



A COMPARISON OF TWO ROUNDABOUT CAPACITY MODELS

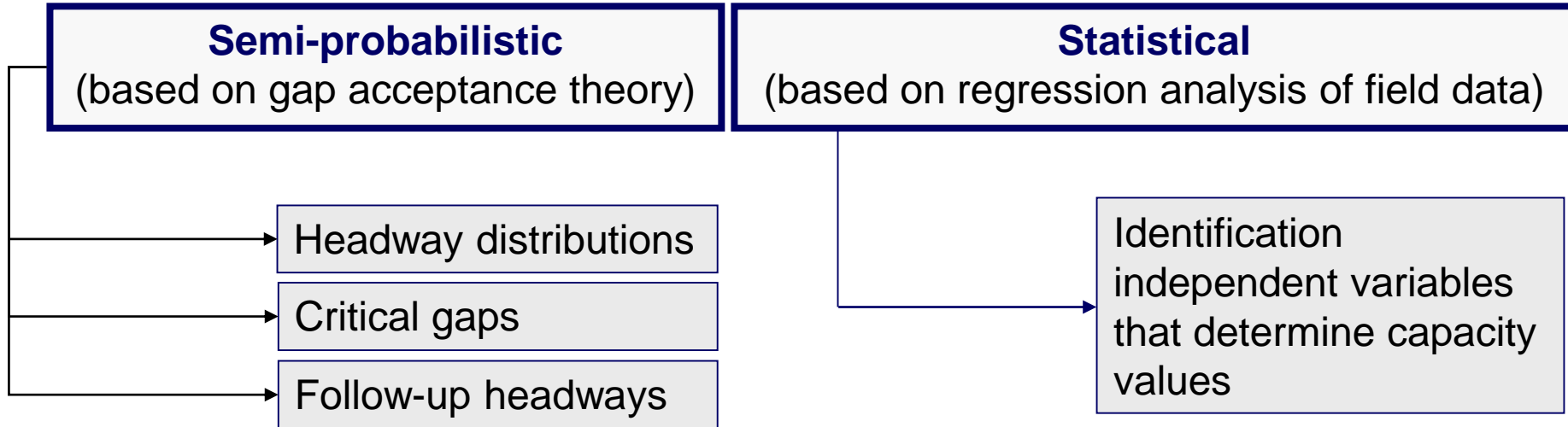
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THE ANALYTICAL MODELS OF ROUNDABOUT CAPACITY



Differences:

- Modeling approach used
- Model level of detail (lane-based or approach-based)
- Model parameters used to represent driver behavior and roundabout geometry
- Model calibration methods
- The levels of model complexity

COMPARISON

Macioszek model

based on research
conducted in Poland

SIDRA Standard model

based on research
conducted in Australia

Lane-based analytical models

Based on gap acceptance theory

Empirical models are used to calibrate gap acceptance parameters

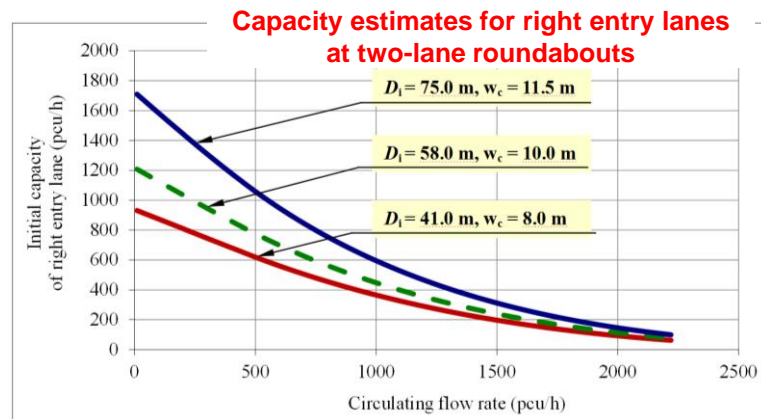
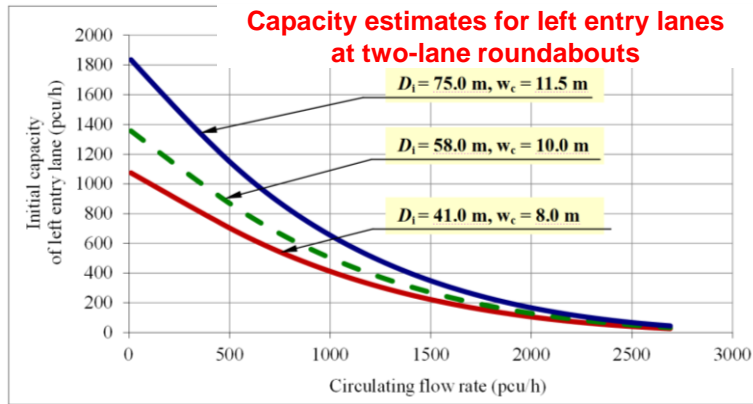
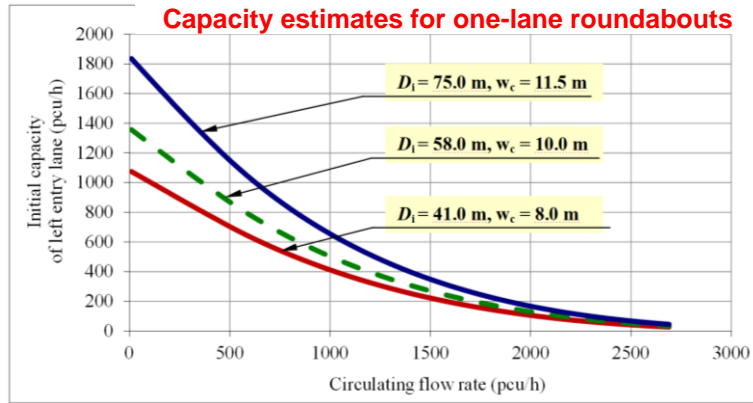
Both models use Cowan's bunched exponential distribution of circulating road headways



