Industry Perspective on Ontario Pavement Cracking Research

Alexander W. (Sandy) Brown, P.Eng.
Ontario Hot Mix Producers Association - Technical Director
Asphalt Institute - Canadian Field Engineer

www.ohmpa.org

ASPHALT INSTITUTE

Outline

- Hwy 655 Phase I project
- Hesp, S.A.M, et al, *Asphalt pavement cracking: analysis of extraordinary life cycle variability in eastern and northeastern Ontario,* International Journal of Pavement Engineering, Vol. 10, No. 3, June 2009, 209–227.
- 2011 MTO Asphalt Cement Initiatives
- Hwy 655 Phase II project

Disclaimers

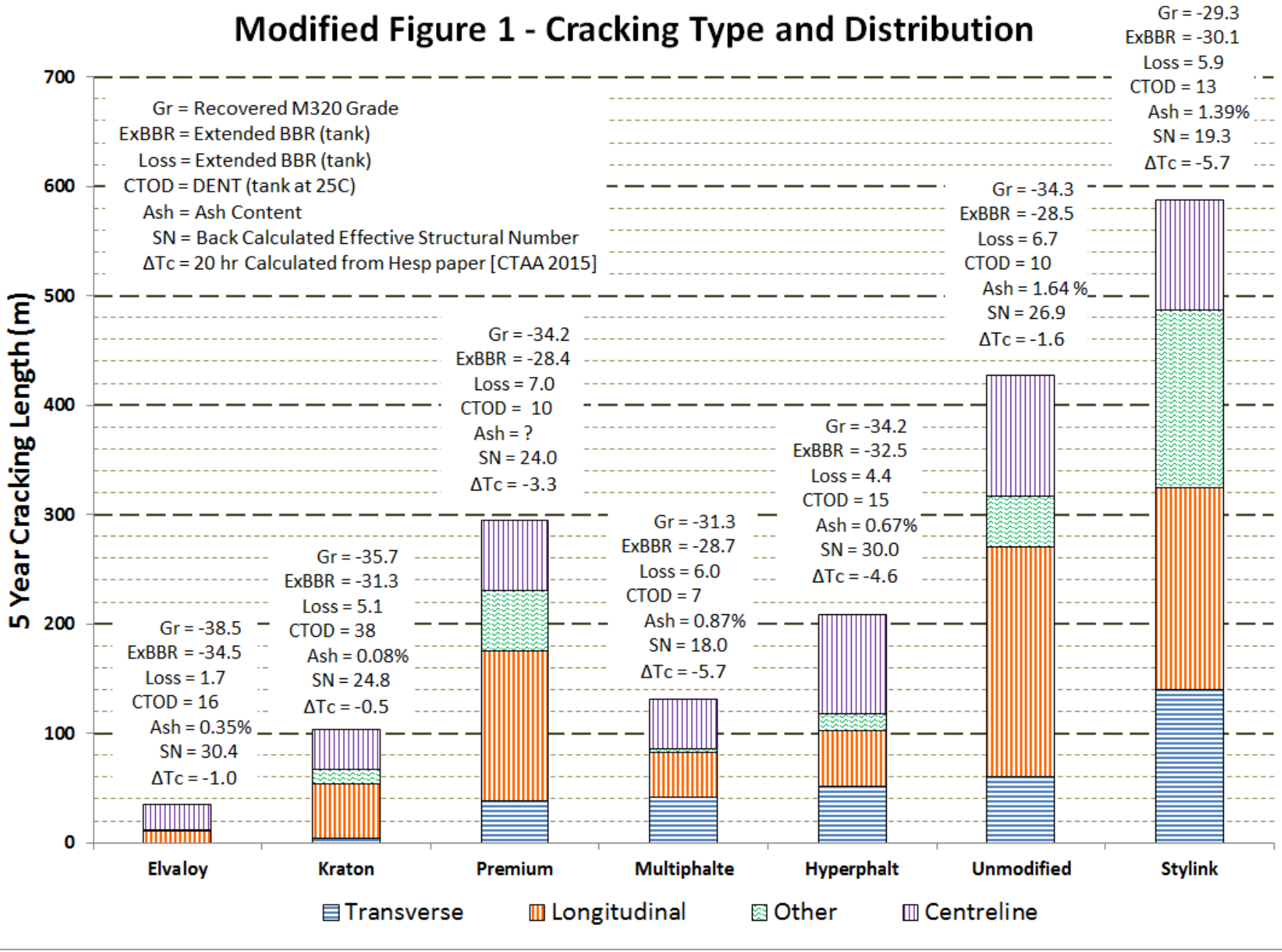
- This is an Ontario industry perspective
- Industry did not collect any of the data

