

NZTA Research Report 526

Stability of motorcycles on audio tactile profiled (ATP) roadmarkings

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We have no evidence  
that ATP roadmarkings create  
any significant instability  
issues for motorcycles

# Why research ATP roadmarkings and motorcycles?

## Existing experience of ATP roadmarkings



- New Zealand adopted the raised-profile type of ATP roadmarkings
  - Trials in 2004
  - Expanded use since 2008/2009



- Early usage of ATP roadmarkings was predominantly as edge lines with expectations of low rates of being traversed
- Usage of ATP roadmarkings has evolved and increased so that ATP roadmarkings are now where they may be more routinely traversed



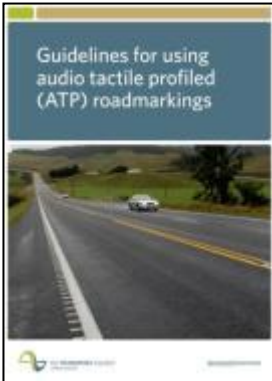
- Other studies have associated the use of ATP roadmarkings with a 15 to 20 percent reduction in crashes
  - Could specific effects of ATP roadmarkings for motorcycles be masked by a general trend?

# Why research ATP roadmarkings and motorcycles?

## Public interest and parliamentary questions

While there is no evidence to suggest that ATP roadmarkings would cause cyclists to lose control or crash, cyclists would prefer to avoid them and they may pose a danger to cyclists if they are encountered unexpectedly or if the cyclist is already not in full control of their bike.

There is limited information regarding the risks (or benefits) that ATP roadmarkings pose to cyclists and motorcyclists. [...] Some motorcyclists have indicated that as long as they can see them, they can take reasonable steps to avoid them.



9553 (2010). Hon Rick Barker to the Minister of Transport (25 May 2010): Has any research been undertaken on the stability of motorcycles in relation to the new rumble strips, in particular for wet weather conditions, if so what did it reveal and if not, why not?

Hon Steven Joyce (Minister of Transport) replied: The rumble strip dimensions were derived from extensive research of international practices and are contained within NZTA specification M/24. Wet weather skid resistant requirements are also contained within this specification. No New Zealand specific research on motorcycle stability has been undertaken. I have not been made unaware of any stability issues in New Zealand.

aware of any international research on how these rumble strips may affect motorcycle and scooter safety, and if not why was no New Zealand Research undertaken?

Hon Steven Joyce (Minister of Transport) replied: The New Zealand specifications and guidelines for the use of rumble strips have been based upon research of international best practices. Rumble strips similar to New Zealand's are widely used throughout Europe and Australia that have motorcyclists and scooters within their vehicle fleet. The NZ Transport Agency is unaware of any motorcycle stability issues in those countries or with rumble strips laid to date in New Zealand. Please see also my response to question for

Are larger bumps are being laid on rumble strips; if so, what research, if any, has been undertaken on the effects of motor vehicle stability before the new rumble strips were laid, and what did it reveal?

Hon Steven Joyce (Minister of Transport) replied: Larger lumps are not being laid. The rumble strip dimensions were derived from careful extensive research of international practice and are similar to those being used in many countries. No specific motor vehicle stability research was undertaken in New Zealand. However, video surveillance of driver behaviour was undertaken in the Waikato in 2005 and 2008. I have not been made aware of any motor vehicle stability issues.

Further to the reply to question for written answer 9553 (2010) did the research into international practice reveal any research into how motorcycles and scooters may be affected by rumble strips; if not, is it reasonable to assume the placement of these strips is a "wait and see what happens" and if there is an adverse affect put any resulting accidents down to rider error, or that motorcycle and scooter safety on the road is a low priority or concern for the Ministry?

Hon Steven Joyce (Minister of Transport) replied: There is no research or evidence that indicates that rumble strips could not be used safely in New Zealand or that any additional research, into how motorcycles and scooters may be affected by rumble strips, is required. This is supported by information



Submission on 'High Risk Rural Roads Guide' Paint in the wet is slippery, and the 'rumble strips' used now are worse. Both slippery paint and the grooves in the 'rumble strips' will throw a leaned over motorcycle off line.

Rumble strips are nasty, whether on the centre line or the side line (a motorcycle cornering line will always approach near the road side edge marking).

