

# Barriers

Design, modelling and crash testing of the  
modified SANRAL temporary barriers  
to achieve EN compliance

Stephen Humphries

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# 1. Background / timeline

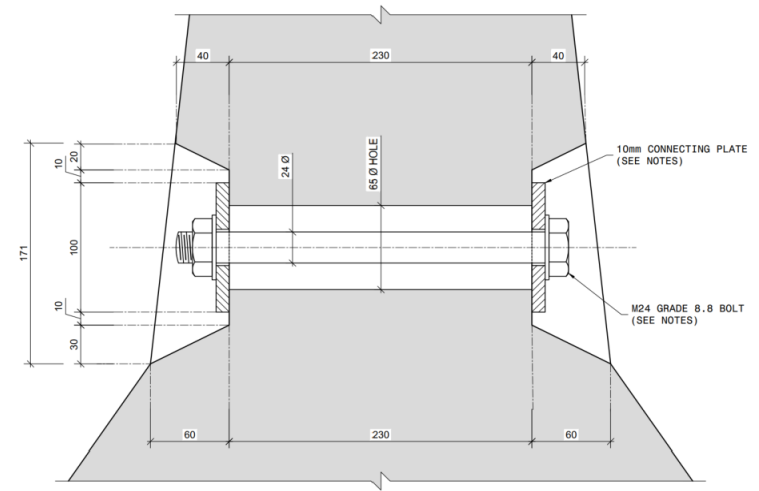
- 2008 - 2012: Many km's of the original barriers were manufactured and utilised for the 2010 Soccer World Cup projects.
- 2011: SANRAL appointed *Advance Structural Mechanics* to conduct sophisticated computer simulations to validate the original barrier's compliance to code.
- 2012 – 2018: Growing pressure from industry (mainly commercial barrier suppliers) that the original barriers do not comply.
- 2019 – I was approached by SANRAL to investigate what needs to be done for the original barriers to comply, so that it can be utilised for the upcoming N3 projects from PMB – Durban.



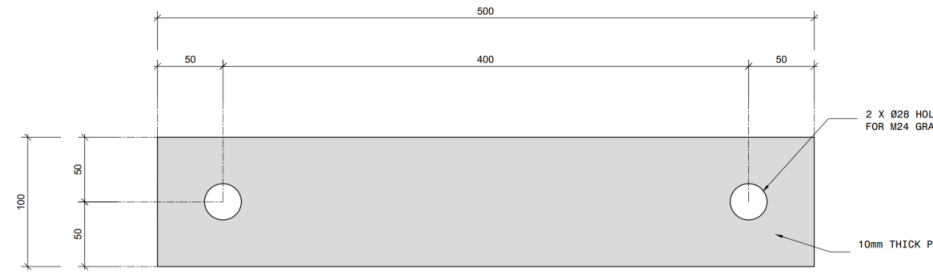
# 1. Background / timeline (cont.)

- Later in 2019: SANRAL took a decision to go with commercial barriers for the N3 project.
- 2020: Raubex approached me to continue the investigation to revise and crash test the original barriers.
- 2021: Modify design and test barriers in Italy.
- 2022 – to date: Raubex is using the modified barriers for their Kwamashu to Mhloti N2 project in Durban.

## 2. Original barrier details



**CONNECTION DETAIL**  
 SCALE 1:2.5



**CONNECTION PLATE DETAIL**  
 SCALE 1:2.5

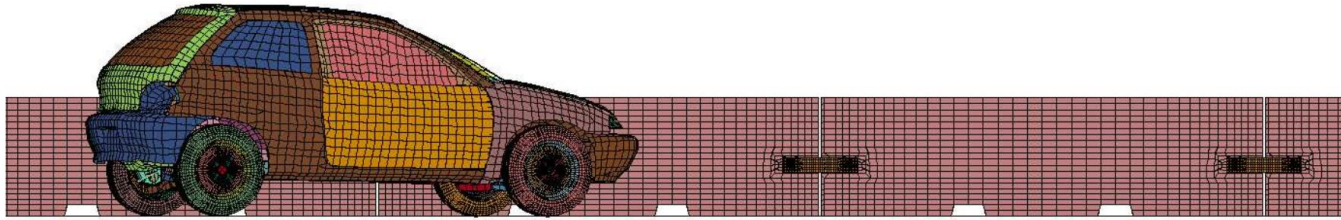
REFER TO TYPICAL SANRAL DRAWINGS - STRUCTURES SHEET TD-S-P-1001-V1 FOR TEMPORARY BARRIER CONSTRUCTION DRAWING

