IMPROVING CONCRETE PUMP ROAD SAFETY

Technology Convergence 2023

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INTRODUCTION

- NHVR HVSI funded project aimed road safety
  - Literature review and market scan
  - Fleet performance and risks
  - Field testing and operating studies
  - Guidelines and standards
  - Training
- Global trend to longer and heavier concrete pumps
- Inconsistent acceptance and access in jurisdictions makes vehicle supply and use difficult

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BACKGROUND

- PBS turning performance requirements are based on general access freight vehicles not concrete pumps.
- Concrete pumps behave differently and have a different risk profile.
- Performance of existing concrete pumps operating in Australia and overseas has not been considered when setting performance limits.
- Concrete pump truck operating requirements and chassis configurations such as multiple steerable axles need consideration when setting the limits.
- Existing standards drive poor vehicle configuration and access outcomes for the concrete pumping industry.
- Operators of large concrete pumps have a unique set of challenges to overcome to ensure safe operation.
- All stakeholders need to better understand how large concrete pumps behave on the road, potential safety risks and appropriate strategies and conditions that can be employed to mitigate safety risks
- Operating these vehicles across different jurisdictions is difficult due to varied acceptance of concrete pump trucks as SPV and the different access conditions applied

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RESEARCH QUESTIONS & GOALS

- Analyze concrete pump safety risks
- Review and enhance Performance Based Standards (PBS) for large concrete pumps
- Establish nationally consistent operating and access conditions
- Enhance driver awareness and promote safe driving behaviors
- Stay abreast of latest concrete pumping technology and industry trends, especially for pumps > 50 m
- Align with international standards and leverage technology for improved road safety
- Conduct field testing to validate computer models
- Develop improved performance standards and guidelines for safe operation
- Provide stakeholders with comprehensive safety information

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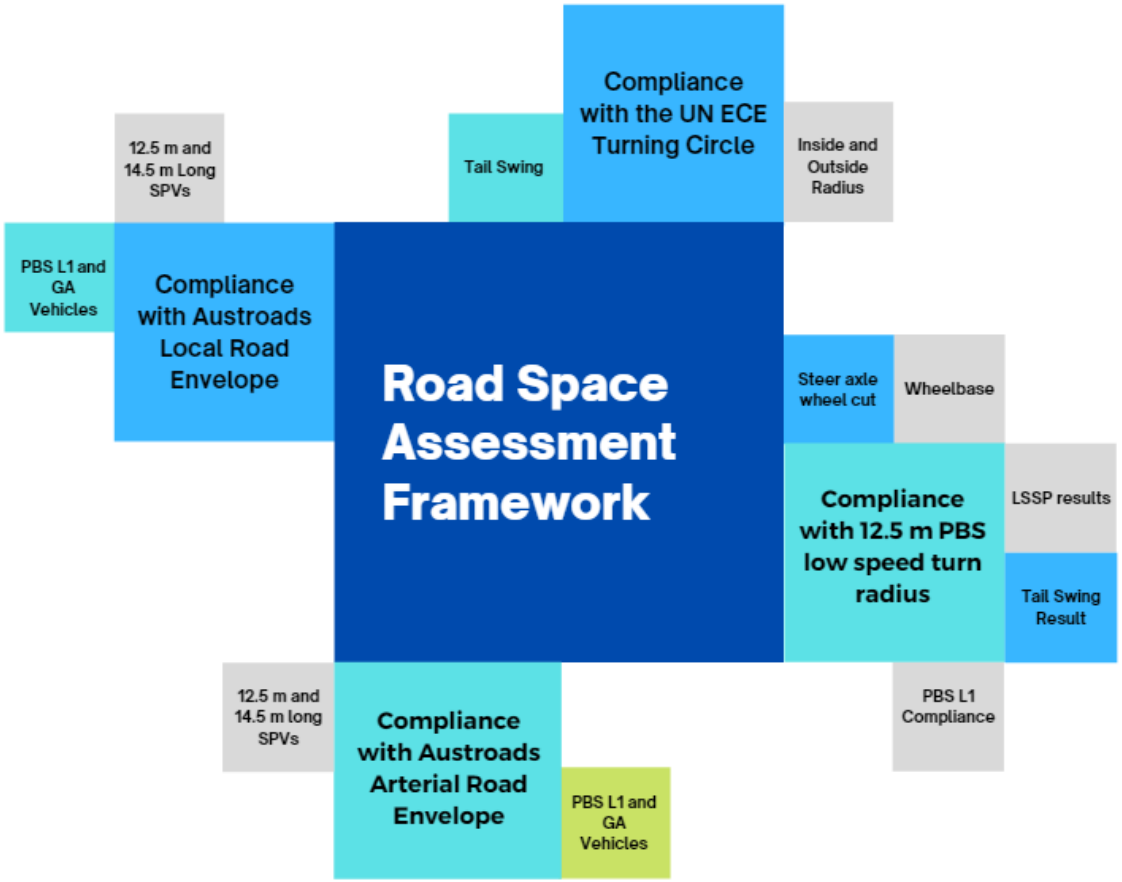
ROAD SPACE ASSESSMENT FRAMEWORK