# Why research ATP roadmarkings and motorcycles?

## ATP roadmarkings and bicycles

- ATP roadmarking dimensions
  - Other studies inspected road surface irregularities and bicycle stability
  - Findings used in guidelines for ATP roadmarkings dimensions
- ATP roadmarking usage
  - Edge line with clear shoulder for cyclists to ride in
  - Avoiding usage or provide gaps where cyclists would have to cross the
- Do the considerations for bicycles apply equally to motorcycles?
  - Cyclists benefit from ATP roadmarkings through better lane-keeping by motorists, but this benefit may not apply to motorcyclists who use the road differently
  - The ATP roadmarking dimensions have been tested for bicycles at cycling speeds but the stability may not be the same for motorcycles at higher speeds

# The research

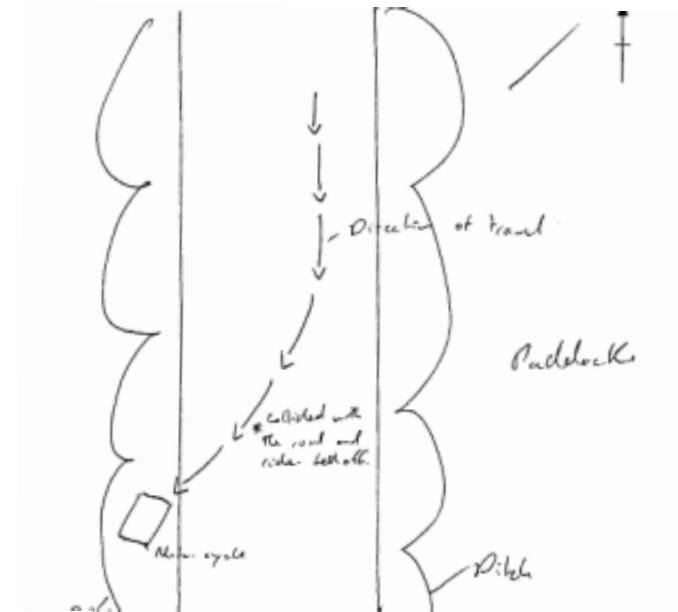
- We are clear about the benefit of ATP roadmarkings overall but we are unclear about the potential instability issue for motorcycles
- Three stages:
  - **Existing evidence:**  
Analysis of existing crash records
  - **Emerging evidence:**  
Review of associated literature
  - **More evidence:**  
Simulation testing of motorcycles ridden on ATP roadmarkings
- If these three stages do not indicate an instability issue for motorcycles, then based on the established benefits of ATP roadmarkings, the current practices can be continued

# Analysis of existing crash records

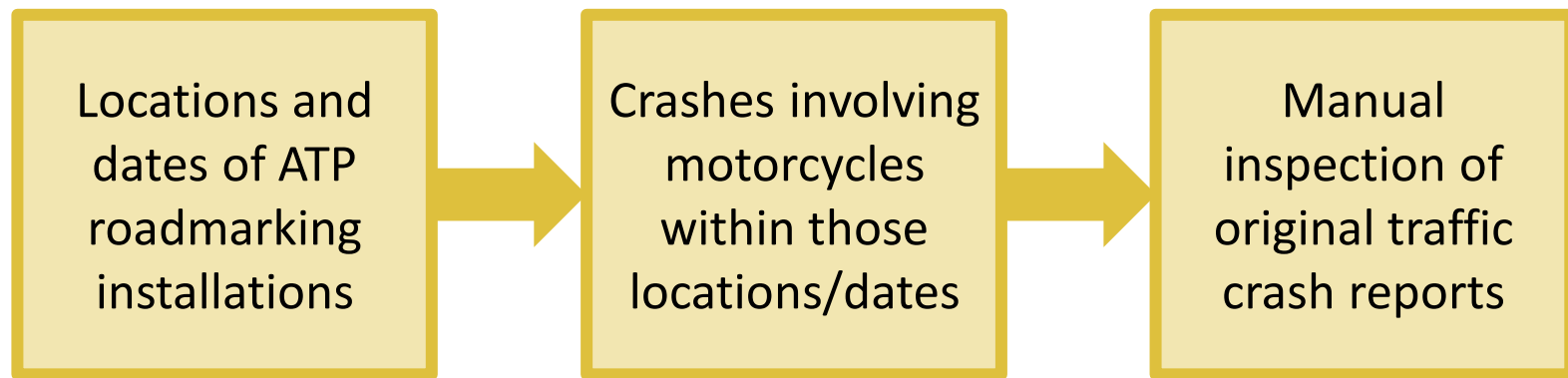
- CAS (Crash Analysis System)
  - Database of coded traffic crash reports