On the other hand

The two models use different capacity and headway distribution equations, and they are calibrated for different traffic conditions in two different countries

MACIOSZEK MODEL



The initial entry capacity

under ideal conditions at the roundabout
i.e. without the influence of heavy vehicles
and pedestrians

The actual entry capacity

can then be estimated allowing for heavy
vehicles and pedestrians

- ✓ **Stepwise function** of gap acceptance by drivers entering the roundabout is assumed

The model uses two different circulating stream headway distributions according to the range of the circulating flow rate (Q_{nwl})

Shifted exponential distribution

for
 $1 < Q_{nwl} \leq 100 \text{ [pcu/h]}$

Cowan M3 distribution

for
 $100 \text{ [pcu/h]} < Q_{nwl} < C_{jr}$
(circulating stream capacity)

THE MODEL PARAMETERS INCLUDING:

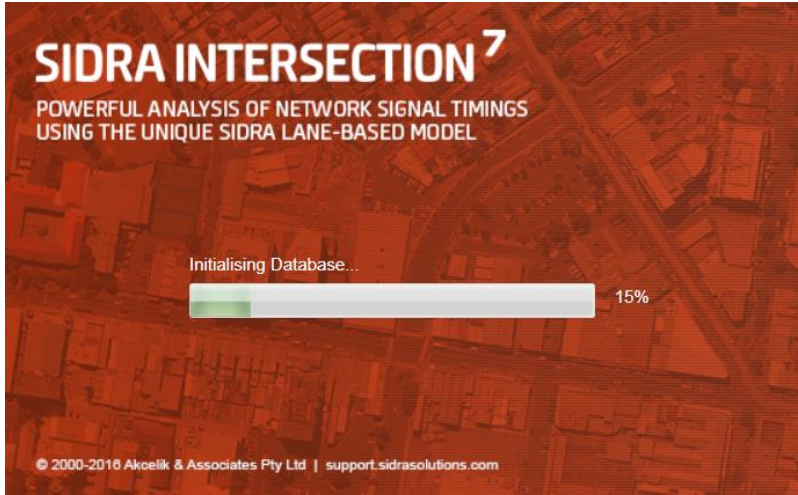
- ✓ The critical gap and follow-up headway for drivers entering the roundabout
- ✓ The minimum headway
- ✓ The proportions of free (unbunched) vehicles for the circulating stream

SUMMARY OF SURVEY DATA FROM ROUNDABOUTS IN POLAND USED FOR CALIBRATING THE MACIOSZEK CAPACITY MODEL

Parameter	One-Lane Roundabouts	Two-Lane Roundabouts
Inscribed diameter (m)	26.0 - 45.0	41.0 - 75.0
Central island diameter (m)	15.0 - 26.0	32 - 63.0
Circulating road width (m)	4.0 - 10.0	8.0 - 11.5
Total entry width (m)	3.0 - 4.0	6.0 - 7.0
Entry radius (m)	6.0 - 15.0	8.0 - 15.0
Total exit width (m)	4.0 - 4.75	4.0 - 4.75
Exit radius (m)	12.0 - 15.0	14.0 - 16.0
Number of intersection arms	4	4
Presence of splitter island	Yes, at all entries	Yes, at all entries
Follow-up headway (s)	2.50 - 3.08	2.20 - 3.72
Critical gap (s)	3.16 - 6.05	4.06 - 4.43
Follow-up headway/ Critical gap ratio	0.51 - 0.79	0.54 - 0.84
Circulation flow (veh/h)	186 - 568	246 - 939
Total entry flow (veh/h)	172 - 694	261 - 855
Dominant lane flow (veh/h)	172 - 694	139 - 465
Subdominant lane flow (veh/h)	-	122 - 403