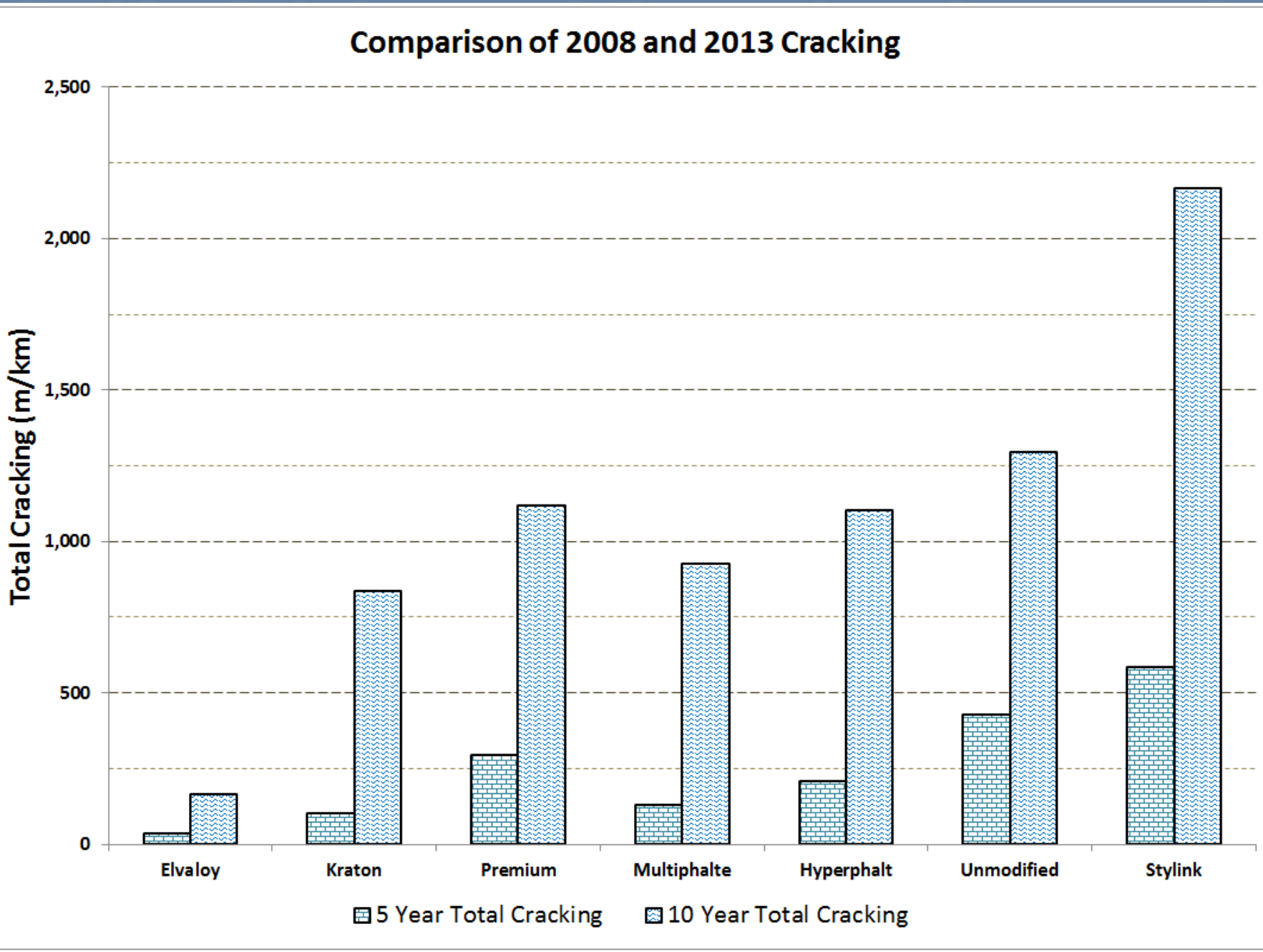
Hwy 655 Phase I

- Located about 25 km N of Timmins
- 7 test sections (500 m) paved in 2003
  - All specified PG 64-34 to ensure modification
  - Pavement temperatures below -37°C @ pavement surface (calculated from pavement thermistors at 20 mm) were observed in the first 2 years (T_{air} < -40°C)
  - Winter of 2013-14, had multiple T_{air}<-40°C
  - OHMPA and MTO shared the cost to retain an independent consultant to report on the test sections in 2008 (Gerry Huber)

LTPPBind v3.1	
Lat =	48.62°N
Lon =	81.30°W
T_{air} =	-39.4°C
T_{pav} =	-31.0°C
Low_{StdDev} =	2.5°C
$T_{pav}98\%$ =	-36.1°C

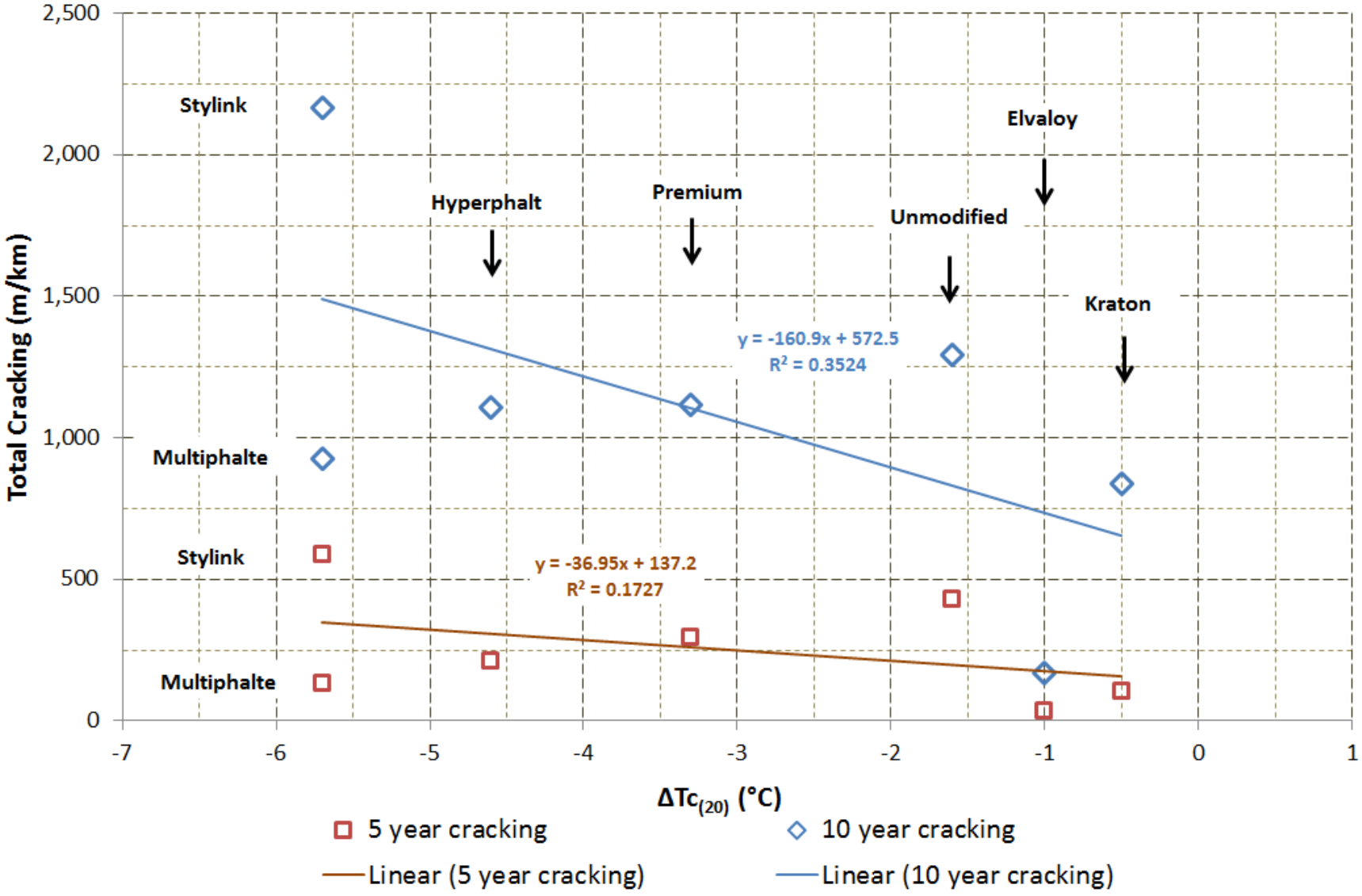
Modified Figure 1 - Cracking Type and Distribution




Comparison of 2008 and 2013 Cracking
Total Cracking (m/km)
2,500
2,000
1,500
1,000
500
0
Elvaloy
Kraton
Premium
Multiphalte
Hyperphalt
Unmodified
Stylink
5 Year Total Cracking
10 Year Total Cracking