CRASH ROAD	CRASH DIST	CRASH DIRN	SIDE ROAD	CRASH ID	CRASH DATE	CRASH DOW	CRASH TIME	MVMT DESCR	CAUSES	ROAD WET	LIGHT	WTHRa
2/858/0.124	100	S	MT BRUCE SUM	2356093	29/12/2003	Mon	1042	CAR1 SBD on SH 2 lost control; went off road to left, CAR1 hit Fence	CAR1 too far left/right, lost control while returning to seal from unsealed shoulder, inexperience	Dry	Bright Sun	Fine
2/858/0.324	300	S	MT BRUCE SUM	2756014	17/10/2007	Wed	645	CAR1 SBD on SH 2 lost control turning right CAR1 went Over	CAR1 lost control due to road conditions ENV: road slippery	Wet	Overcast	Heavy Rain

- Contains original traffic crash reports
  - Written descriptions of crash
  - Driver and witness interview notes
  - Details on damage, injuries, obstructions



## Analysis of existing crash records



- 90 motorcycle/moped crashes were found to have occurred where ATP roadmarkings were likely to be present
- Manual review of the traffic crash reports found no reports indicating evidence of the involvement of ATP roadmarkings in the crash
  - Police, witnesses, motorcyclists have many things to observe or remember
  - There is no “prompt” ATP roadmarking field on the traffic crash report form
  - However, if there was a clear issue we might expect to see some evidence within 90 traffic crash reports



## Review of associated literature

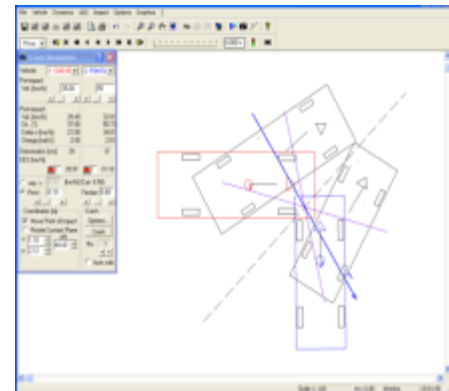
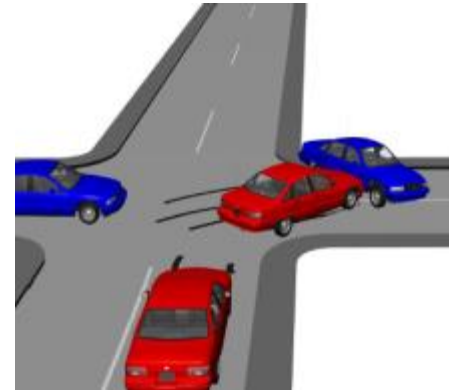
- Impacts on motorcycles of contacting ATP roadmarkings
  - This study and others have found no reports of motorcycle crashes involving ATP roadmarkings
  - Roadside video in the United States observed no directional changes or unusual riding behaviours as motorcycles crossed milled-in ATP roadmarkings
  - Field trials in Japan, Germany and the United States had motorcycles riding over milled-in ATP roadmarkings with no adverse outcomes
  - Field trials in the United Kingdom and the United States had motorcycles riding over and braking on raised-profile ATP roadmarkings with no adverse outcomes

## Review of associated literature

- Impacts on motorcycles of contacting other surface irregularities
  - A study of motorcycle crashes reported on the surface irregularities present at the crash sites finding the road surface actively contributed to 15 % of the motorcycle crashes
  - Field trials in the United States had motorcycles riding over grooved roads with no adverse outcomes
- We also found...
  - Implications of assumed harm such as “some motorcyclists have indicated that as long as they can see the ATP roadmarking ribs they can take reasonable steps to avoid them”
  - Backing-down from results of studies
  - Very small sample sizes