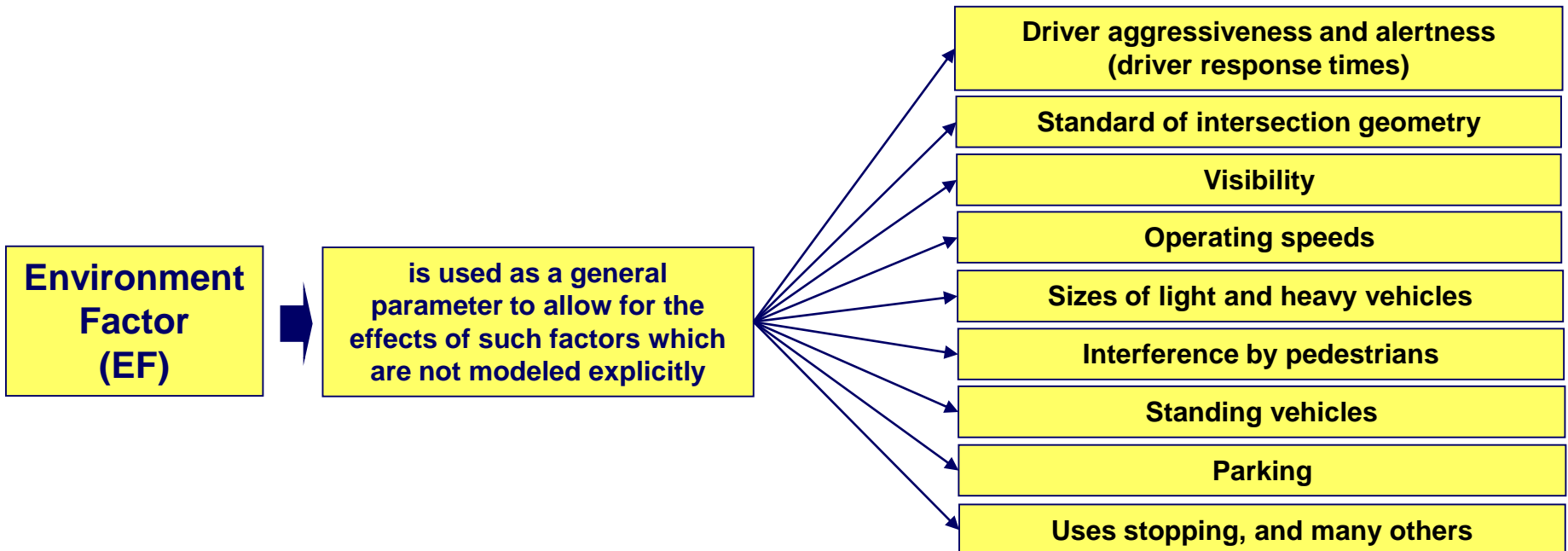


SIDRA Standard MODEL



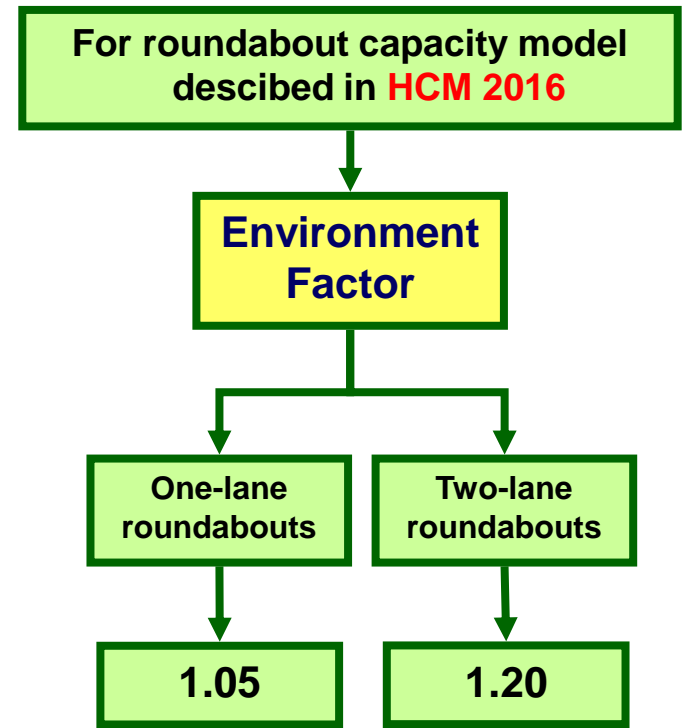
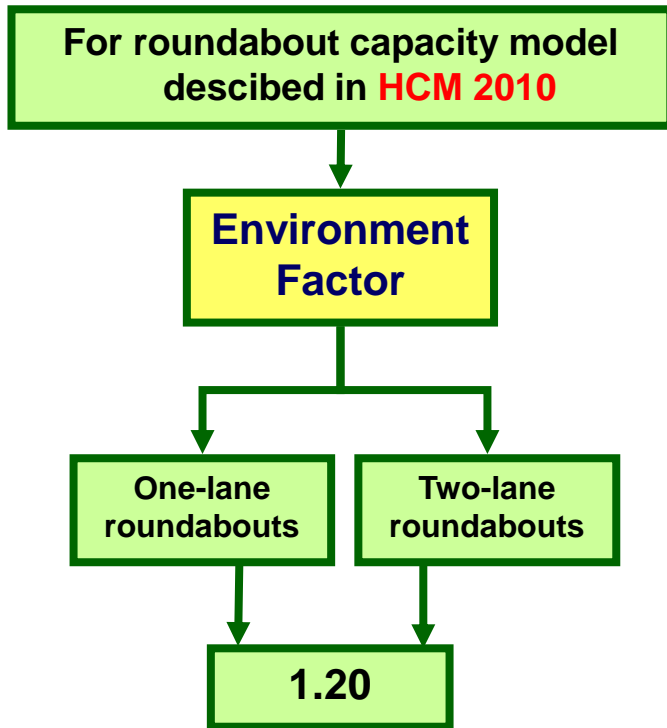
- ✓ Is based on research on Australian roundabouts, thus reflecting Australian driving characteristics
- ✓ The model was originally based on the method developed at the Australian Road Research Board as described in Special Report SR 45 which was introduced into SIDRA INTERSECTION with some variations and extensions
- ✓ A significant early addition to the model was provision for handling unbalanced flow conditions
- ✓ Model allows for the effects of both roundabout geometry and driver behavior