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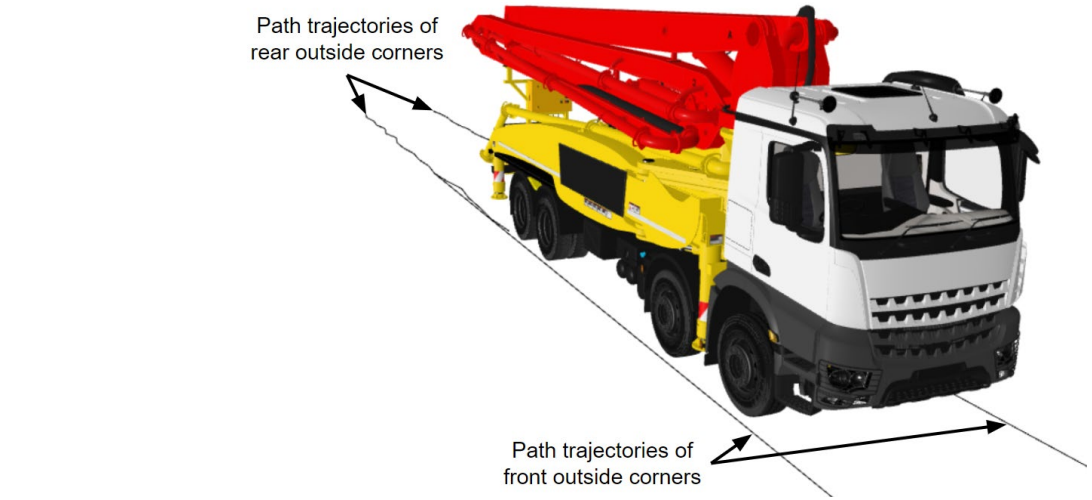
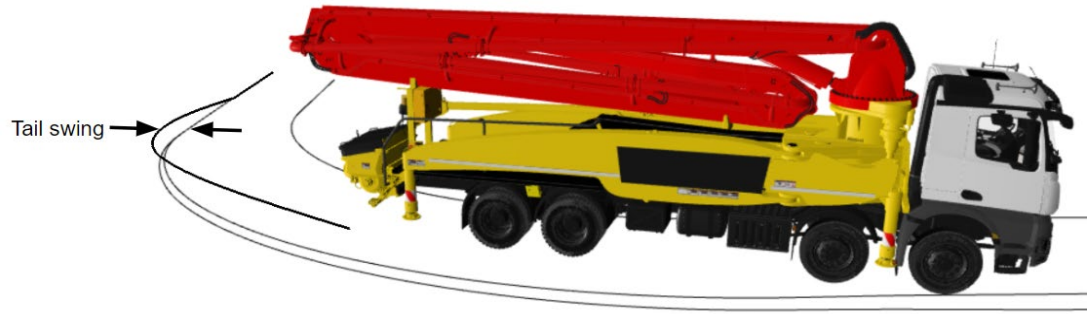
METHODOLOGY

- 27 SPV's assessed to establish performance baseline.
- Computer modelling of SPV's used in Australia and large vehicles successfully operating in other markets.
- Different vehicle configurations (i.e., tri-steer, whole axle group steer, passive steer rear axles, force steered rear axles, drive axles in different locations, articulated vs. rigid vehicles).
- Assessments include Low Speed Swept Path (LSSP), Tail Swing (TS), and Frontal Swing (FS)
- High speed performance of SPV reviewed, including Tracking Ability in a Straight Path (TASP).





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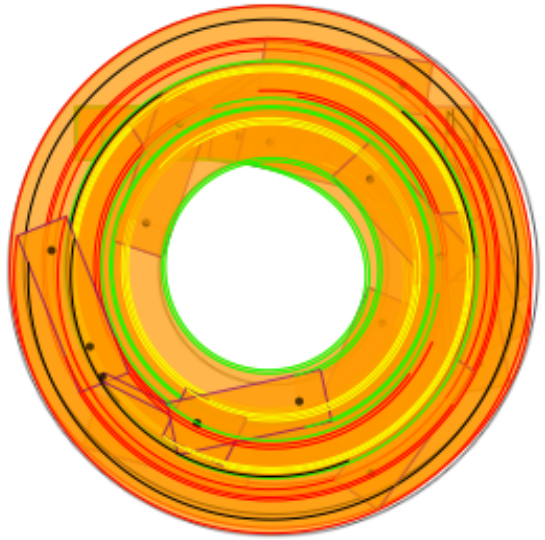
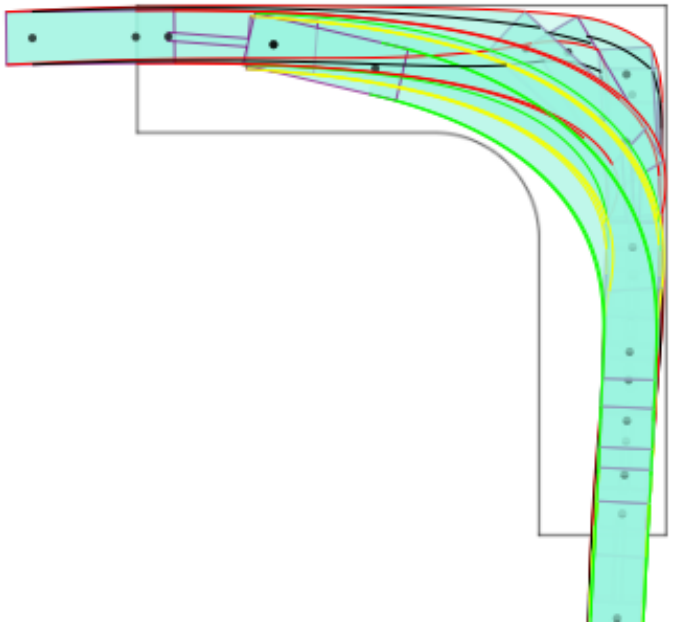
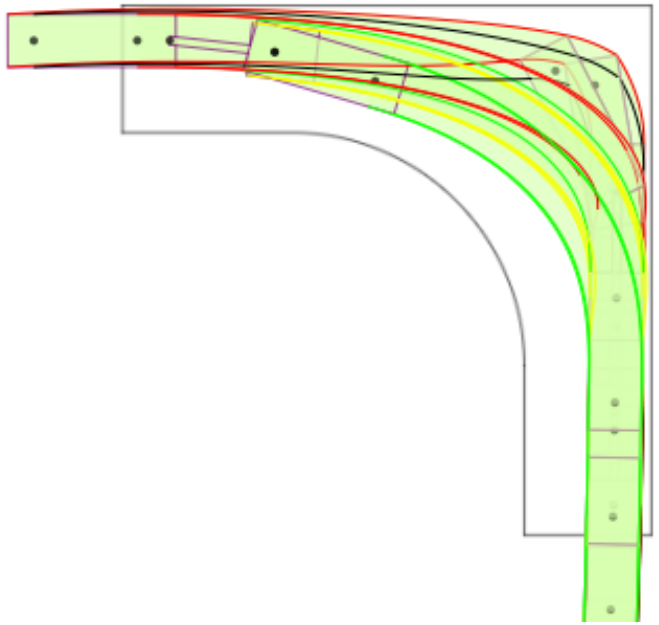
FLEET ASSESSMENTS