$\Delta Tc_{(20)}$ on Hwy 655 - Phase I

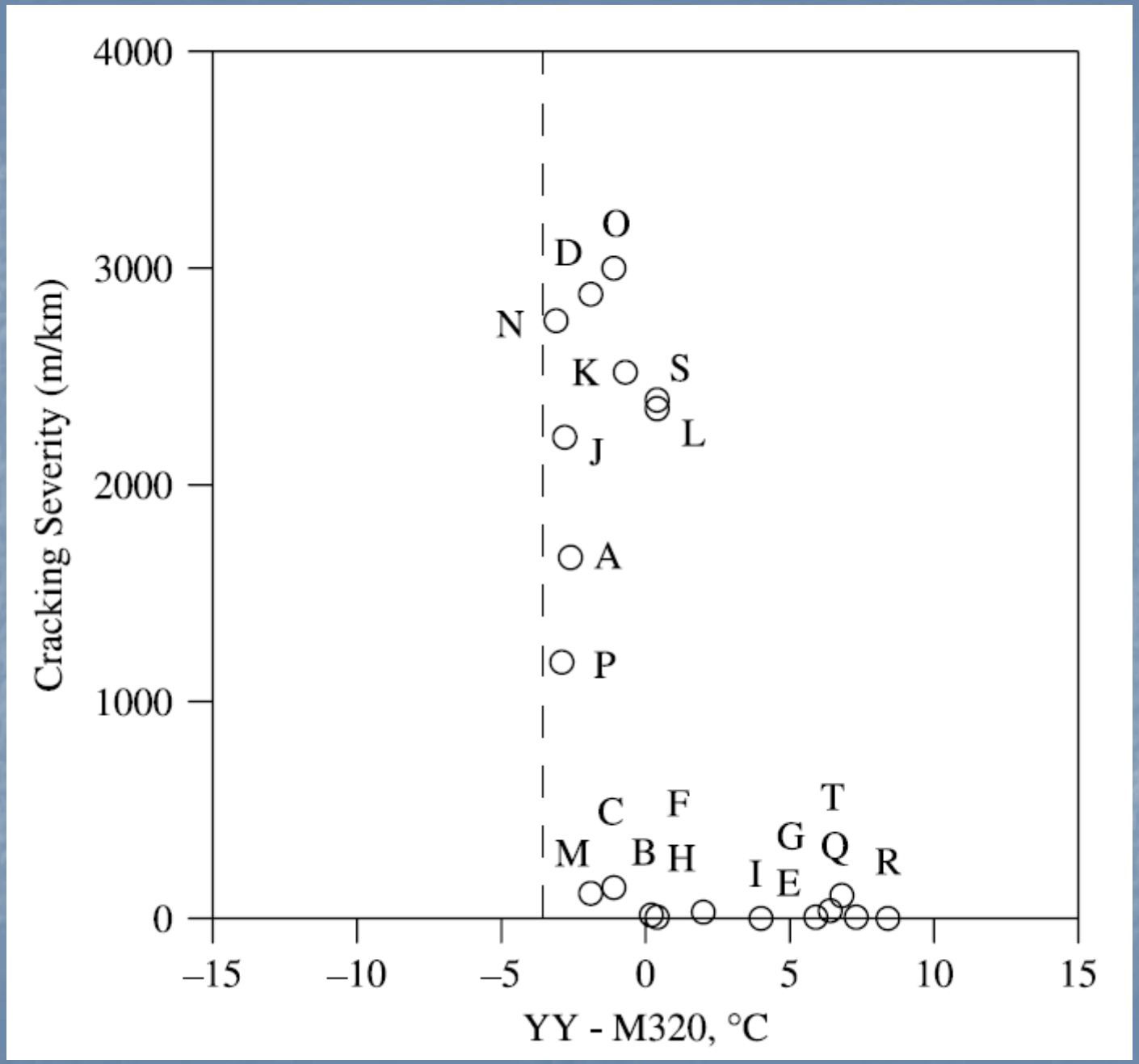
Data extracted from *Physical Hardening in Asphalt*, Hesp, CTAA 2015



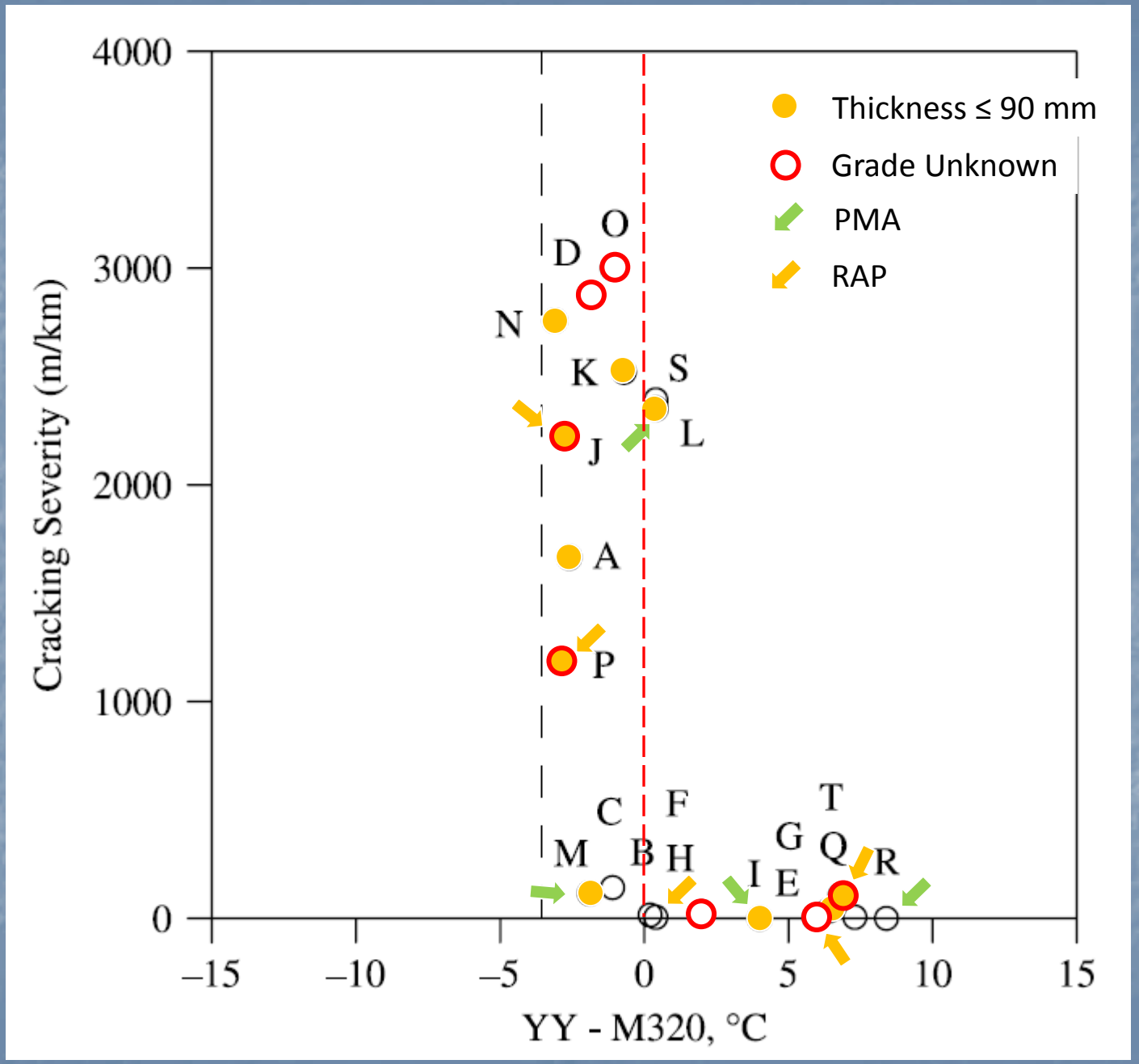
Study on 20 Pavements in Eastern and Northeastern Ontario*

- Study done in 2007 on pavements that were 7 to 14 years old at that time
- AC – 6 pen graded contracts, 13 PGAC and 1 unknown
- Distress survey carried out at three locations and averaged – only transverse cracks were measured
- 4 cores taken for recovered testing of the AC
  - Extended BBR (LS 308) and DENT (LS 299)

*Hesp, S.A.M, et al, *Asphalt pavement cracking: analysis of extraordinary life cycle variability in eastern and northeastern Ontario,* International Journal of Pavement Engineering, Vol. 10, No. 3, June 2009, 209–227.