- ✓ Further enhancements were introduced in various versions of the SIDRA INTERSECTION software based on research and development including the handling of roundabout metering signals



THE CAPACITIES OF ROUNDABOUTS IN THE USA AND AUSTRALIA

- ✓ The US research indicates that capacities of roundabouts in the USA are lower compared with Australian roundabouts
- ✓ The SIDRA Standard capacity model was calibrated for US applications to provide capacity estimates closer to those observed in the USA



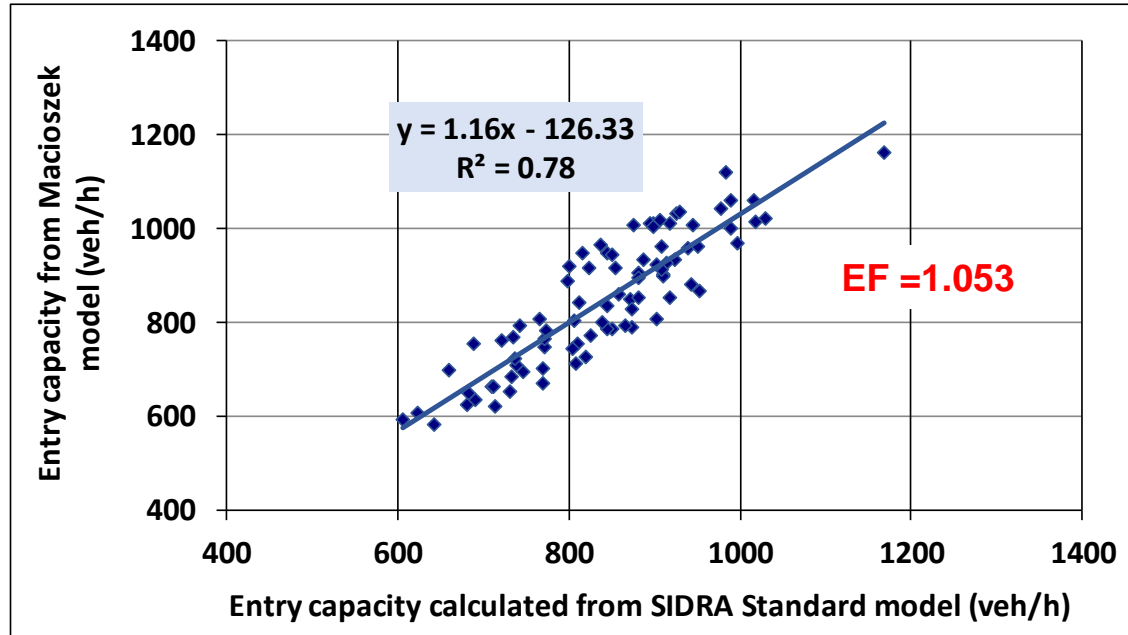
THE VALUE OF THIS PARAMETER FOR AUSTRALIAN CONDITIONS IS 1.0

SUMMARY OF SURVEY DATA FROM ROUNDABOUTS IN AUSTRALIA USED FOR CALIBRATING THE SIDRA STANDARD ROUNDABOUT CAPACITY MODEL

	Total Entry Width (m)	No. of Entry Lanes	Average Entry Lane Width (m)	Circul. Width (m)	Inscribed Diameter (m)	Entry Radius (m)	Entry Angle (°)
Minimum	3.7	1	3.20	6.5	16	4	0
Maximum	12.5	3	5.50	12.0	220	∞	80
Average	8.1	2	3.84	9.6	56	39.0	29
15th percentile	6.4	2	3.34	8.0	28	10.0	0
85th percentile	10.5	3	4.48	11.9	70	39.8	50
Count	55	55	55	55	55	55	55
	Follow-up Headway (s)	Critical Gap (s)	Fol. Hdw / Crit. Gap Ratio	Circul. Flow (veh/h)	Total EntryFlow (veh/h)	Dominant Lane Flow (veh/h)	Subdom. Lane Flow (veh/h)
Minimum	0.80	1.90	0.29	225	369	274	73
Maximum	3.55	7.40	0.92	2648	3342	2131	1211
Average	2.04	3.45	0.61	1066	1284	796	501
15th percentile	1.32	2.53	0.43	446	690	467	224
85th percentile	2.65	4.51	0.79	1903	1794	1002	732
Count	55	55	55	55	55	55	55