Length = 3.0 m  
 Height = 800 mm  
 Base width = 800 mm

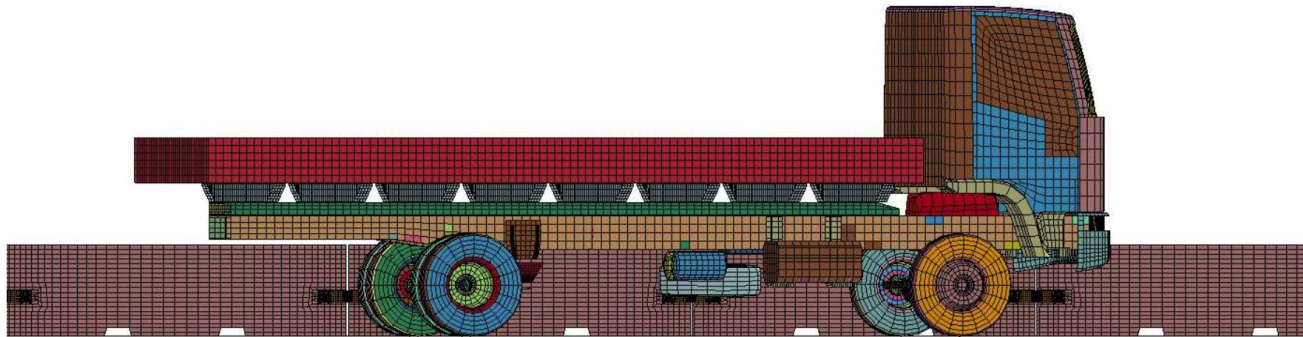
### 3. Non-linear dynamic FE modelling

- Extensive modeling and crash test simulation was conducted by Advance Structural Mechanics (Pty) Ltd. (2011)
- Determine containment level (H1 or H2) of the barrier by means of three impact assessment tests – TB11, TB42 and TB51 – as defined in EN1317
- Connection detail was also assessed

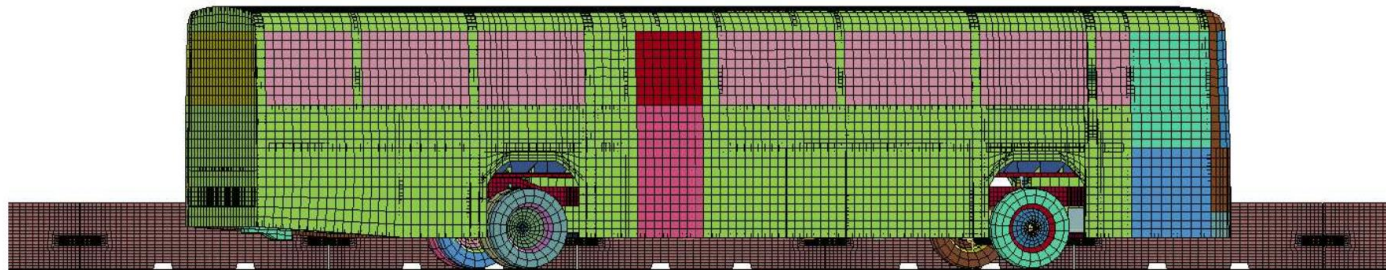
## 3. Non-linear dynamic FE modelling (cont)