Cracking Severity (m/km)
4000
3000
2000
1000
0
–15
–10
–5
0
5
10
15
YY - M320, °C
O
D
N
K
S
L
J
A
P
C
F
T
G
Q
M
B
H
I
E
R

	Site	Hwy	Location	AADT	Trucks (%)	Daily Truck Number	Total Asphalt (mm)	Age	LTPP Bind v2.1 (°C)	Binder Course Grade (%RAP)	Surface Course Grade (%RAP)
Poor	O	60	Wilno	2800	10.0	280	–	13	-34.4	–	–
Good	G	33	Conway	1828	3.4	62	50	9	-25.9	–	58-28
Good	I	41	Dacre	1680	19.8	333	80	7	-31.7	58-34	58-34 PMA
Poor	J	41	Denbigh	2950	11.8	348	80	11	-33.6	300/400 (35)	150/200
Poor	L	41	Northbrook	3330	13.9	463	80	7	-33.6	58-34 M	58-34 M
Good	Q	62	Bloomfield	3143	4.3	135	90	14	-27.7	150/200 (20)	150/200 (20)
Good	M	41	Vennachar	1557	12.0	187	90	9	-33.6	58-34 PMA	58-34 PMA
Poor	K	41	Kaladar	3001	9.8	294	90	8	-33.7	58-34	58-34
Poor	P	62	Bannockburn	2500	13.0	325	90	10	-33.6	300/400 (30)	300/400 (30)
Poor	N	60	Bat Lake	2550	15.2	388	90	9	-34.8	58-34	58-34
Poor	A	6	Little Current	3560	11.2	399	90	7	-29.3	58-34	58-34
Good	F	28	Lakefield	5740	9.3	534	120	9	-29.2	52-34 (25) 64-34	58-28
Good	E	28	Burleigh Falls	3972	8.5	338	130	14	-29.2	300/400 (30)	150/200
Good	C	11	Smooth Rock Falls	2705	24.1	652	130	9	-36.8	52-34	52-34
Poor	S	138	Monkland	4700	15.3	719	130	9	-31.5	58-34	58-34
Good	H	35	Lindsay	8062	9.0	726	130	10	-31.0	85/100	85/100
Poor	D	17	Petawawa	6565	12.2	801	130	11	-32.5	85/100	85/100
Good	B	11	Cochrane	3227	29.3	946	130	8	-37.8	52-34	52-34
Good	R	138	Cornwall	7750	13.3	1031	130	6	-28.7	58-34 PMA	58-34 M
Good	T	416	Spencerville	12000	13.4	1608	140	8	-29.0	64-34	64-34


Thickness ≤ 90 mm
Grade Unknown
PMA
RAP
Cracking Severity (m/km)
4000
3000
2000
1000
0
–15
–10
–5
0
5
10
15
YY - M320, °C
O
D
N
K
S
J
L
A
P
C
F
T
M
B
H
G
Q
I
E
R

2011 MTO Asphalt Cement Initiatives

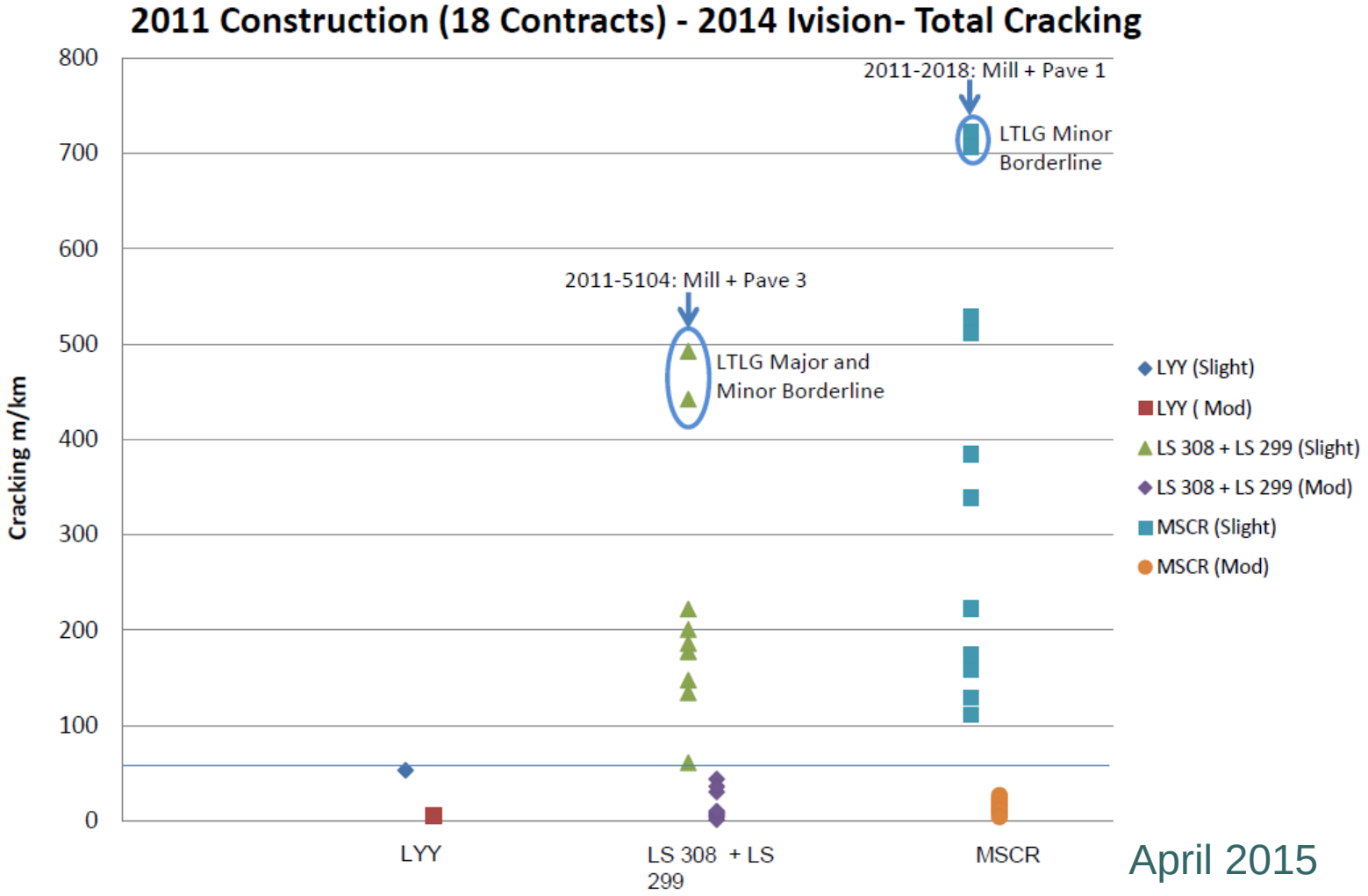
- MTO and Industry collaborated between 2005 and 2011 on 2 new test procedures – ExBBR and DENT
- A mutually acceptable test protocol and acceptance limits were developed by the MTO-OHMPA Binder Task Group
- Total of 38 trial projects paved between 2012 and 2015
- 16 have reached the end of the warranty period with no contract disputes and so the projects are considered closed
- Data from these 16 projects was shared with Industry and analysed for this presentation