#	Chassis	Length (m)	Width (m)	ROH (m)	No. Axles	LSSP (m)	FS (m)	TS (m)	STFD	EU 1230/2012	PBS turn Radius	TASP	LTR	Access
1	4x2	11.3	2.5	3.7	2	4.64	0.65	0.32	8%	Yes	12.5	2.68	0.29	General
2	6x4	11.275	2.5	3.675	3	4.68	0.62	0.29	18%	Yes	12.5	2.68	0.27	General
3	8x4	11.275	2.5	3.675	4	4.68	0.62	0.29	13%	Yes	12.5	2.67	0.25	General
4	6x4	11.075	2.5	4.0	3	4.42	0.60	0.38	20%	Yes	12.5	2.72	0.27	Class 1 Notice
5	8x4	12.282	2.5	3.935	4	5.10	0.79	0.35	12%	No	12.5	2.78	0.27	Class 1 Notice
6	6x4	12.225	2.5	4.0	4	5.09	0.65	0.33	35%	No	12.5	2.72	0.28	Class 1 Notice
7	6x4	11.78	2.5	4.0	4	4.80	0.63	0.33	17%	Yes	12.5	2.71	0.23	Class 1 Notice
8	6x4	12.295	2.5	3.995	4	5.00	0.64	0.38	19%	No	12.5	2.70	0.21	Class 1 Notice
9	10x4	12.22	2.5	4.0	5	5.04	0.64	0.34	25%	No	12.5	2.72	0.23	Class 1 Notice
10	10x4	13.78	2.5	5.26	5	5.13	0.63	0.66	26%	No	12.7	2.75	0.23	AU Permit
11	10x4	14.2	2.5	6.10	5	4.92	0.62	0.92	14%	No	12.5	2.75	0.23	AU Permit
12	10x4	14.2	2.5	4.7	5	5.47	0.64	0.48	13%	No	14.2	2.75	0.24	AU Permit
13	10x4	15.085	2.5	6.67	5	5.12	0.67	1.16	13%	No	12.5	2.77	0.22	South Korea
14	12x4	14.5	2.5	5.5	6	5.31	0.64	0.72	7%	No	13.5	2.74	0.23	AU Permit
15	12x4	14.5	2.5	4.908	6	5.59	0.65	0.48	15%	No	14.1	2.74	0.22	AU Permit
16	12x4	15.3	2.5	4.976	6	5.76	0.7	0.5	16%	No	14.9	2.74	0.37	EU
17	12x4	16.435	2.55	6.345	6	6.02	0.77	1.03	24%	No	14.9	2.88	0.30	EU
18	12x4	15.3	2.5	5.662	6	5.54	0.7	0.72	9%	No	14.3	2.82	0.36	AU Permit
19	14x4	15.41	2.5	5.055	7	5.18	0.57	0.36	5%	No	19	2.82	0.26	AU Permit
20	14x4	15.41	2.5	6.425	7	4.83	0.56	0.82	6%	No	16.4	2.90	0.55	AU Permit
21	14x4	15.41	2.5	4.37	7	5.47	0.58	0.22	10%	No	19.8	2.90	0.43	AU Permit
22	16x4	16.7	2.6	7.2	8	4.95	0.51	0.97	5%	No	17.6	2.99	0.59	USA
23	16x4	17.5	2.6	5.4	8	5.64	0.57	0.33	23%	No	22.5	3.42	0.39	USA
24	4x2	12.5	2.5	3.7	3	5.28	0.93	0.29	14%	Yes	12.5	2.69	0.21	General
25	6x2	13.5	2.5	4.0	3	5.65	1.08	0.32	12%	No	12.5	2.69	0.30	CAB
26	6x2	14.5	2.5	4.7	3	5.84	1.38	0.52	13%	No	12.5	2.70	0.19	CAB
27	6x2	14.5	2.5	4.9	3	5.73	1.37	0.59	13%	No	12.5	2.70	0.19	CAB

AUSTROADS ROAD ENVELOP

EU 1230/2012	Austroads Local Road	Austroads Arterial Access
		
Truck and Dog (General Access)		