TB11  
900 kg



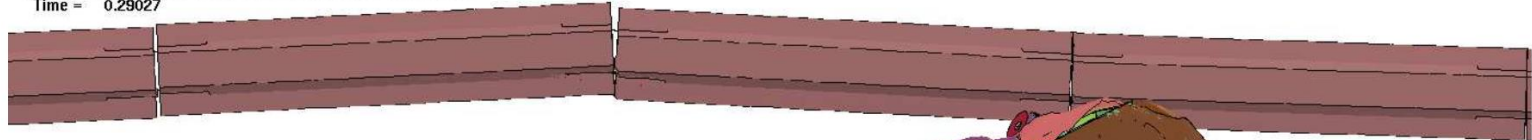
TB42  
10 000 kg



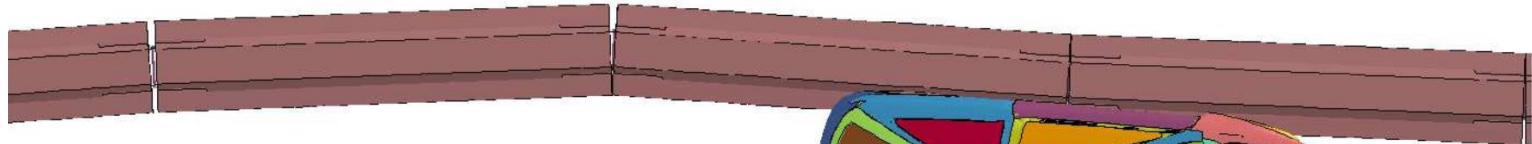
TB51  
13 000 kg

# 3. Non-linear dynamic FE modelling (cont)

LS-DYNA KEYWORD DECK BY LS-PREPOST  