COMPARISON OF MODELS FOR ONE-LANE ROUNDABOUTS

- ✓ **Initial analyses** indicated that entry lane capacities at one-lane roundabouts in Poland are lower but close to those in Australia
- ✓ **The average difference** between the capacity estimates from the two models was **-6.5% (-56 veh/h)** with values in the range -19.7% (-163 veh/h) to 7.6% (69 veh/h)
- ✓ By calibrating the SIDRA Standard model to match the one-lane roundabout capacities observed in Poland (as represented by the Macioszek model) an **EF = 1.053** was determined



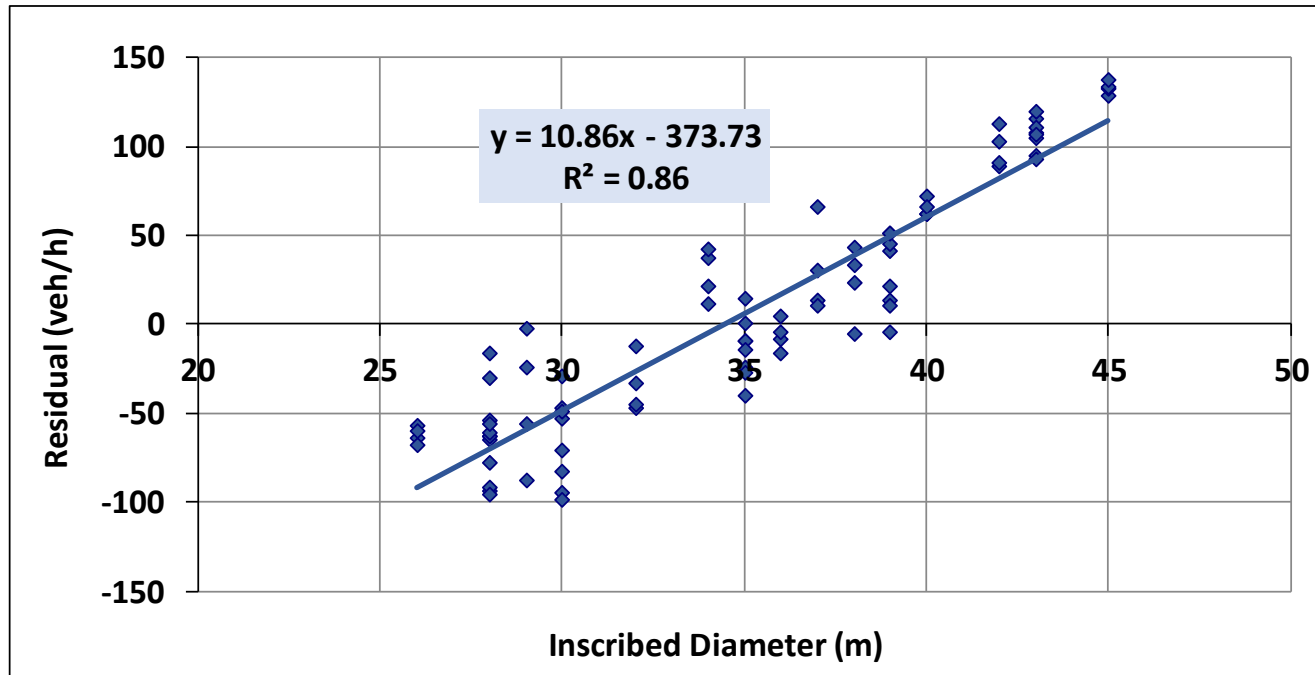
Summary of model comparison results after calibration using **EF = 1.053**

Value	Difference in capacity estimate from two models		Degree of saturation (v/c ratio)	
	Relative difference (%)	Absolute difference (veh/h)*	Macioszek model	SIDRA Standard model
Average	0.6%	7	0.45	0.45
Minimum	-12.9%	-99	0.18	0.19
Maximum	16.4%	138	0.91	0.90
St. Deviation	8.0%	67	0.14	0.13

* values are based on (Macioszek Model estimate - SIDRA Standard Model estimate)

After calibration average difference between the Macioszek model and the SIDRA Standard model using the **EF = 1.053** is reduced to **0.6 % (7 veh/h)**

THE IMPACT OF ONE-LANE ROUNDABOUT INSCRIBED DIAMETER ON THE RESIDUALS



In view of the strong correlation of residuals with the roundabout inscribed diameter, the SIDRA Standard model was calibrated for two categories of roundabouts according to the inscribed diameter

Smaller roundabouts
($26 < Di \leq 35$ m)