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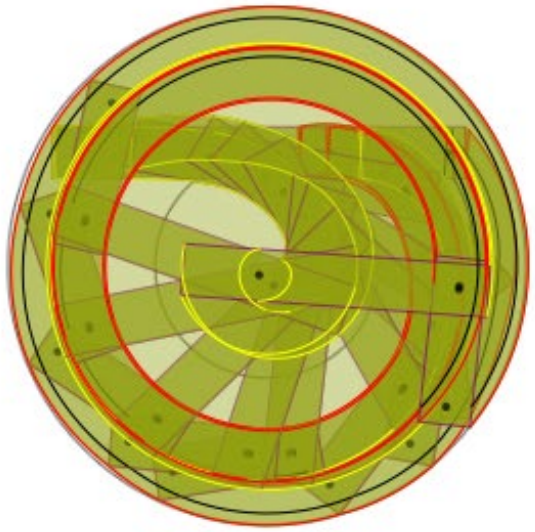
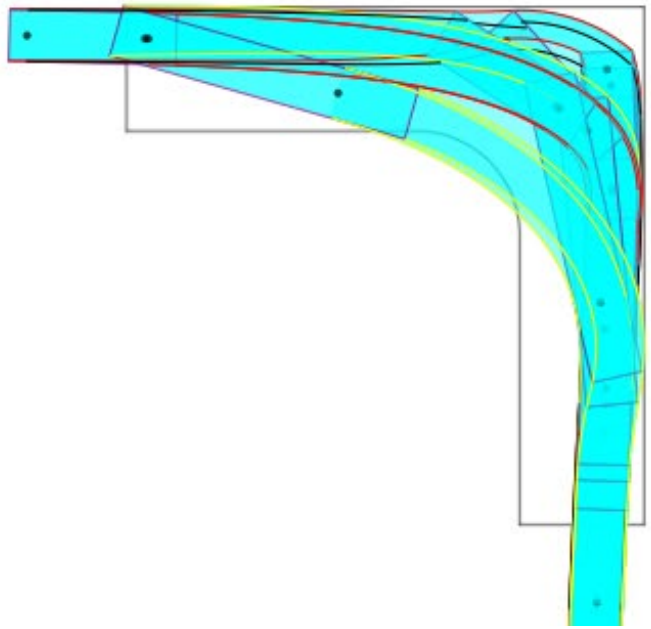
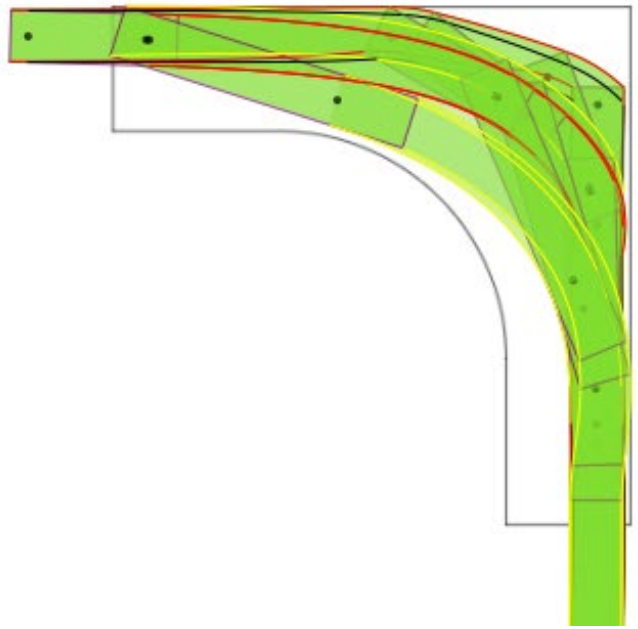
AUSTROADS ROAD ENVELOP

EU 1230/2012	Austroads Local Road	Austroads Arterial Access
		
19 m Semi-Trailer (General Access)		

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AUSTROADS ROAD ENVELOP

EU 1230/2012	Austroads Local Road	Austroads Arterial Access
		
12.5 m Rigid (General Access)		

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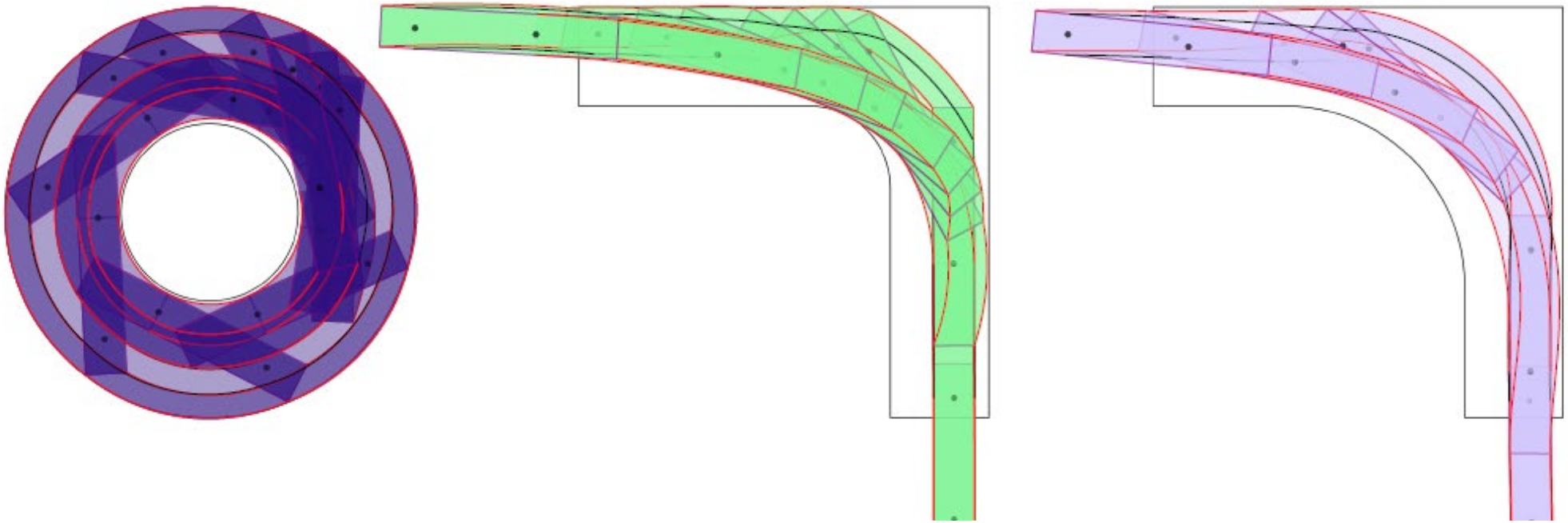
AUSTROADS ROAD ENVELOP

EU 1230/2012	Austroads Local Road	Austroads Arterial Access
		
14.5 m Rigid		

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OPERATING RISKS ASSESSMENT

Common concrete pump design features which may cause unique risks:

1. large rear overhang (hopper & boom)
2. active/passive auxiliary steer axles
3. overall width > 2.5 m
4. left hand drive
5. larger wheelbase and turning circles
6. entering and exiting roads

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RISKS ASSESSMENT

Risk evaluation matrix

Risk ratings:

Very high	VH
High	H
Medium	M
Low	L

Likelihood			Consequence					
			Insignificant C6	Minor C5	Moderate C4	Major C3	Severe C2	Catastrophic C1
	Almost certain	L1	M	H	H	VH	VH	VH
	Very likely	L2	M	M	H	H	VH	VH
	Likely	L3	L	M	M	H	H	VH
	Unlikely	L4	L	L	M	M	H	H
	Very unlikely	L5	L	L	L	M	M	H
	Almost unprecedented	L6	L	L	L	L	M	M