2011 MTO Asphalt Cement Initiatives

cont'd

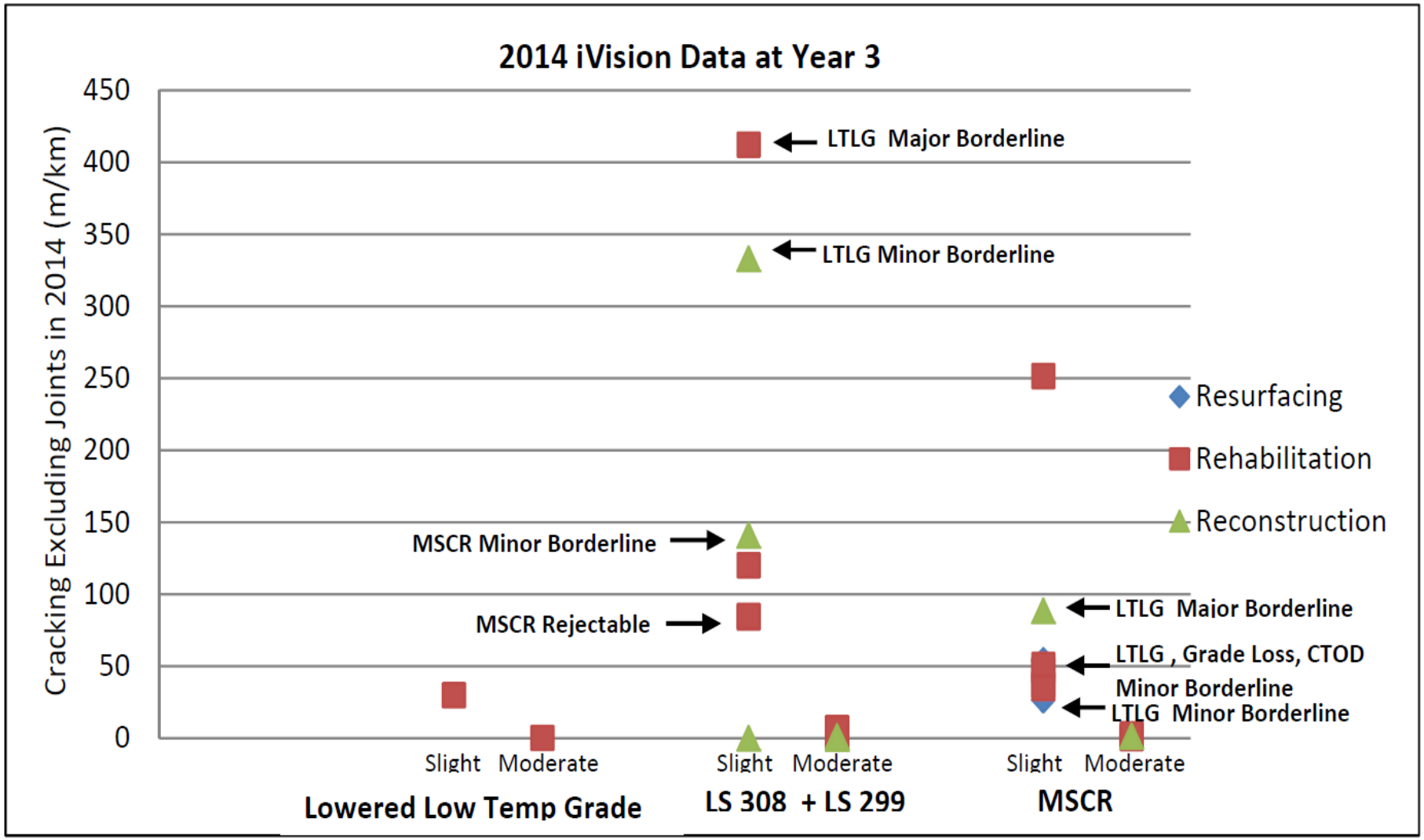
- All testing on new asphalt cement from QA samples and was tested by MTO QA laboratories
- Testing included: Standard (M320) 1 hr BBR test; LTLG and Loss from the Extended (72 hr) BBR test; CTOD from the DENT test (Ontario procedure); MSCR % Recovery; and Ash test.
- Crack monitoring was carried out by MTO at 3 years using their new ARAN
- These results are preliminary in nature
- This is industry's analysis of the results

Asphalt Cement …2011 Trials



April 2015

MTO presentation at the 2015 OHMPA Annual General Meeting

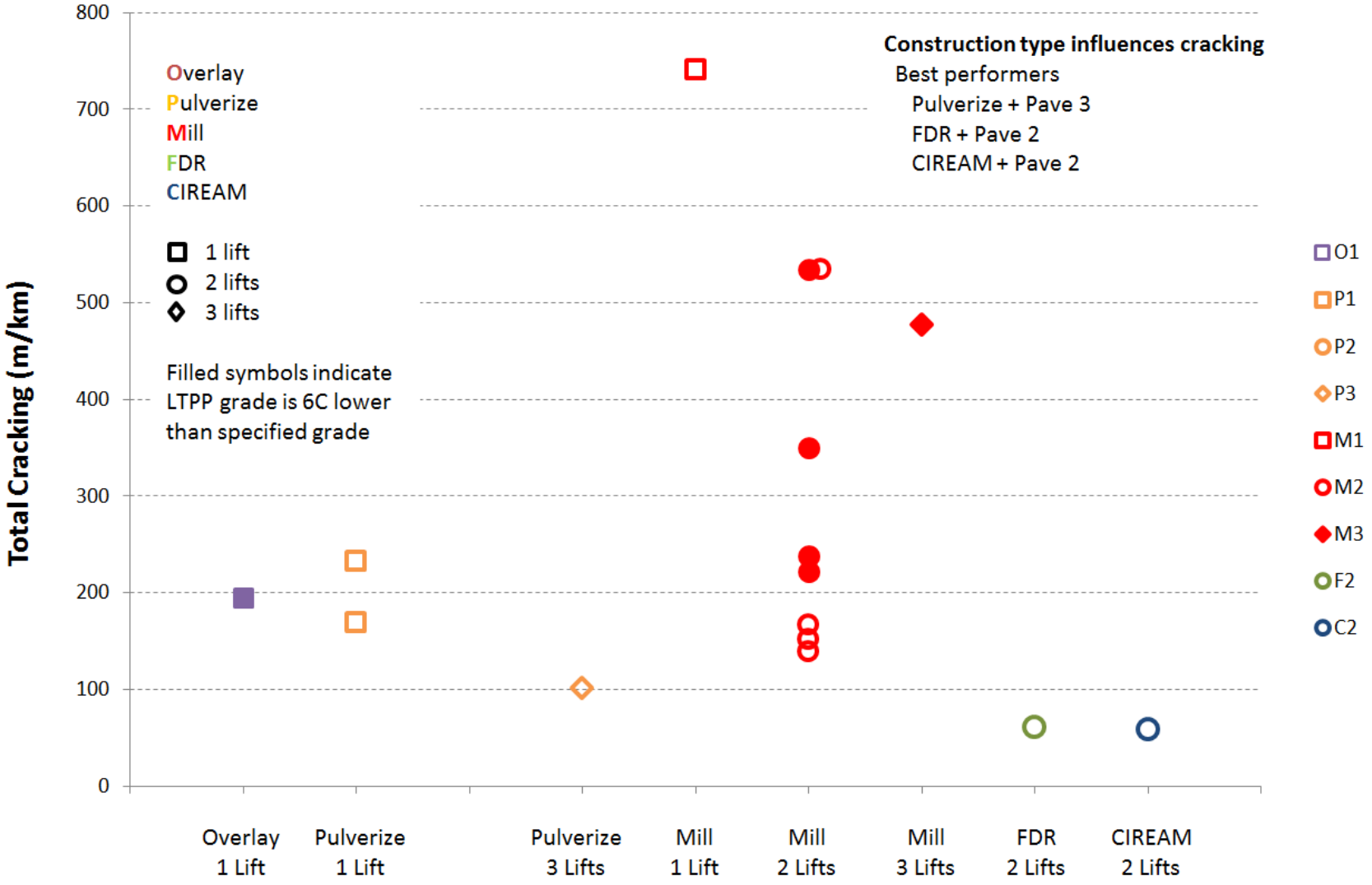


Note: LTLG is Low Temperature Limiting Grade and MSCR is Multiple Stress Creep Recovery test.