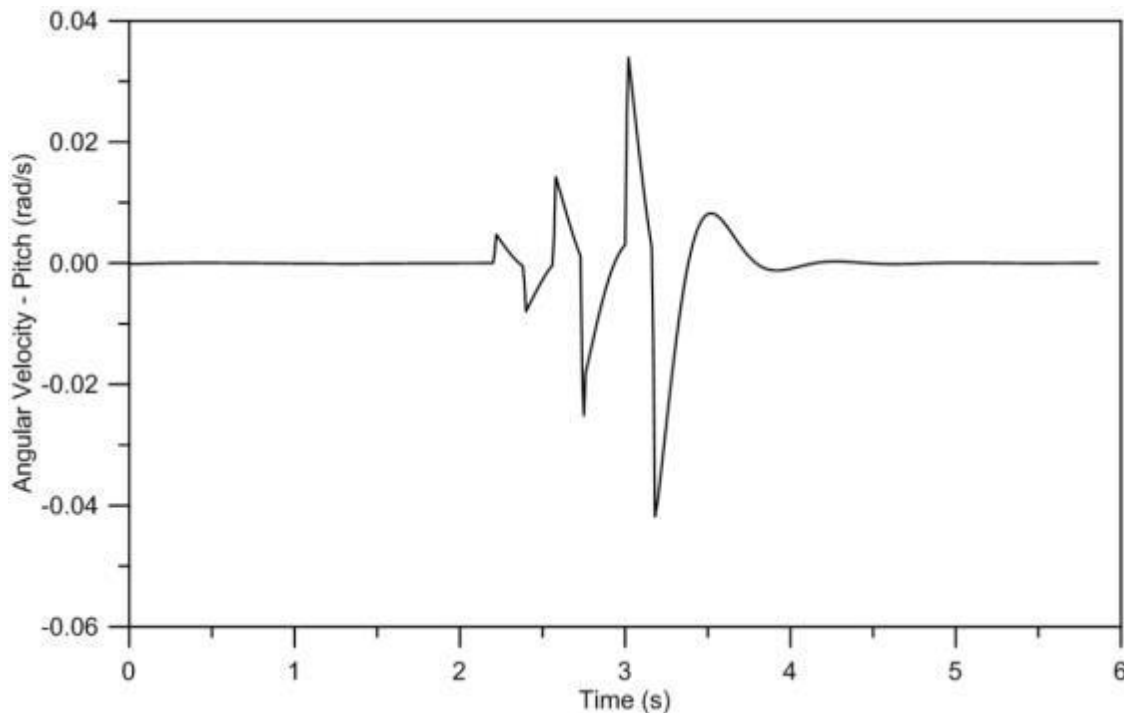
# Simulation testing of motorcycles ridden on ATP roadmarkings

- Vehicle crash and trajectory simulation modelling software: PC-Crash
  - Three-dimensional road element
  - Vehicle manufacturer data on physical characteristics and performance parameters of vehicles
  - For vehicle(s), specify the path to follow during the simulation, with any sequence of speed, acceleration, braking...
  - Kinetic model determines vehicle response during the simulation as the vehicle performs the specified movement as far as possible under application of the laws of physics



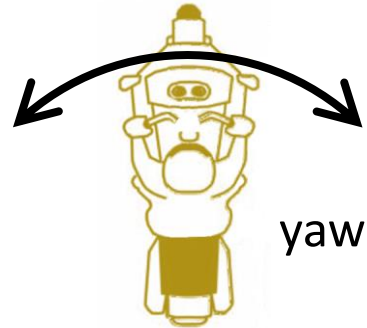
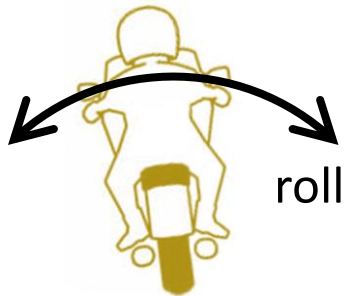
# Verify PC-Crash for our intended application

- Response to the details of ATP roadmarkings
  - Motorcycle pitch during travel over single ATP roadmarking ribs of 3 mm, 6 mm, and 9 mm high



# Verify PC-Crash for our intended application

- Verify PC-Crash by comparing with full-scale physical testing
  - Quantities that can be measured by both PC-Crash and a real-life motorcycle