Source:PN224F RMS enterprise framework *Risk management*

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SCENARIO RISK RATING

Scenario	Risk Index
Scenario 1 – Right turn from an urban median	Medium
Scenario 2 – Protected bicycle lane	-
Scenario 3 – Unprotected bicycle lane	-
Scenario 4 – Left turn on single lane urban streets	Low
Scenario 5 – Left turn on multilane urban streets	Low
Scenario 6 – Left turn on single lane roads without median	Low
Scenario 7 – Right turn with an adjacent straight path lane	Low
Scenario 8 – Two adjacent right turn lanes no lane straddling	Low
Scenario 9 – Two adjacent right turn lanes lane straddling	Not required
Scenario 10 – Busy urban hook turns	Restricted Access
Scenario 11 – Right turn on single lane roads without median	Low
Scenario 12 – Traversing through tight roundabouts	Low

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FIELD TESTING AND OPERATING STUDIES

- Vehicle Tests included:
  - On road tests – observe operating conditions
  - Off road tests evaluate low speed turning performance
- Instrumentation used:
  - Two LiDar scanners – record 3D vehicle movement
  - RTK GPS to correct position of scanners
  - High Resolution video cameras
  - Drone with High Resolution video camera

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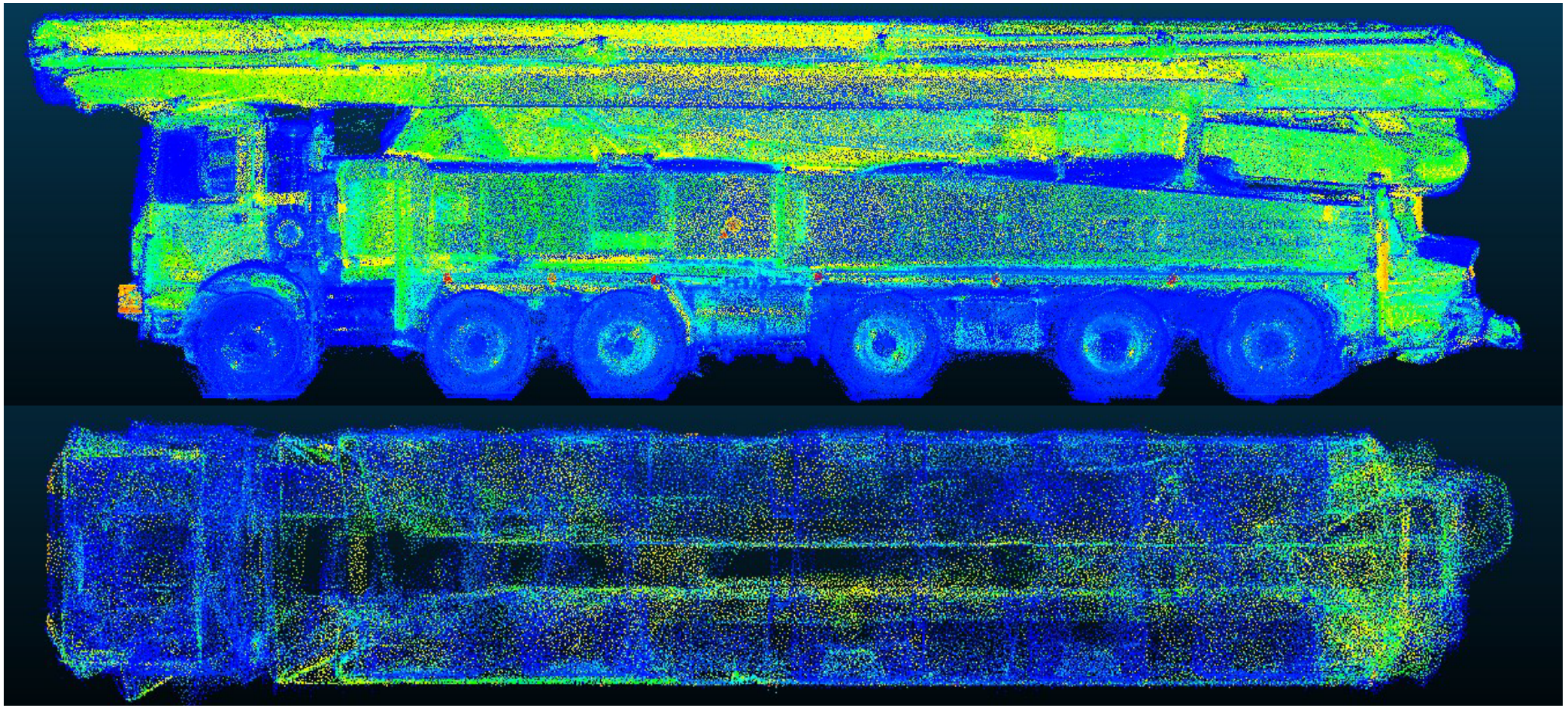
STATIC LIDAR SCAN