Time = 0.29027



Original



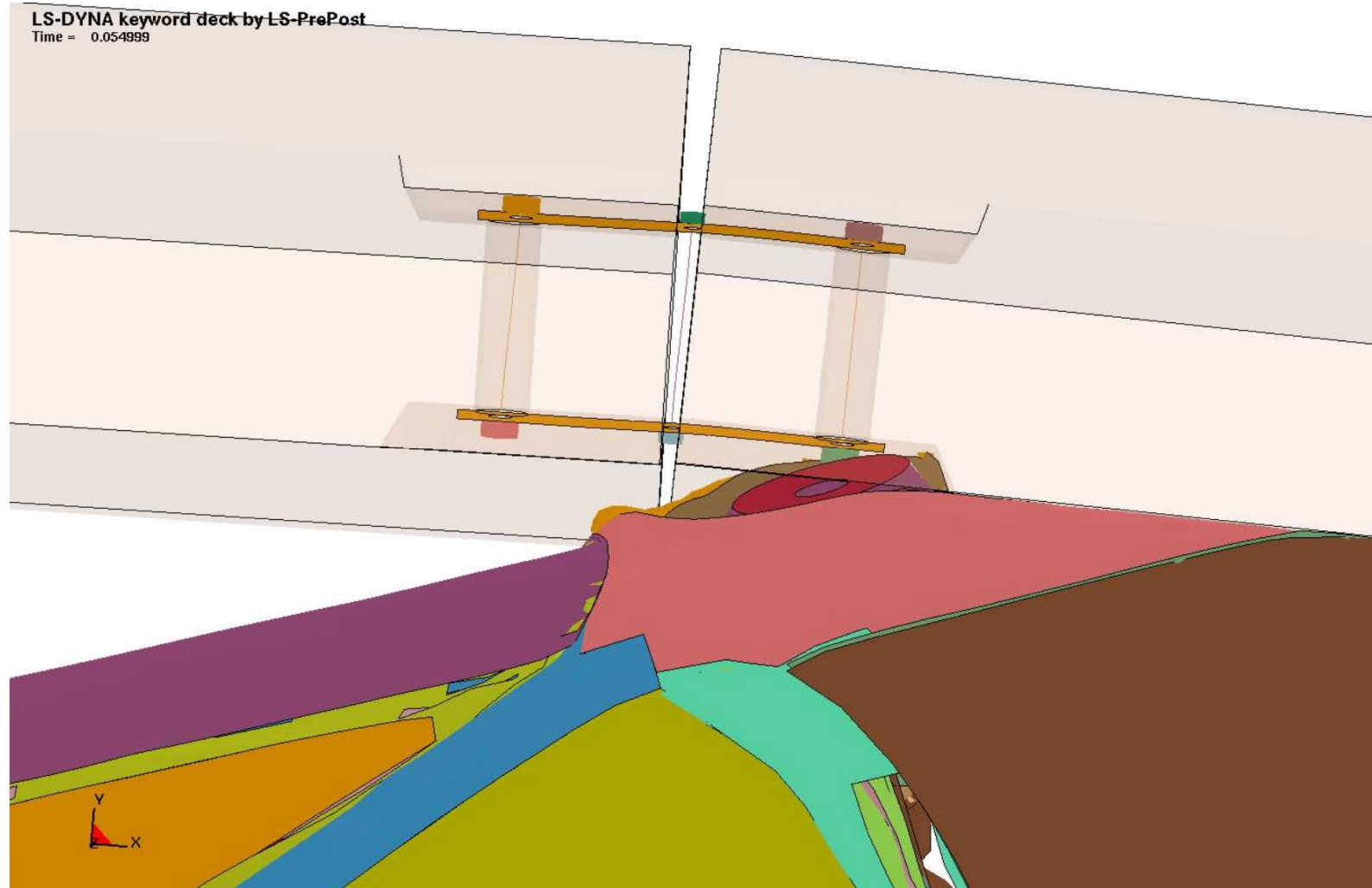
Center bolt



Effect of central bolt



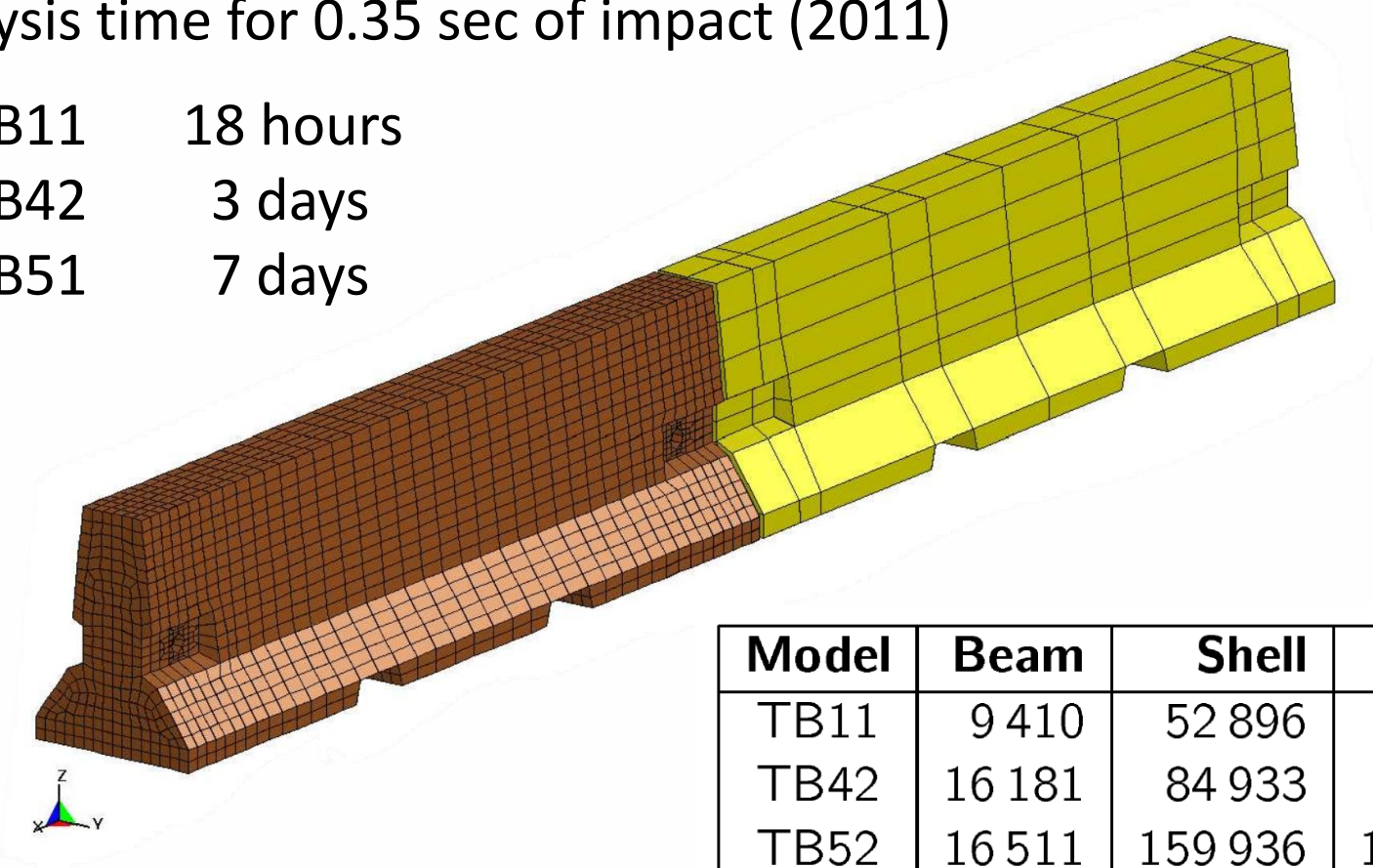
# 3. Non-linear dynamic FE modelling (cont)