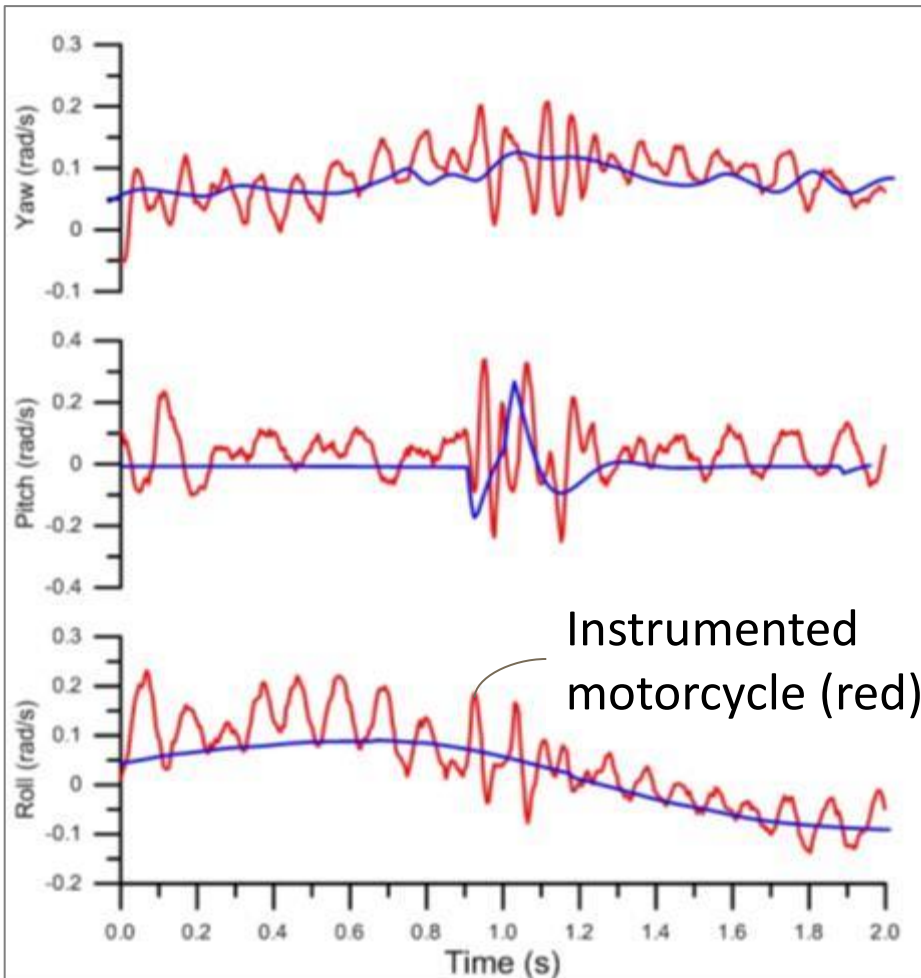


## You will need:

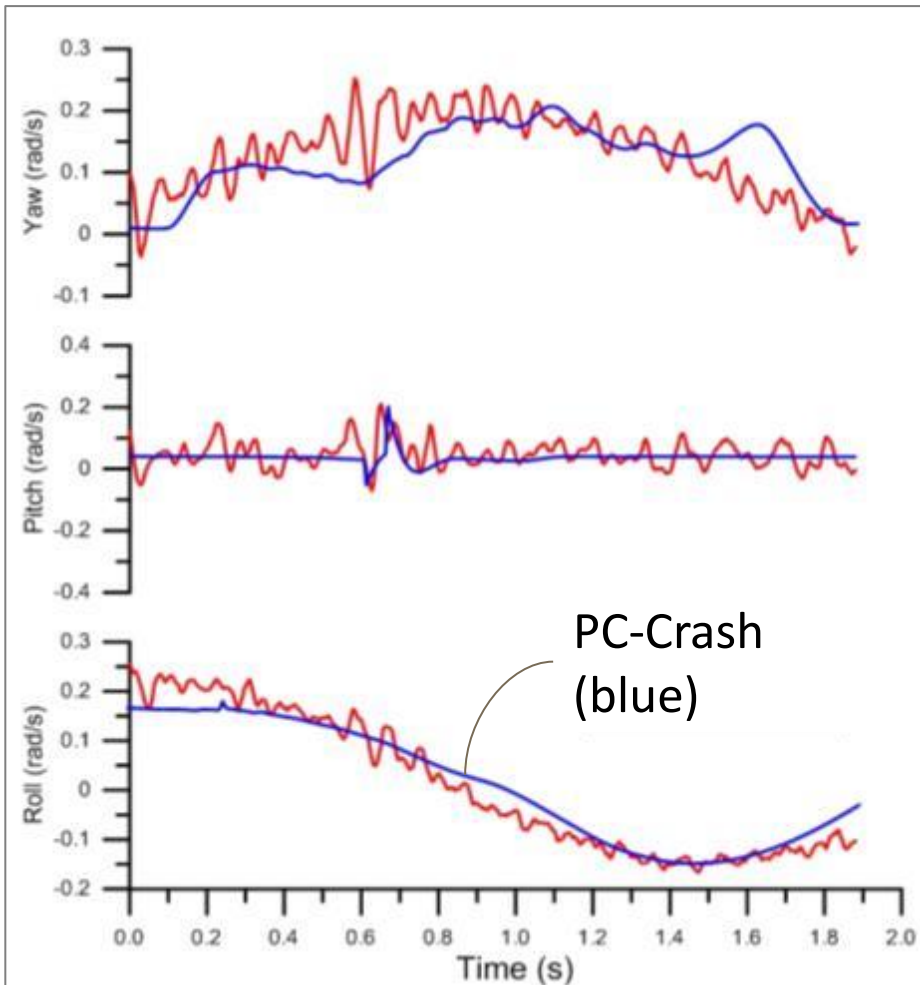
- Full-scale physical testing
  - Instrumented motorcycle  
(gyroscopes, accelerometers, power supply, data acquisition system)
  - Motorcyclist
  - Specified path
  - Without and with ATP roadmarkings
- Equivalent PC-Crash situation:
  - Select same motorcycle
  - Set same motorcyclist weight
  - Set same specified path
  - Without and with ATP roadmarkings  
of same dimensions and layout