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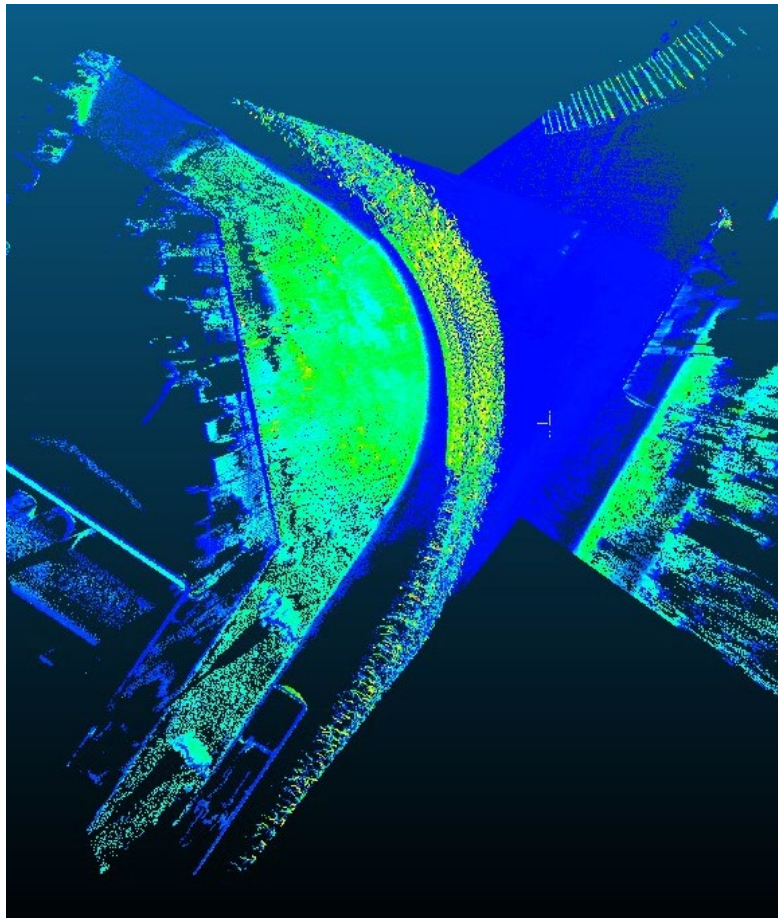
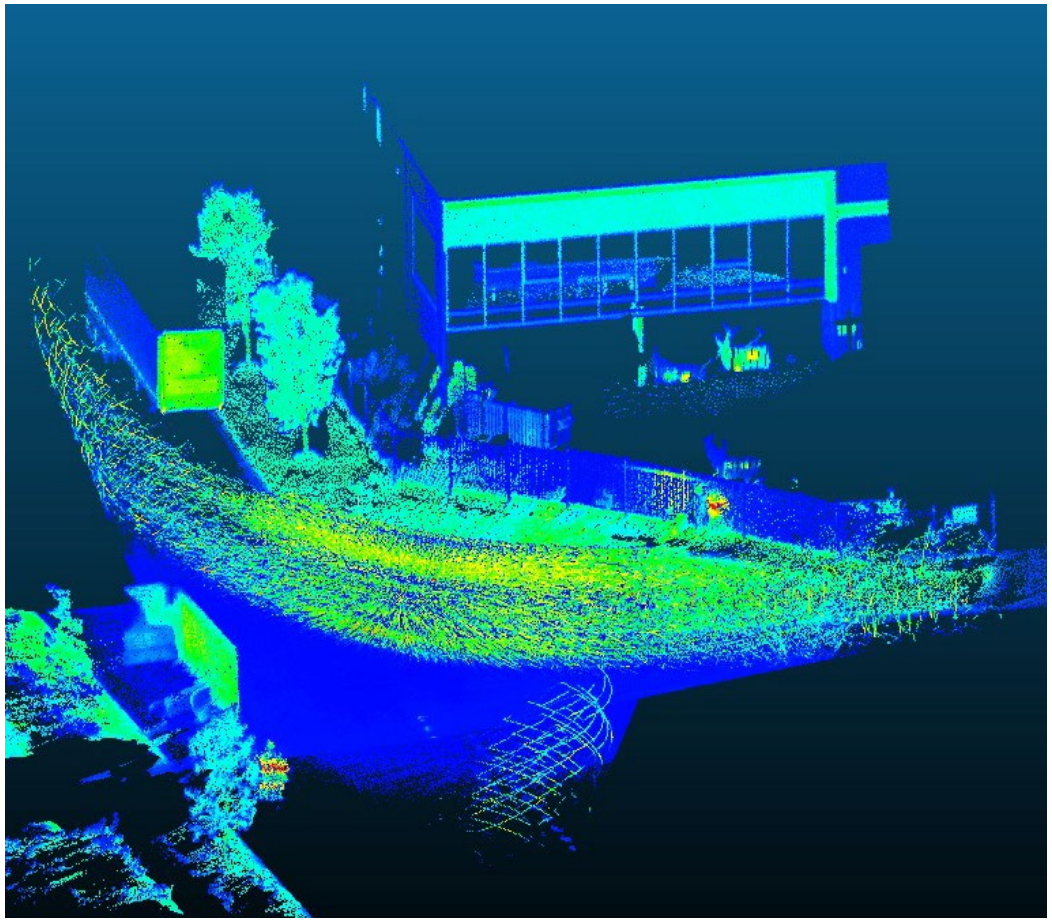
DYNAMIC LIDAR SCAN