MTO, *Ontario's Strategy to Enhance Asphalt Cement Quality* – CTAA 2015

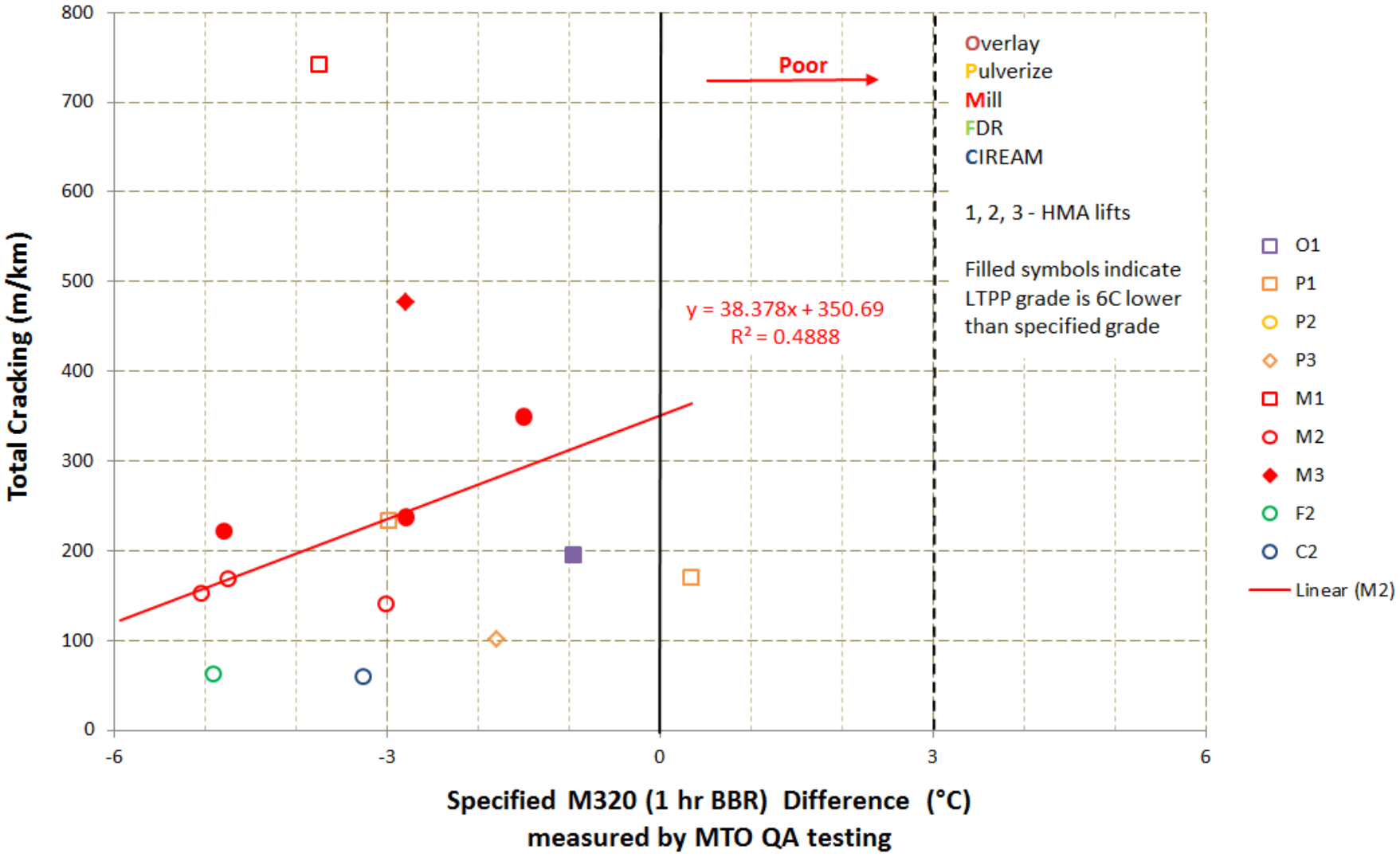
Correlation between Construction Type and Cracking

Results of MTO ARAN Cracking Measurement at 3 years



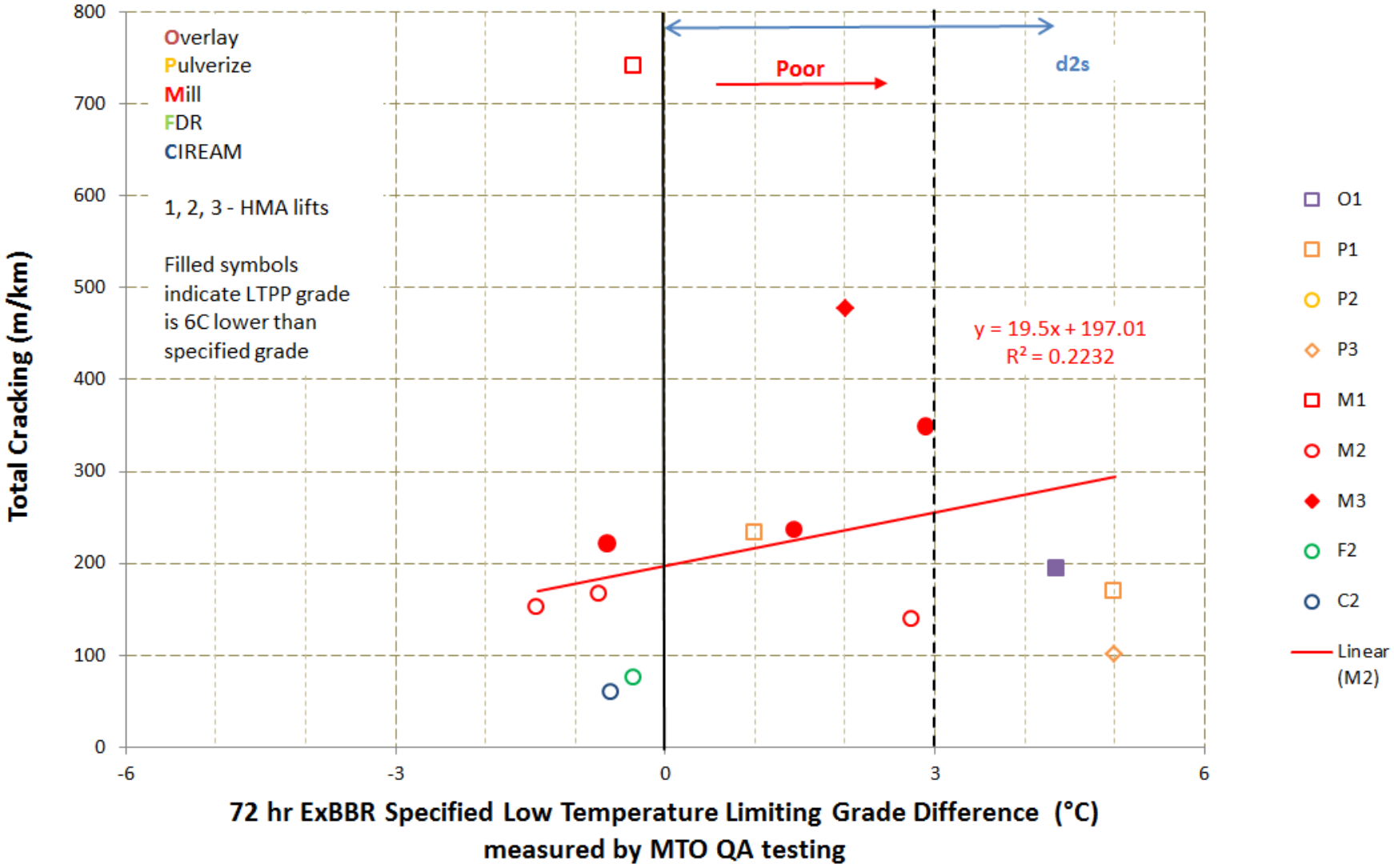
Moderate Correlation (trending correctly)