Snagging of wheel in recess

## 3. Non-linear dynamic FE modelling (cont)

- Analysis time for 0.35 sec of impact (2011)
  - TB11      18 hours
  - TB42      3 days
  - TB51      7 days



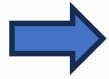
Model	Beam	Shell	Solid
TB11	9 410	52 896	51 076
TB42	16 181	84 933	83 280
TB52	16 511	159 936	160 183

### 3. Results and conclusions of FE analysis

- Central bolt essential in connection plate
  - Recess should be lessened or covered
  - Woven polyester straps should not be used instead of bolts
  - Bolts should be installed with the thread and nut to the traffic side
  - Friction between barrier and road surface proofed less critical
  - Weight of section (inertia) is critical
  - Stiffness of joints between units is critical
- TB11 Compliance – successfully contained
- TB42 Compliance – successfully contained
- TB51 Non-compliance

## 4. Modified barrier details

Modify



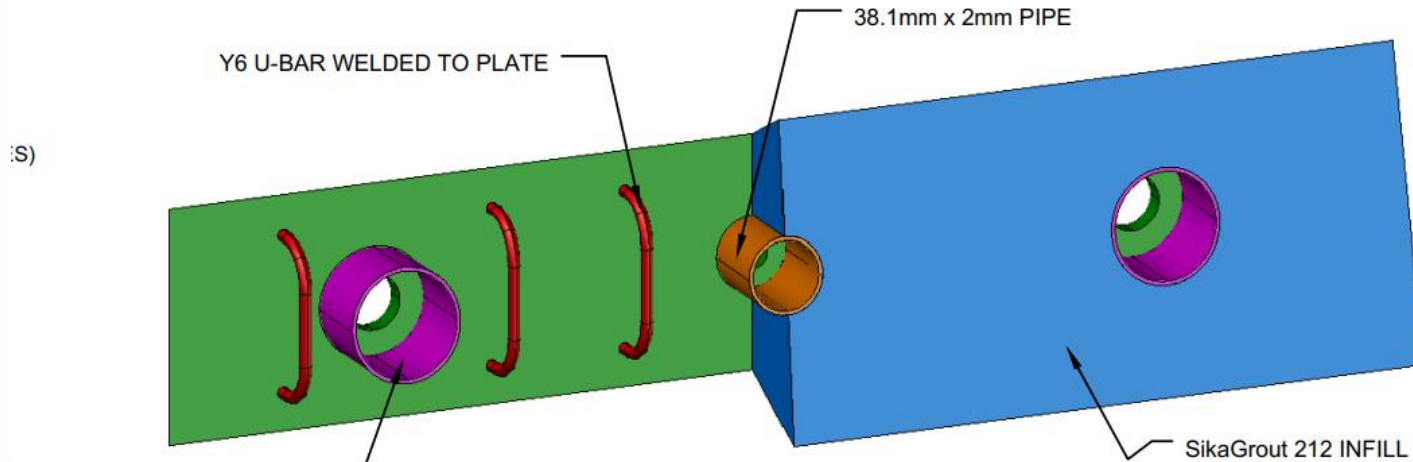
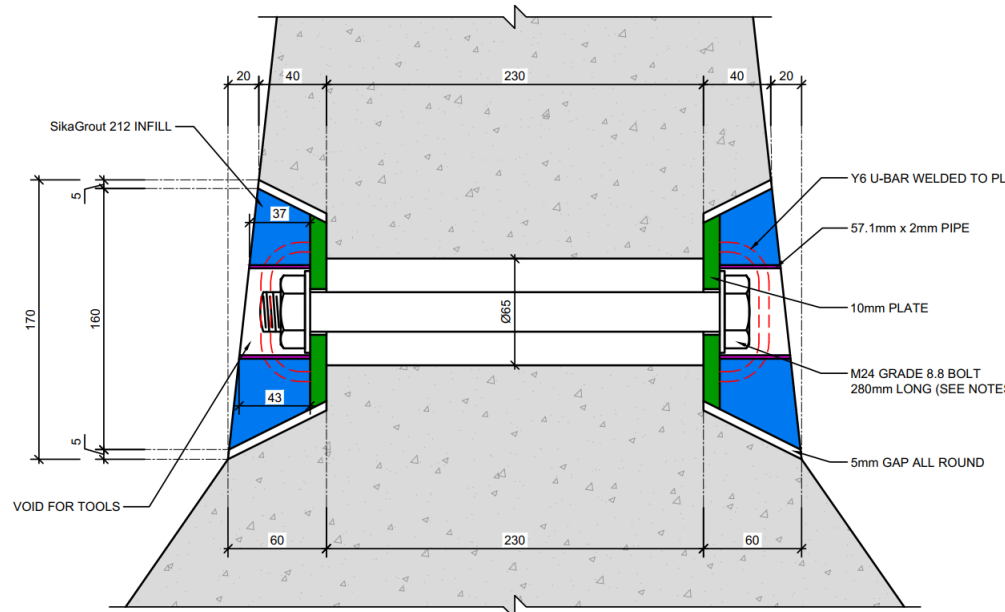
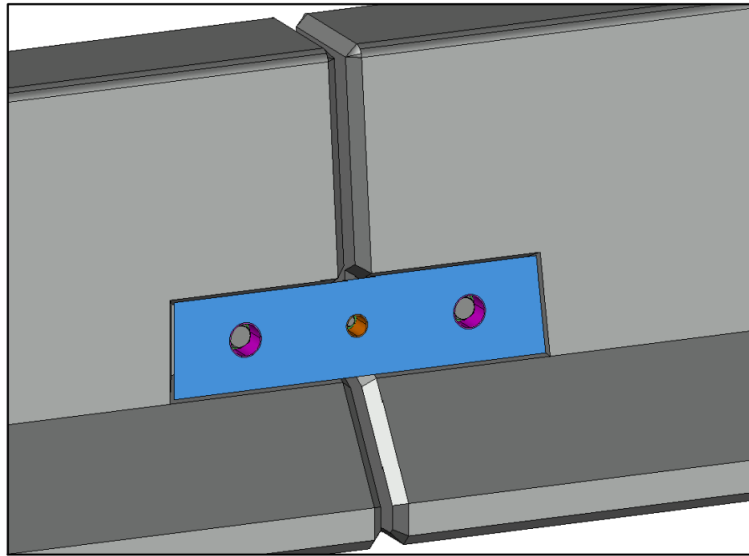
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Crash  
Test