EF = 1.095

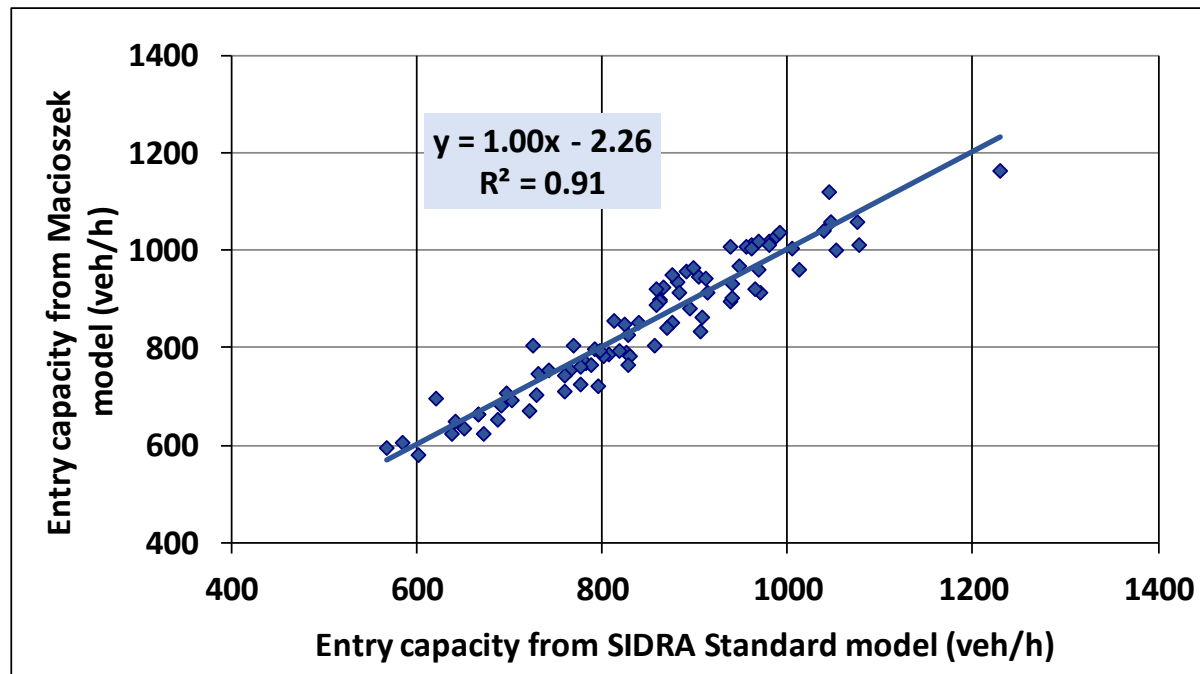
Larger roundabouts
($35 \text{ m} < Di \leq 45$ m)

EF = 1.005

SUMMARY OF MODEL COMPARISON RESULTS FOR ONE-LANE ROUNDBABOUTS AFTER GROUPED CALIBRATION USING

EF = 1.095 for $26 < D_i \leq 35$ m and **1.005** for $35 < D_i \leq 45$ m

- ✓ Results show a satisfactory level of compatibility of the Macioszek and SIDRA Standard capacity models
- ✓ A single **EF = 1.05** could be used in the SIDRA INTERSECTION software to match the conditions for one-lane roundabouts in Poland
- ✓ It is the same value of EF used for one-lane roundabouts to match the model described in the **new US Highway Capacity Manual Edition 6**



Value	Difference in capacity estimate from two models		Degree of saturation (v/c ratio)	
	Relative difference (%)	Absolute difference (veh/h)*	Macioszek model	SIDRA Standard model
Average	0.2%	2	0.45	0.45
Minimum	-9.3%	1	0.18	0.18
Maximum	12.4%	82	0.91	0.84
St. Deviation	4.8%	41	0.14	0.13

* values are based on (Macioszek Model estimate - SIDRA Standard Model estimate)