Results of MTO ARAN Cracking Measurement at 3 years



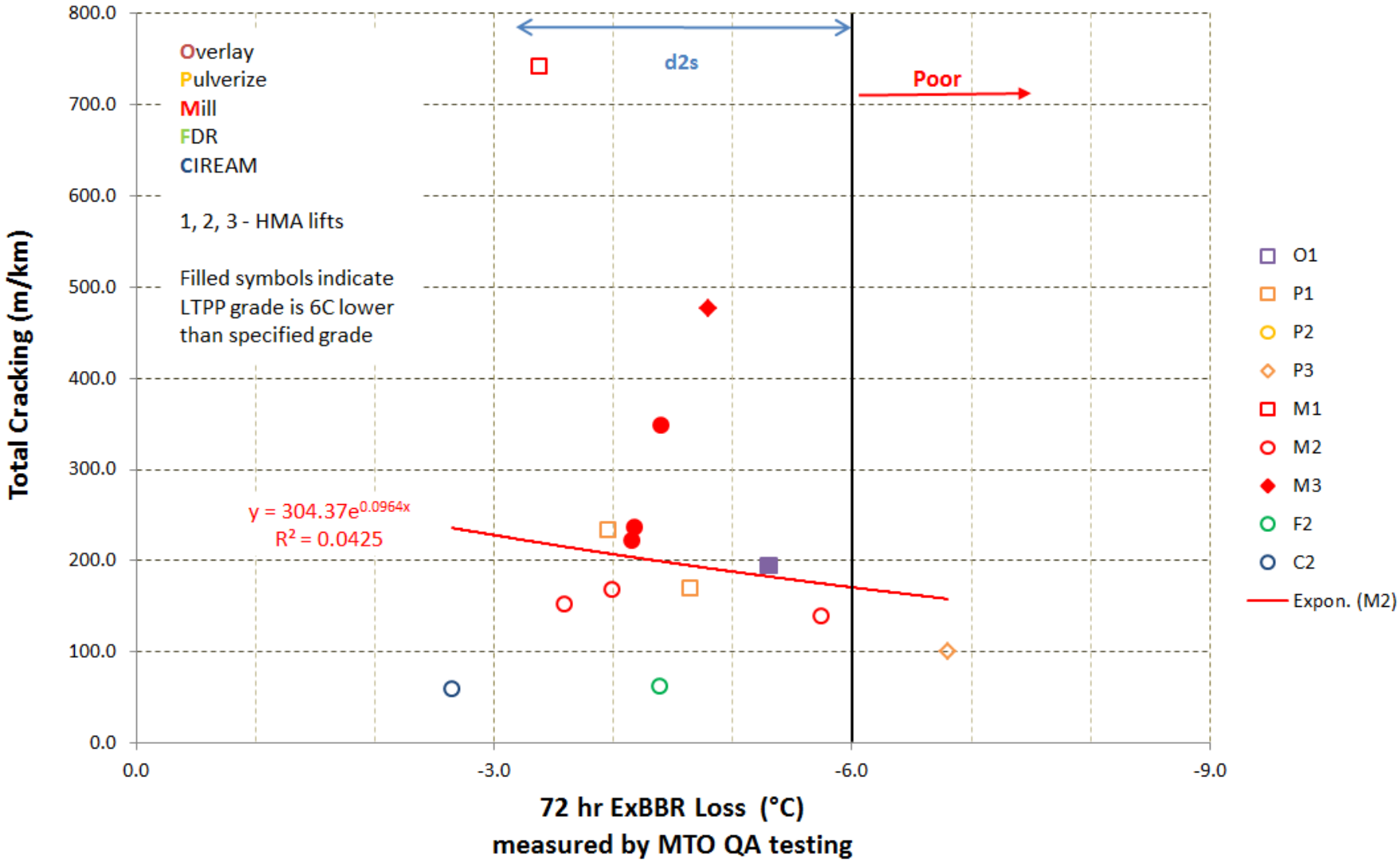
Poor Correlation (trending correctly)

Results of MTO ARAN Cracking Measurement at 3 years



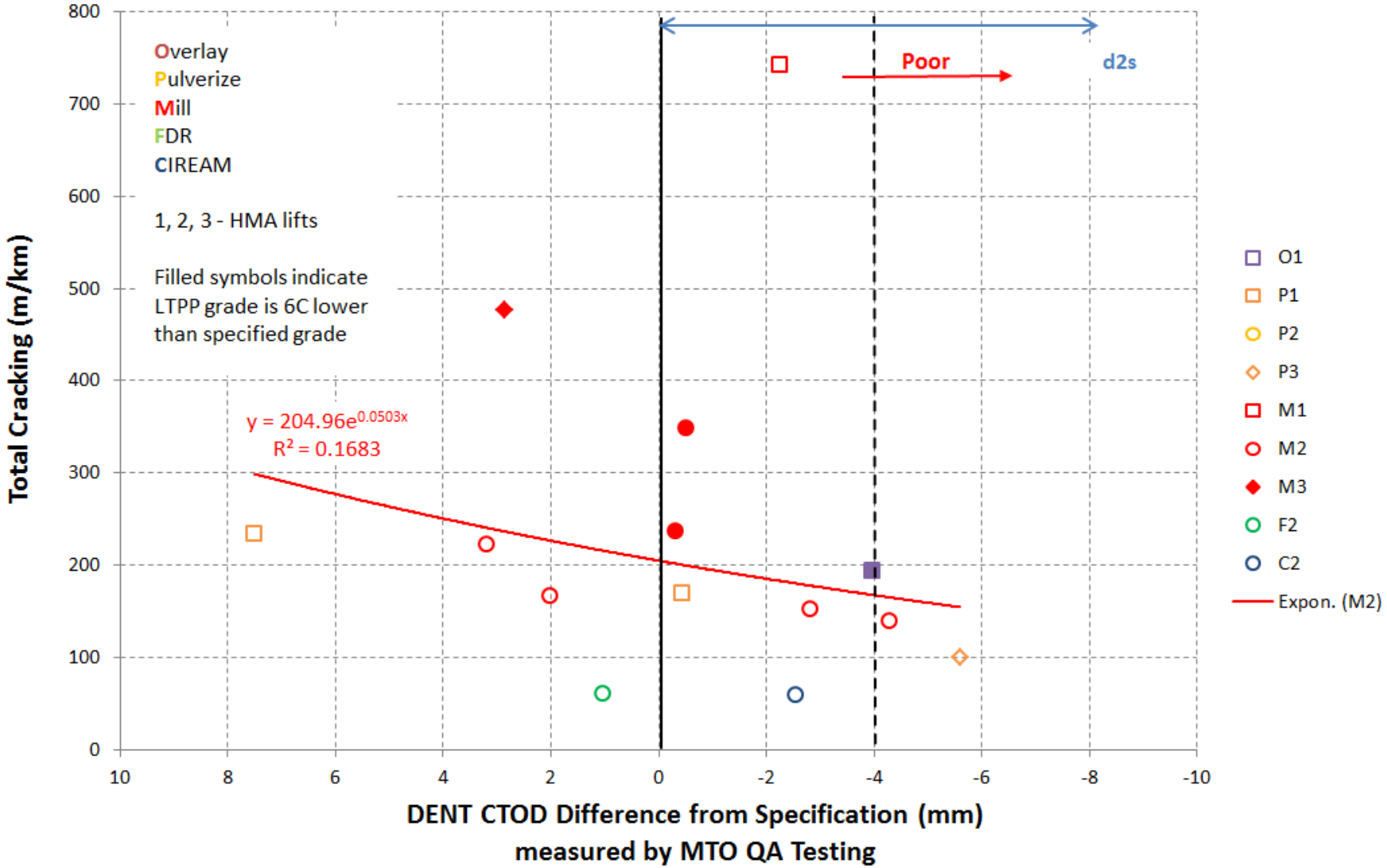
No Correlation (trending incorrectly)