- TB11 Compliance – successfully contained
- TB42 Compliance – successfully contained
- TB51 Non-compliance

# 4. Modified barrier details (Cont)

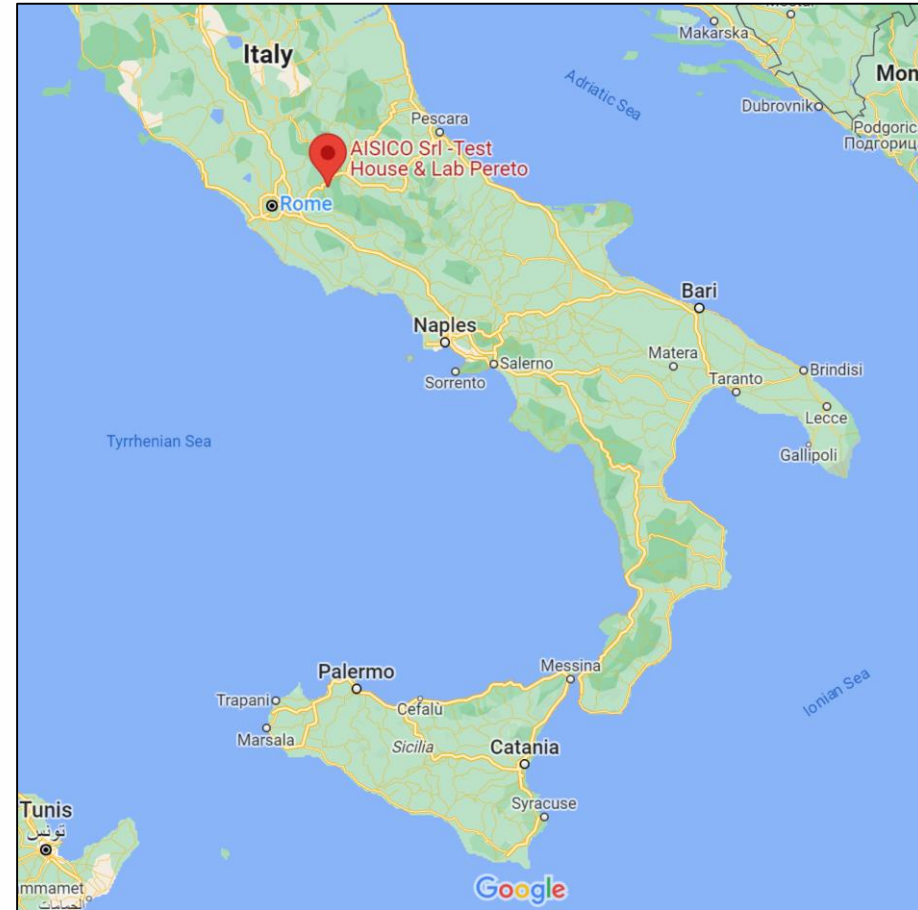


## 5. Crash testing of modified barriers



Desired crash test outcome:

- EN 1317:1-2010 → H1  
Containment class (TB11 & TB42)
- Level of normalised working width →  $W5 \leq 1.7\text{m}$
- Hoping for H2 containment class (TB52)



## 5. Crash testing of modified barriers (Test details)

Description	TB11	TB42
Test type	Impact with angle of incidence	Impact with angle of incidence
Impact velocity	100 km/h	70 km/h
Impact angle	20 °	15 °
Vehicle mass	900 ± 40kg	10 000 ± 300kg
Vehicle type	Car	Truck
Cross impact energy	40 kJ	122.9 kJ

**Result**



- Pass H1 containment class criteria
- Working width level W5 ( $\leq 1.7\text{m}$ )
- Severity class C
- Fail H2 containment class criteria

## 5. Crash testing of modified barriers (TB11 – 900 kg)



Comply





## 5. Crash testing of modified barriers (TB11 – 900 kg)



## 5. Crash testing of modified barriers (TB42 10 ton)



Comply



## 5. Crash testing of modified barriers (TB42 10 ton)



## 5. Crash testing of modified barriers (TB51 13 ton)



Fail



# 5. Crash testing of modified barriers (Certificate)



## CERTIFICATO DI ACCREDITAMENTO Accreditation Certificate

ACCREDITAMENTO N. / ACCREDITATION N. **0424L REV. 07**

EMISSO DA / ISSUED BY **DIPARTIMENTO LABORATORI DI PROVA**

SI DICHIARA CHE / WE DECLARE THAT **AISICO S.R.L.**  
Sede/Headquarters:  
- S.P. 27 del Cavaliere Loc. Salone Km 2,500 - 67064 Pereto AQ

È CONFORME AI REQUISITI DELLA NORMA / MEETS THE REQUIREMENTS OF THE STANDARD **UNI CEI EN ISO/IEC 17025:2018**

**ISO/IEC 17025:2017**

MF-CL-02 rev. 03

QUALÈ / AS **Laboratorio di Prova  
Testing Laboratory**

Data di 1ª emissione / 1st issue date  
**16-10-2002**

Data di modifica / Modification date  
**18-02-2020**

Data di scadenza / Expiring date  
**16-10-2027**

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Il Direttore di Dipartimento  
The Department Director

Dott. Filippo Trifiletti  
Il Direttore Generale  
The General Director

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# 6. Application in current N2 project