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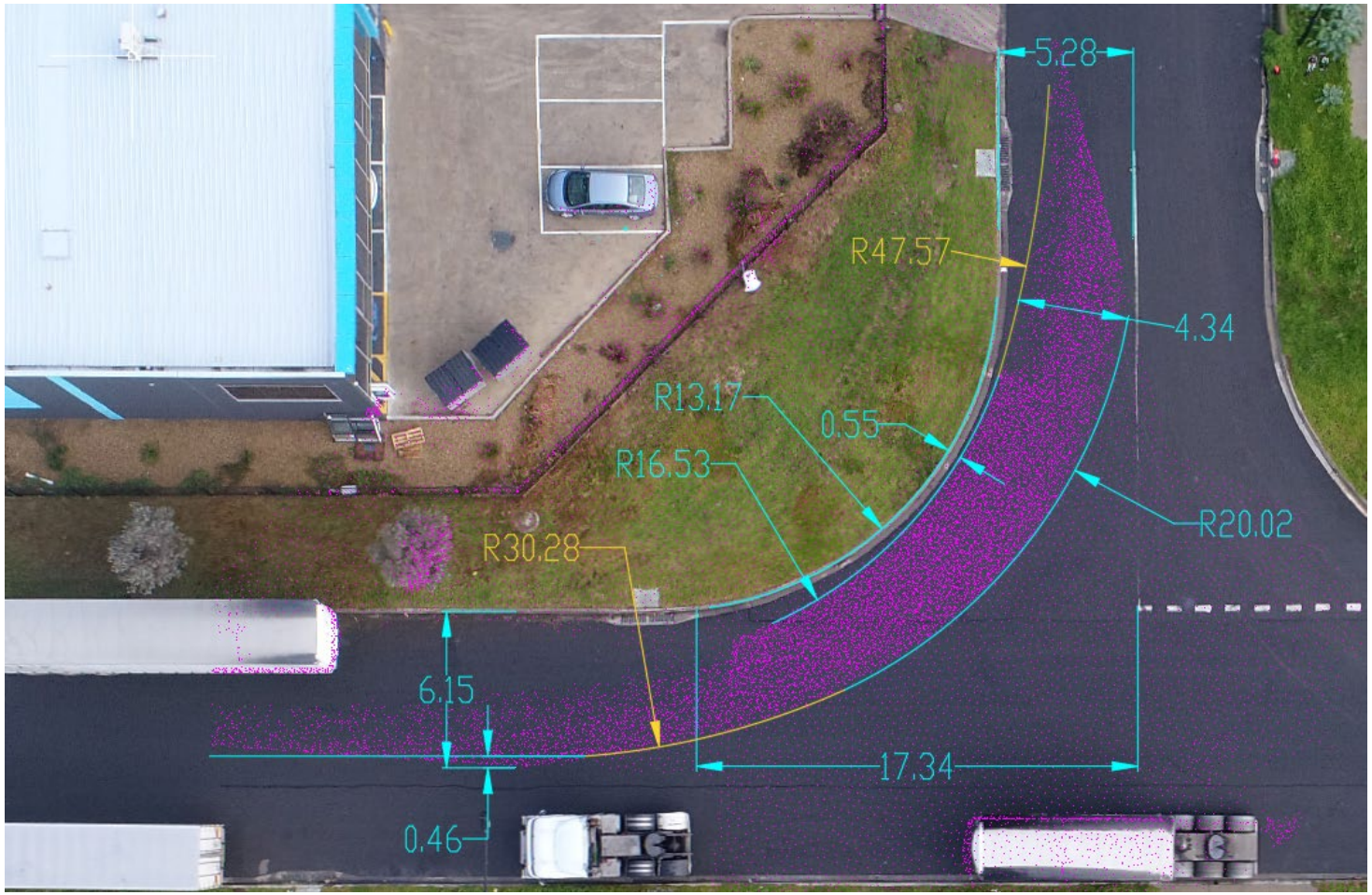
INTERSECTION CASE STUDY



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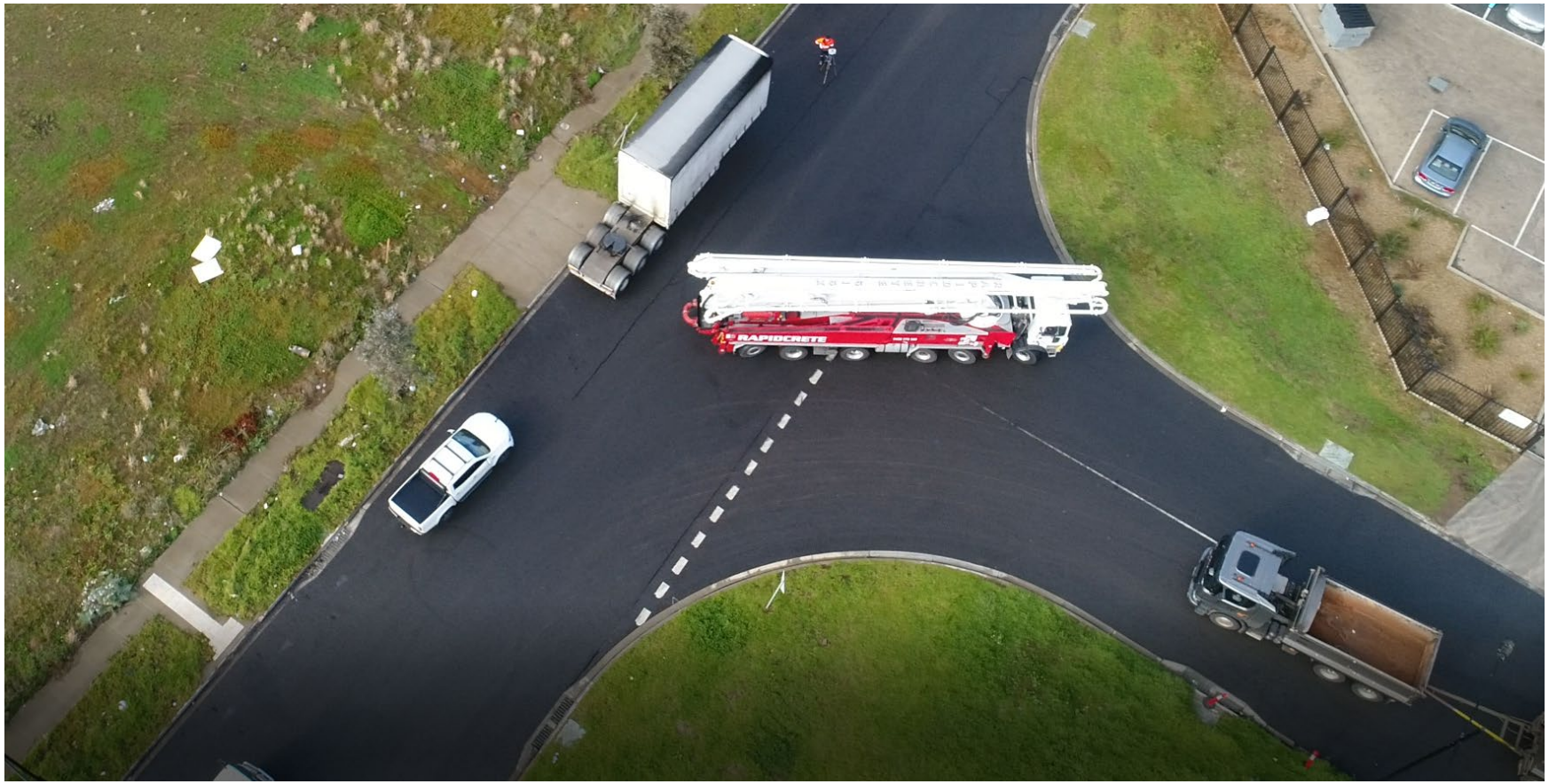