# Response from instrumented motorcycle (red) and PC-Crash (blue)



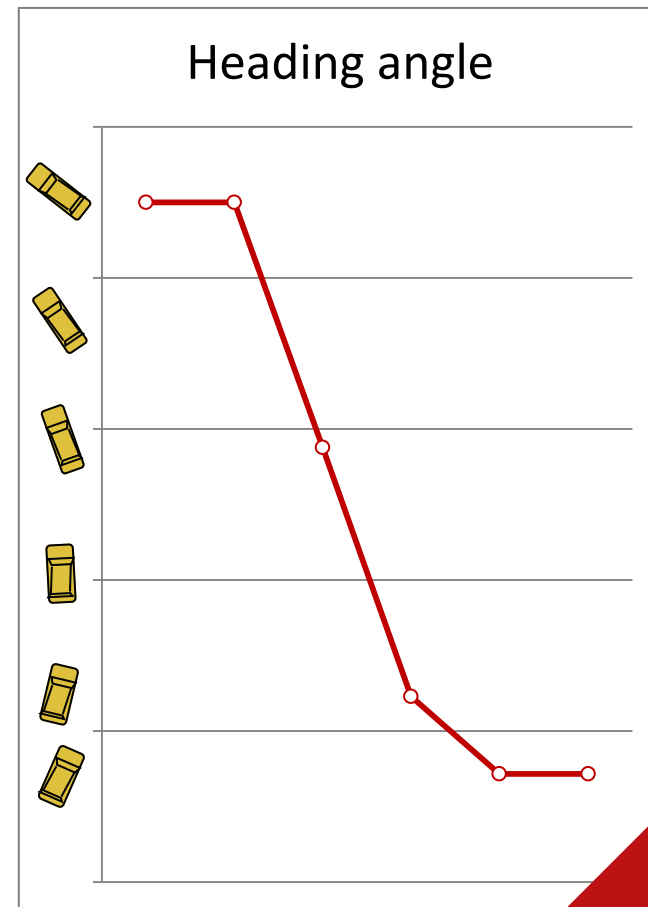
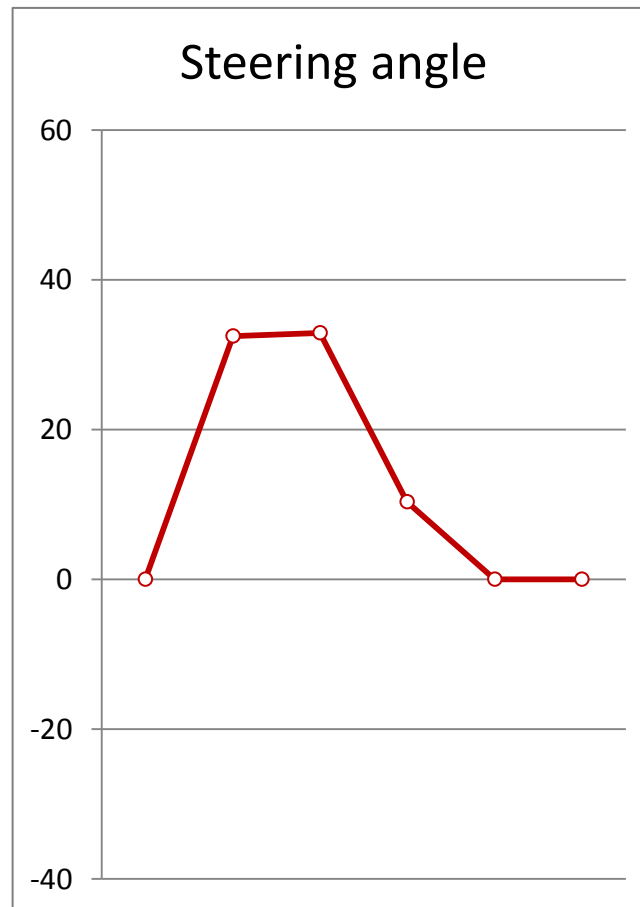
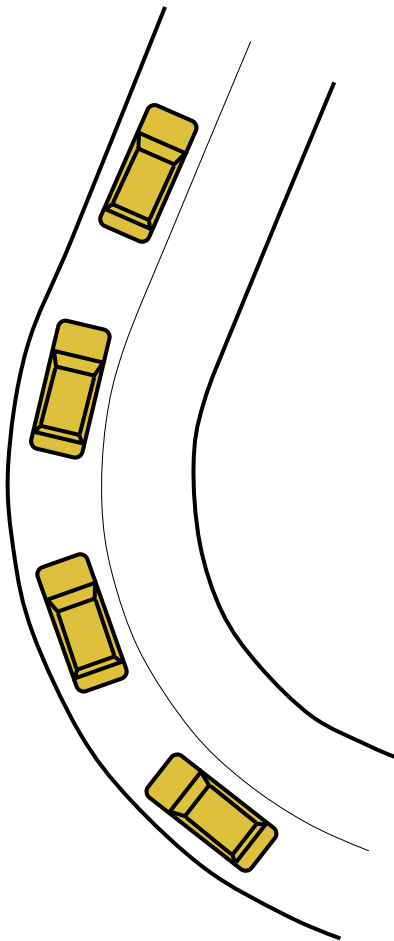
100 metre radius corner,  
30 km/h  
9 mm high rib