Contract N002-260-2018/9

Upgrading of N2 from Kwamashu I/C to Umdloti river bridge in Durban

Client: SANRAL  
Supervision: Naidu Consulting  
Contractor: Raubex KZN



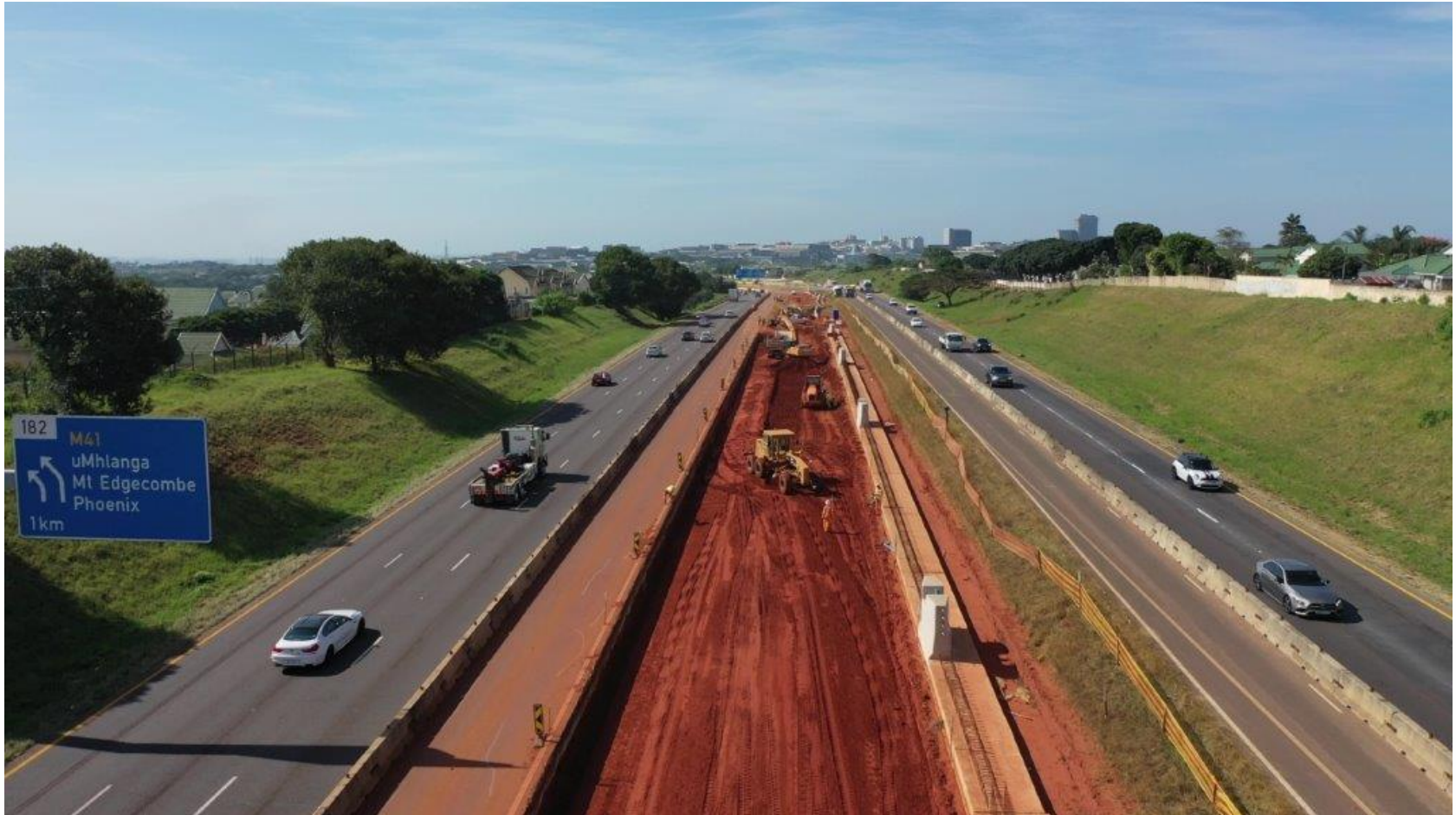
➔ 24 km of temporary barriers required

Description	Amount (Excl VAT)
Option 1: Purchase H1 temporary barriers	R 43 040 250
Option 2: Proposed modified barriers (incl collection, modification, testing and certification)	R 18 100 000
<b>SAVING</b>	<b>R 24 940 250</b>



- 15 km from Camperdown
- 9 km from Gauteng

## 6. Application in N2 project (Cont)



## 6. Application in N2 project (Cont)





## 6. Application in N2 project (Cont)

Accident data to date:

No	Date	Carriageway	Chainage	No. of Barriers Displaced	Deflection (m)	Vehicle Information
1	15/09/22	SB	1.600	3	1.56	Unknown
2	20/02/23	SB	8.000	4	1.20	NP 200, carrying food, speeding (120 km/h)
3	07/03/23	SB	3.600	3	1.20	Unknown
4	08/03/23	SB	2.110	4	1.02	Hyundai ix35, speeding
5	29/06/23	SB	10.500	2	0.68	Unknown

## 6. Application in N2 project (Cont)



## 7. Lessons learned and Conclusion

- The modified connection plate proved to be very stiff and prevented tapering of the barriers at the start and end sections.
- The barriers was crash tested and practically proven in a current freeway project as “fit for purpose”.
- A significant saving was achieved - which can be repeated on many more projects for many years to come.

A special mention to the three parties involved:

1. *Raubex* – For having the initiative and energy to pursue this matter to the end.
2. *Naidu Consulting* for being prepared to listen to reason and be willing to motivate this change to the client.
3. *SANRAL* for being willing to negotiate the terms of this value engineering proposal.

# Thank you