COMPARISON OF MODELS FOR TWO LANE ROUNDABOUTS

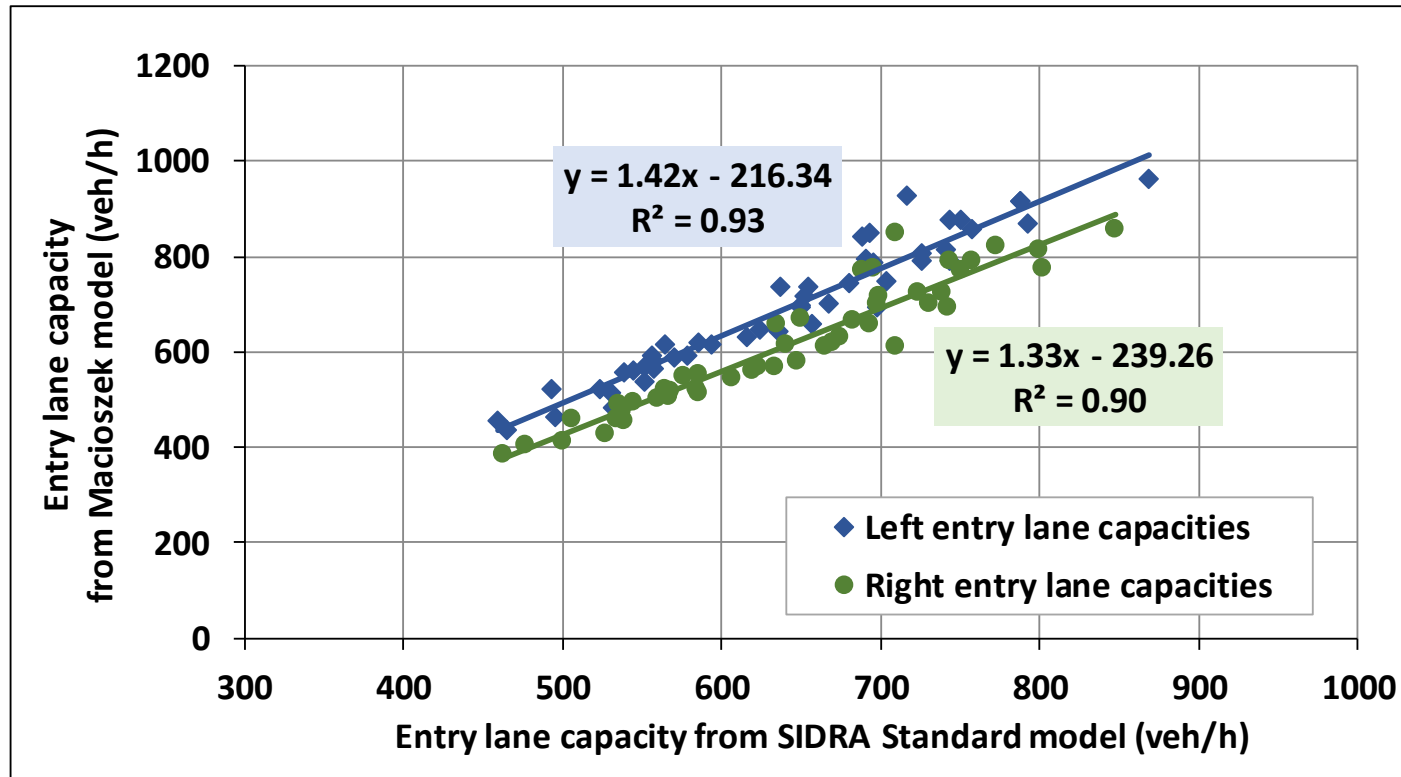
- ✓ A method similar to the comparison for one-lane roundabouts was used.
- ✓ The analyses were made in a single group without grouping according to the inscribed diameter.
- ✓ In the SIDRA Standard model, entry lane capacities and lane flow rates are interdependent for multi-lane roundabout approaches. For this reason, lane flows determined by the SIDRA INTERSECTION software were used in both models in order to limit the model comparison to the comparison of capacity estimates for given lane flows.
- ✓ The initial analyses showed that the differences in capacity estimates from the two models are much larger than those for one-lane roundabouts.
- ✓ The average differences were -34.9% (-363 veh/h) for left entry lanes and -31.5% (-278 veh/h) for right entry lanes.
- ✓ The differences for both lanes considered together were in the range -7.1% (-65 veh/h) to -49.4% (469/veh/h).
- ✓ Entry lane capacities at two-lane roundabouts in Poland are substantially lower than those in Australia.
- ✓ By calibrating the SIDRA Standard model to match the capacities observed in Poland (as represented by the Macioszek model), an **EF = 1.387** (approximately **1.4**) was determined.

SUMMARY OF MODEL COMPARISON RESULTS FOR TWO LANE ROUNDABOUTS AFTER CALIBRATION USING **EF = 1.387**

Entry lane	Value	Difference in capacity estimates from two models		Degree of saturation (v/c ratio)	
		Relative difference (%)	Absolute difference (veh/h)*	Macioszek model	SIDRA Standard model
Left	Average	7.1%	50	0.47	0.50
	Minimum	-9.6%	-51	0.26	0.27
	Maximum	29.5%	211	0.86	0.78
	St. Deviation	7.9%	55	0.15	0.14
Right	Average	-5.1%	-27	0.53	0.49
	Minimum	-19.0%	-100	0.29	0.27
	Maximum	19.7%	140	0.96	0.78
	St. Deviation	8.2%	51	0.17	0.14

