much of the network, there are no bicycle facilities. 68% of the roads have no paved shoulder.

Speed

Speed plays a critically important part in road safety. In these assessments, results are mostly based on speeds of 50-60km/h in urban areas and 80-90km/h in rural areas.



SOLUTIONS

A Safer Roads Investment Plan (SRIP) identifies economically viable countermeasures that can improve a road's Star Ratings and prevent deaths and serious injuries.

The most comprehensive plan developed for India indicates that investments of up to INR 100 billion (USD 1.6 billion) would generate positive economic returns. With this level of investment, it is estimated that 300,000 deaths and serious injuries would be prevented over 20 years, representing a 55% reduction. The economic benefit over that period, in terms of crash costs avoided, would be INR 225 billion (USD 3.6 billion).

The top nine types of countermeasures include safety barriers, intersection upgrades, pedestrian footpaths, pedestrian crossings, street lighting and traffic calming (see next page). If all the countermeasures were implemented, the length of road rated in the highest risk one- and two-star bands were be significantly reduced for all road users (see below).

For those roads where it is not economical to lift the standard above one- or two-star with infrastructure, lower-cost speed management initiatives should be pursued, including adjustment of legal speed limits and enforcement.

Three steps to developing a SRIP

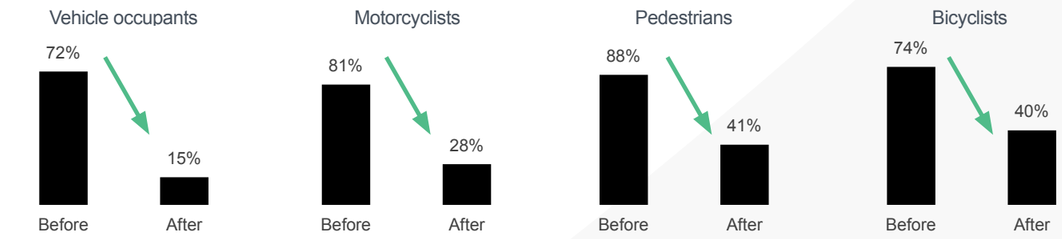
1. Drawing on Star Ratings, traffic volumes and crash rate data, estimates of fatalities and serious injuries on the roads were generated.
2. Countermeasure options were tested for their potential to reduce deaths and serious injuries. For example, a road that is high risk for pedestrians might be a candidate for a pedestrian refuge pedestrian crossing or signalised pedestrian crossing.
3. Countermeasures were assessed against affordability and economic criteria. For the most comprehensive plan developed, the economic benefit of each countermeasure at least exceeded the cost of its construction (that is, it had a benefit cost ratio (BCR) greater than one).

300k The most comprehensive plan has the potential to prevent **300,000 deaths and serious injuries** over 20 years.

55% The number of deaths and serious injuries would **more than half** if all the countermeasures were built.

225bn If all countermeasures were built, some **INR 225 billion** (USD 3.6 billion) in crash costs would be avoided over 20 years.

Change in road length rated 1- and 2-stars if all countermeasures are implemented



SAFETY COUNTERMEASURES

Duplication and additional lanes

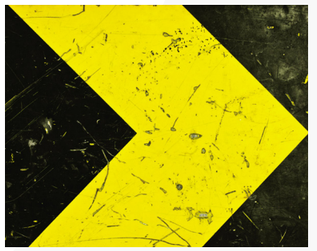
Investment: INR 34 bn
FSI prevented: 74,500
Economic benefit: INR 55 bn

Safety barriers

Investment: INR 12 bn
FSI prevented: 45,200
Economic benefit: INR 34 bn

Intersection upgrades

Investment: INR 13 bn
FSI prevented: 34,700
Economic benefit: INR 26 bn



Delineation and lighting

Investment: INR 5 bn
FSI prevented: 30,600
Economic benefit: INR 23 bn

Pedestrian crossings and fences

Investment: INR 10 bn
FSI prevented: 29,900
Economic benefit: INR 22 bn

Pedestrian footpath

Investment: INR 15 bn
FSI prevented: 29,000
Economic benefit: INR 22 bn

Traffic calming

Investment: INR 3 bn
FSI prevented: 15,200
Economic benefit: INR 11 bn

Motorcycle lanes

Investment: INR 2 bn
FSI prevented: 13,000
Economic benefit: INR 10 bn

Pavement improvements

Investment: INR 4 bn
FSI prevented: 11,600
Economic benefit: INR 9 bn

Note: FSI = fatalities and serious injuries

IMPLEMENTATION

The Safer Roads Investent Plans (SRIP) developed for India are now being used in World Bank projects worth more than USD 4 billion - meaning there is now an opportunity to make large-scale, immediate improvements to high-risk roads that will save lives today and long into the future.

As with any engineering programme or concept plan, the implementation of a SRIP requires local knowledge and detailed planning and design. Typically, the planning and engineering steps involved in implementing a countermeasure programme include:

- local examination of proposed iRAP countermeasures, often in conjunction with Road Safety Audits (RSA)
- preliminary scheme investigation studies
- Star Rating of designs (see next page)
- detailed costing, final evaluation and construction.

In addition to separate technical reports, detailed, interactive Star Rating and SRIP reports are available to funding bodies, elected members, government officials, design engineers and planners in the iRAP online software: **http://vida.irap.org**.

Finally, an important part of the implementation process should be ongoing traffic volume, crash and speed data collection for before-and-after evaluations of the improvements. This will demonstrate their success and enable a later-phase improvement programme for the next investment period to be developed based on documented local experience.