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OUTCOMES

- Maintains safe distance through tight intersections and narrow lanes.
- Less road space compared to semi-trailers and B-doubles.
- Low risk of collision in most scenarios.
- Most risk found in narrow median turning lanes.
- Slight encroachment required in certain scenarios.
- Driver need to patiently wait for a safe gap and wait for other road user's drivers to turn safely.
- Alternative performance standard (e.g. EU test) will facilitate better vehicle maneuverability without increased road space requirements.
- Driver training, signage, vision technologies can potentially remove need for escort vehicles.
- Driver training to focus on defensive driving and appreciation of unique concrete pump risks.

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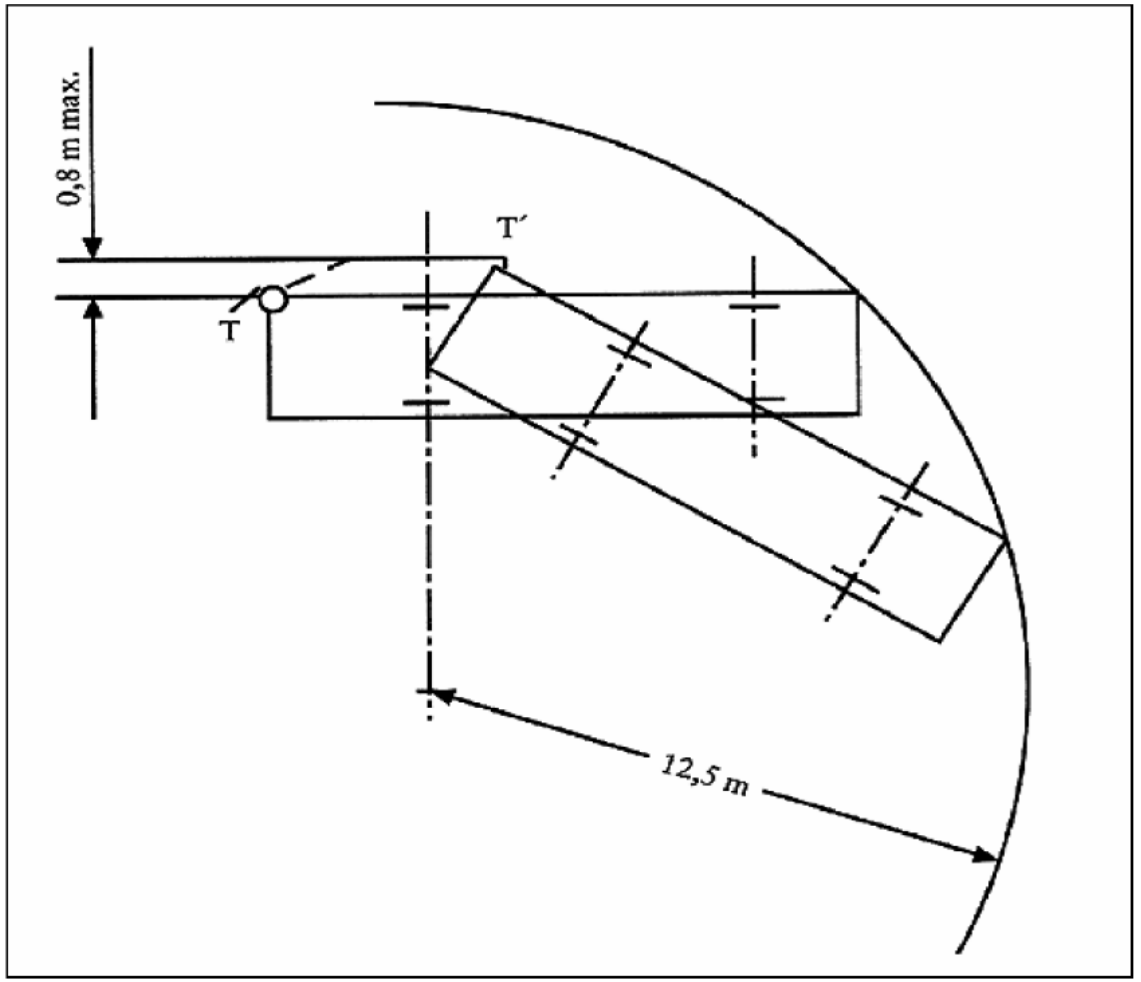
EU REGULATION 1230 TEST

Steady-state method for N_2 and N_3 vehicles



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CONCLUSIONS

- Proposing alternative turning performance standards based on the EU doughnut test for improved vehicle maneuverability without increased road space requirements.
- Introducing a preferred option with alternative PBS Level 1 limits for Tail Swing (TS) and Low Speed Swept Path (LSSP), offering flexibility for rigid trucks and optimized low-speed maneuverability.
- Suggesting alternative PBS Level 2 performance standards for very large vehicles, allowing a larger 15 m turn radius while ensuring the primary purpose of limiting required road space during a turn is preserved.
- Driver training to focus on defensive driving and appreciation of unique concrete pump risks

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ALTERNATIVE STANDARD

Tiger Spider proposed alternative PBS performance standards based on the risk assessments of large concrete pumps

Performance Standards Class	Option	Performance Level Required		
		Tail Swing	Low Speed Swept Path	Turn Radius
Level 1	(I)	No greater than 0.3 m	No greater than 7.4 m	12.5 m
	OR			
	(II)	No greater than 0.8 m	No greater than 5.4 m	12.5 m
Level 2	(I)	No greater than 0.35 m	No greater than 8.7 m	12.5 m
	OR			
	(II)	No greater than 1.0 m	No greater than 6.0 m	15 m

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THANK YOU