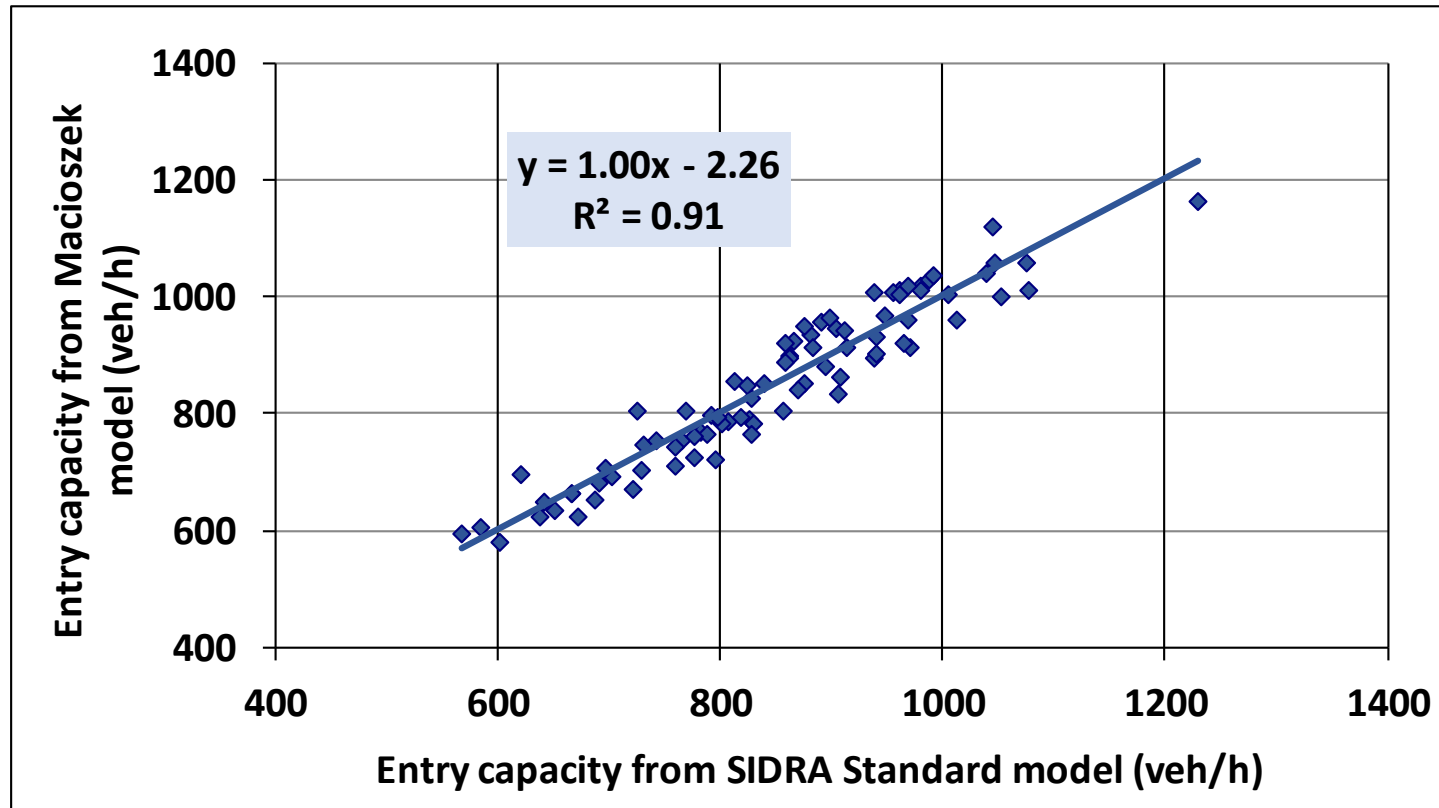
* values are based on (Macioszek Model estimate - SIDRA Standard Model estimate)

LINEAR REGRESSION ANALYSIS AFTER CALIBRATION USING $EF = 1.387$



- ✓ The dominant lane in Poland is found as the left lane which differs from the US and Australian behavior.
- ✓ In SIDRA Standard model the left lane was specified as the dominant lane to match the conditions in Poland.
- ✓ The results shows the difference in **dominant lane (left entry lane)** and **subdominant (right entry lane)** capacities.

LINEAR REGRESSION ANALYSIS BETWEEN DEGREE OF SATURATION ESTIMATES (ALL LANES) AT TWO-LANE ROUNDABOUTS AFTER CALIBRATION USING $EF = 1.387$



Results shows very good quality of fit between the two models

CONCLUSIONS

- ✓ The comparisons of entry lane capacity estimates from the two models for one-lane and for two-lane roundabouts indicated that:
 - ❑ the entry lane capacities at one-lane roundabouts in Poland are lower but close to those in Australia
 - ❑ the entry lane capacities at two-lane roundabouts in Poland are much lower than those in Australia.

- ✓ Calibrating the SIDRA Standard model using data for 21 one-lane roundabouts and 12 two-lane roundabouts resulted in capacity estimates from this models with very good match to driving conditions in Poland.

- ✓ Analyses showed very good levels of compatibility between the Macioszek and SIDRA Standard capacity models for one-lane and two-lane roundabouts.

CONCLUSIONS

✓ In analyses, the SIDRA Standard model was used with values of:

- entry lane width (4.0 m)
- entry radius (20 m)
- entry angle (30 degrees).

Whereas the parameter ranges for roundabouts in Poland indicate lower values of:

- entry lane width (3.0 to 4.0 m for one-lane roundabouts and 3.0 to 3.5 m for two-lane roundabouts)
- entry radius (6.0 to 15.0 m for one-lane roundabouts and 8.0 to 15.0 m for two-lane roundabouts)
- entry angle.

EF values used to calibrate the SIDRA Standard model for roundabout capacities in Poland would have been lower if the lower values of entry lane width and entry radius (and possibly values of entry angle higher than 30 degrees) were used in the SIDRA Standard model since the capacity estimates would have been closer to the observed values.

The effect of these parameters can be the subject of further analysis.

Thank you for your attention

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