World Bank financed projects that are using iRAP assessments

Project name	Total value (USD million)
Andhra Pradesh Road Sector Project	645
Assam State Roads Project	397
Gujarat State Highway Project II	566
National Highways Interconnectivity Improvement Project	1,152 *
Second Karnataka State Highway Improvement	1,003
Second Kerala State Transport Project	445
Total	4,208

* Status: pipeline

STAR RATING DESIGNS

There is growing international agreement on the need for a greater emphasis on safety in road designs. The Commission for Global Road Safety recommended that “desired design speeds for new roads should be subject to achieving minimum safety ratings.”

India was the first country to ‘Star Rate’ road designs on a large scale. To date, designs for more than 1,800km of roads have been shaped using the Star Rating methodology, with outstanding success (see below).

By providing a means of objectively measuring the impact on risk of various design iterations, the Star Rating design process is helping harness the potential of designers to find creative solutions to challenging safety problems.

For governments and development banks, the process opens the opportunity to set performance-based targets for vehicle occupants, motorcyclists, pedestrians and bicyclists that not only improve safety but create a high level of transparency and accountability.

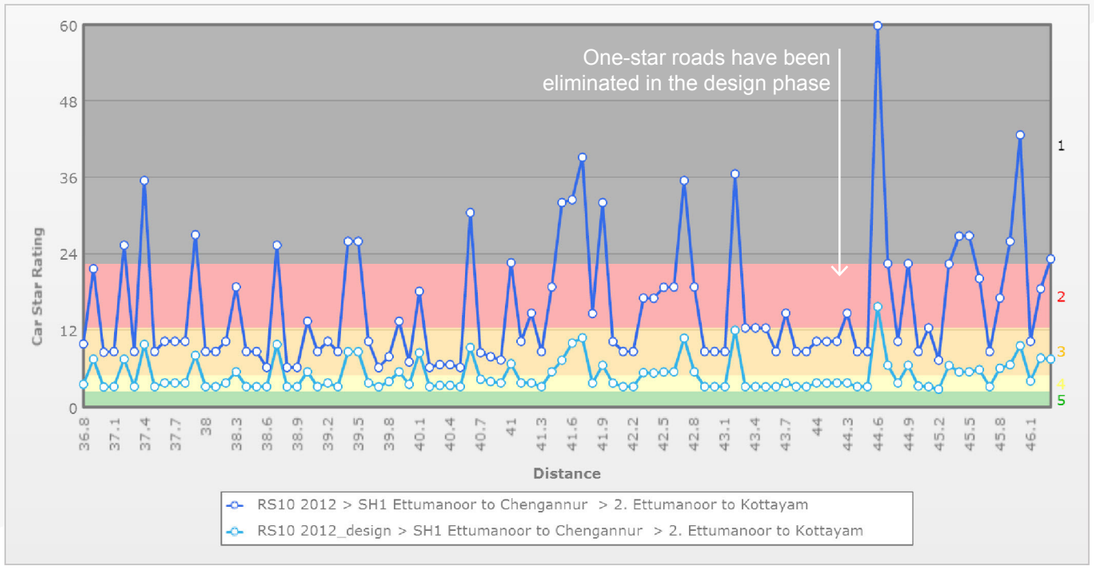
The Star Rating design process has been successfully used in conjunction with existing mechanisms such as Road Safety Audits and highway design standards.

Karnataka was the first jurisdiction in the region to commit to setting minimum Star Ratings for new road designs.

1. The World Bank initially set a three-star target for demonstration corridors. The Government then extended this to include 500km additional roads.
2. Star Ratings were calculated for the existing roads.
3. Detailed supporting data, including from road crash investigations, were collected.
4. Consulting and road authority engineers used Star Ratings to test the impact and suitability of various safety options for the roads, such as ‘raised pedestrian crossings’ and safety barriers.
5. Designs were optimised using a combination of Star Ratings, road safety audits, design standards, budget constraints and environmental requirements.

This process resulted in designs with significantly better Star Ratings than the existing roads. For example, the percentage of road rated one-star or two-stars for vehicle occupants reduced from 86% to 2%. It was estimated that the new designs would result in 55% fewer deaths and serious injuries than currently occur.

An example ‘risk worm’ illustrating existing conditions (dark blue) and design conditions (light blue)



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- Deshmukh Sagar, Chief General Manager, LEA Associates South Asia Pvt.Ltd (LASA)
- Premal Sheth, Deputy General Manager and Kalpesh Panchal, Senior Engineer, LEA Associates South Asia Pvt. Ltd (LASA)
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NOTE

Results in this report are were produced using ‘version 3’ of the iRAP methodology. This involved migrating some 3,000km of iRAP India Phase 1 data from the previous methodology to the new methodology. More information on the version 3 methodology is available at: **http://irap.org/about-irap-3/methodology**.

Our vision:
a world free of high risk roads

ABOUT iRAP

The International Road Assessment Programme (iRAP) is a charity dedicated to saving lives through safer roads.

iRAP works in partnership with government and non-government organisations to:

- inspect high-risk roads and develop Star Ratings and Safer Roads Investment Plans
- provide training, technology and support that will build and sustain national, regional and local capability
- track road safety performance so that funding agencies can assess the benefits of their investments.

Road Assessment Programmes (RAP) are now active in more than 80 countries throughout Europe, Asia Pacific, North, Central and South America and Africa.

iRAP is financially supported by the FIA Foundation for the Automobile and Society and the Road Safety Fund. Projects receive support from the Global Road Safety Facility, automobile associations, regional development banks and donors such as Bloomberg Philanthropies.

National governments, automobile clubs and associations, charities, the motor industry and institutions such as the European Commission also support RAPs in the developed world and encourage the transfer of research and technology to iRAP. In addition, many individuals donate their time and expertise to support iRAP.

For more information

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To find out more about the programme, visit www.irap.org. You can also subscribe to ‘WrapUp’, the iRAP e-newsletter, by sending a message to icanhelp@irap.org.

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