50 metre radius corner,  
30 km/h  
9 mm high rib

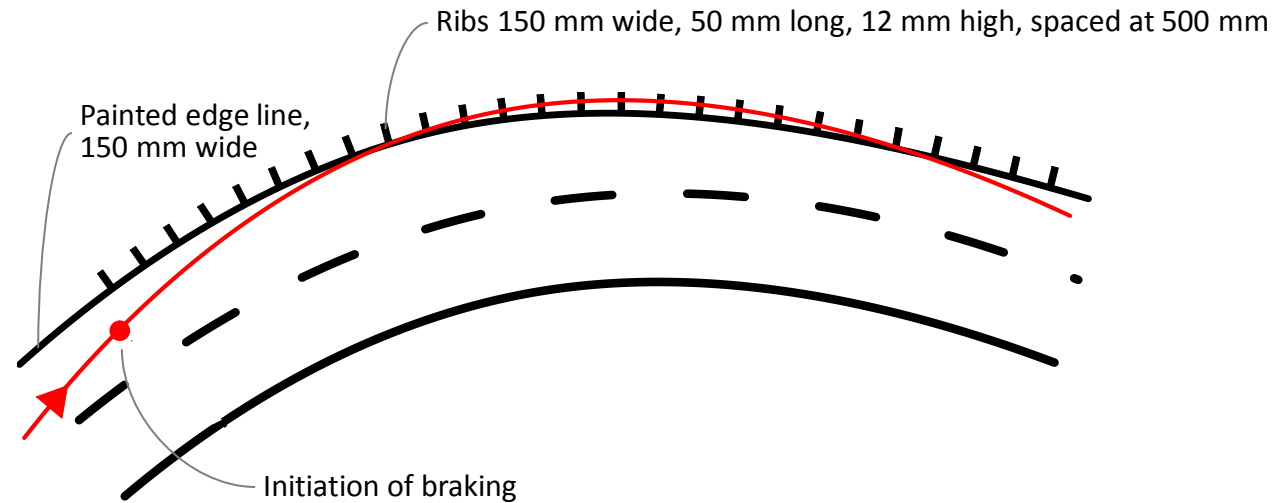
# Steering angles and heading angles

- The plan:
  - Simulate a motorcycle ridden on a road without ATP roadmarkings
  - Simulate a motorcycle ridden on that road with ATP roadmarkings
  - Compare the motorcycle's stability or handling





# Simulation situations



- Wide/poor approach to a “tight” corner
- Wet road surface
- Two speeds
  - 100 km/h
  - 140 km/h
- Three braking scenarios
  - No braking
  - Some braking (50 %)
  - Maximum braking (100 %)

# Simulation situations

- Three motorcycles



Honda CBR 600RR  
sports bike



BMW R1200RS  
road/track bike

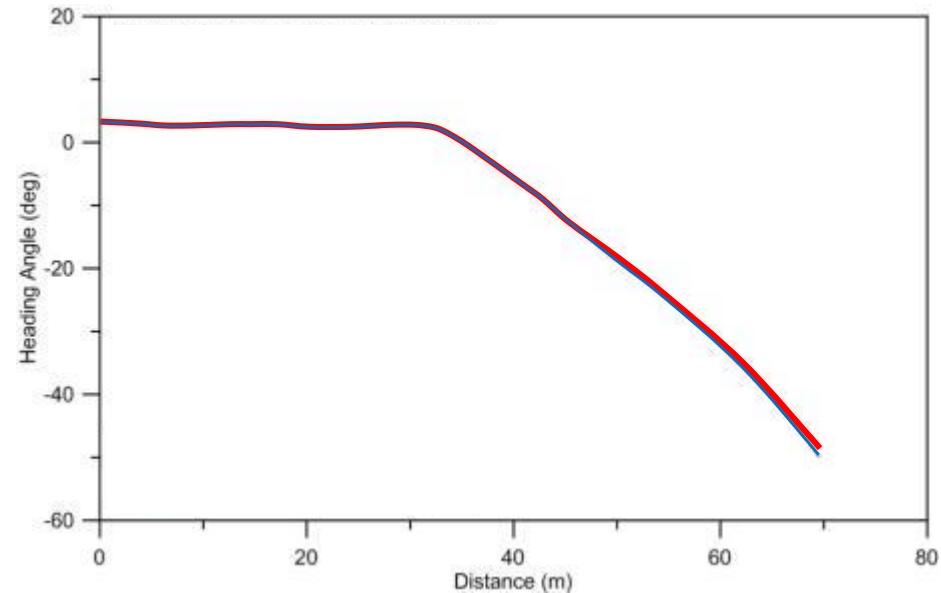
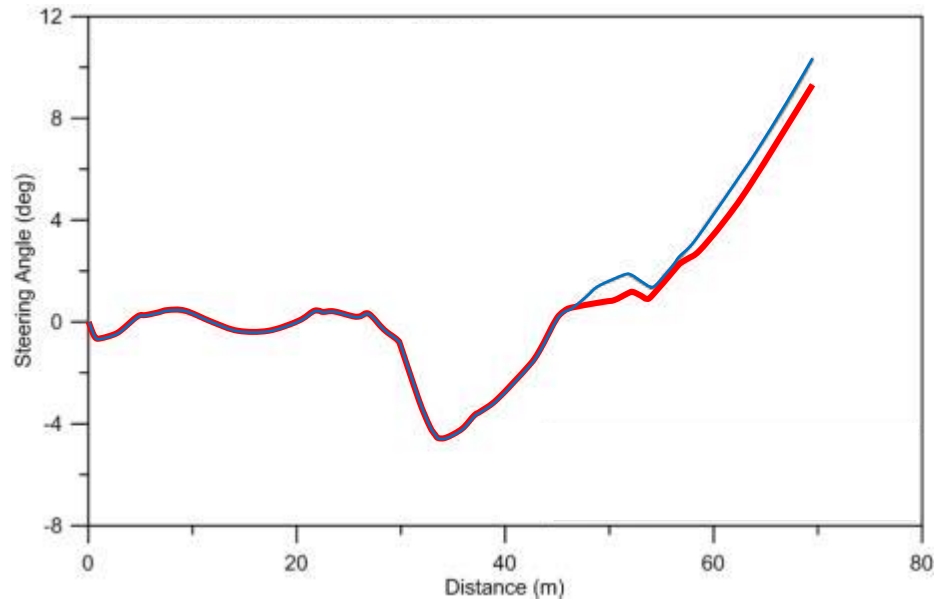


Harley Davidson Softail  
cruising/touring bike

- Without ATP roadmarkings:
  - Two speeds, three braking scenarios, three motorcycles
- With ATP roadmarkings:
  - Two speeds, three braking scenarios, three motorcycles
- Makes 36 situations!

# Outputs from each simulation situation

- 100 km/h, 50 % braking, sports bike
- Without ATP roadmarkings (red) and with ATP roadmarkings (blue)



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