Results of MTO ARAN Cracking Measurement at 3 years



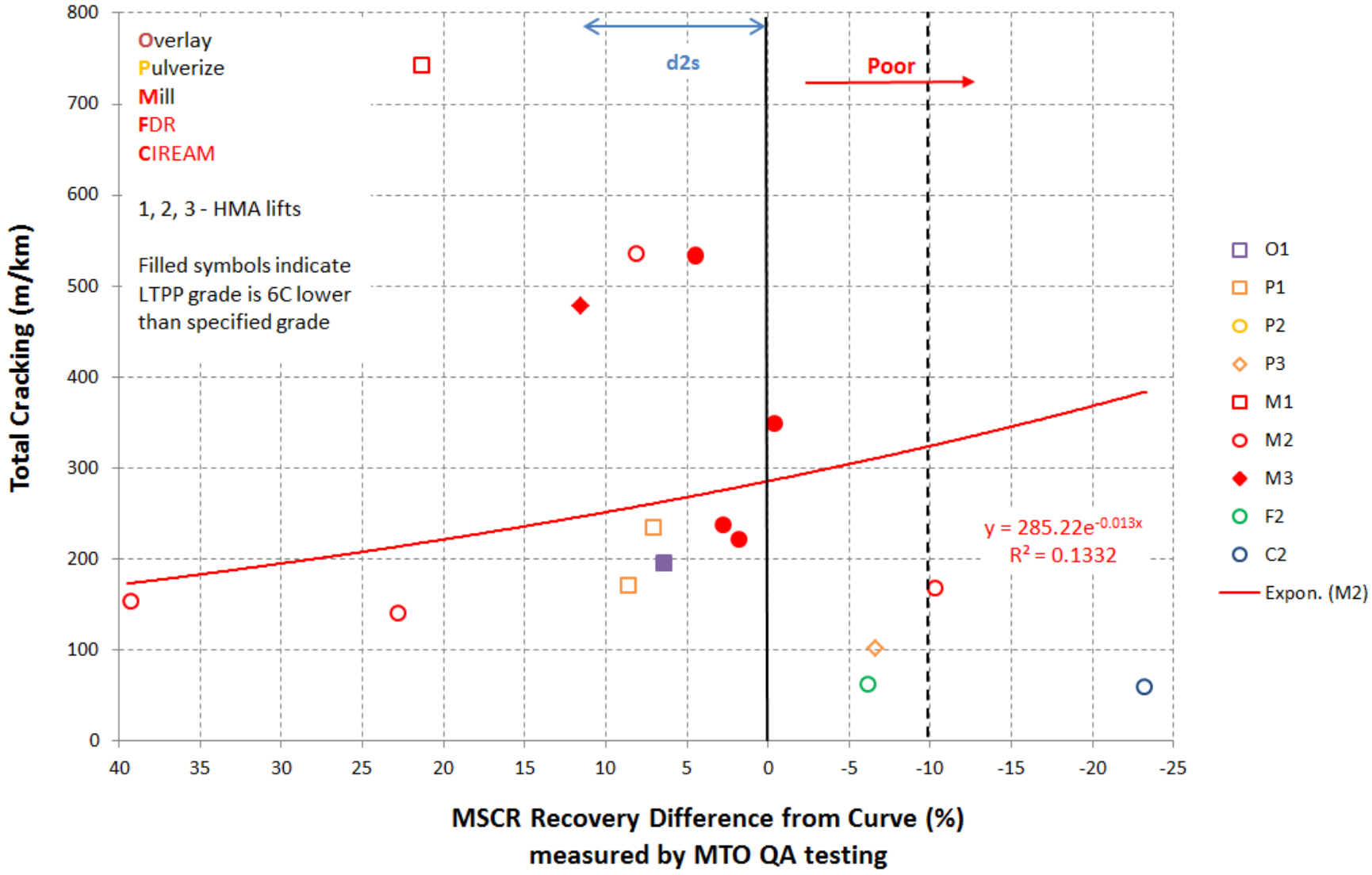
No Correlation (trending incorrectly)

Results of MTO ARAN Cracking Measurement at 3 years



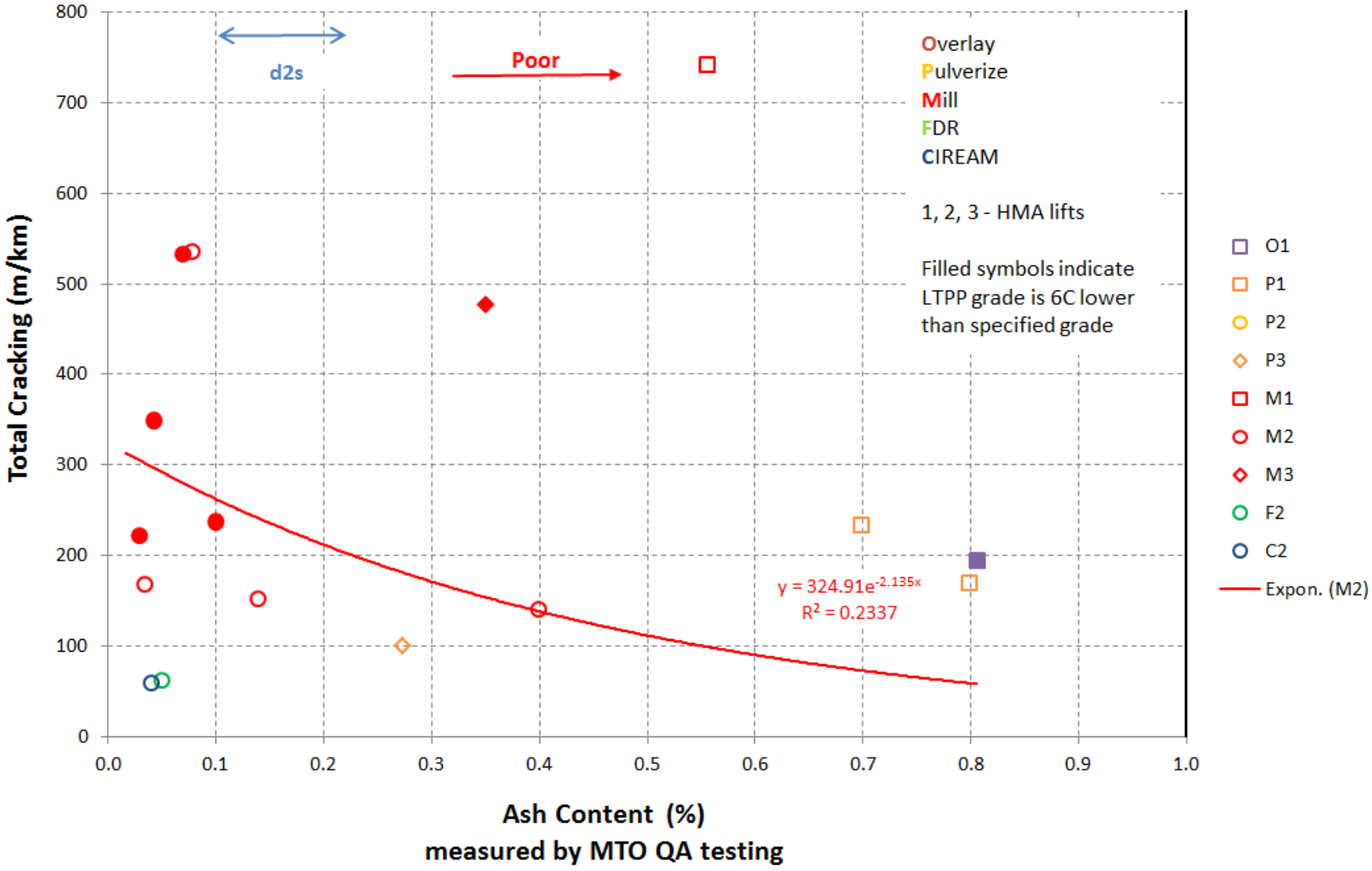
Poor Correlation (trending correctly)

Results of MTO ARAN Cracking Measurement at 3 years



No Correlation (trending incorrectly)

Results of MTO ARAN Cracking Measurement at 3 years



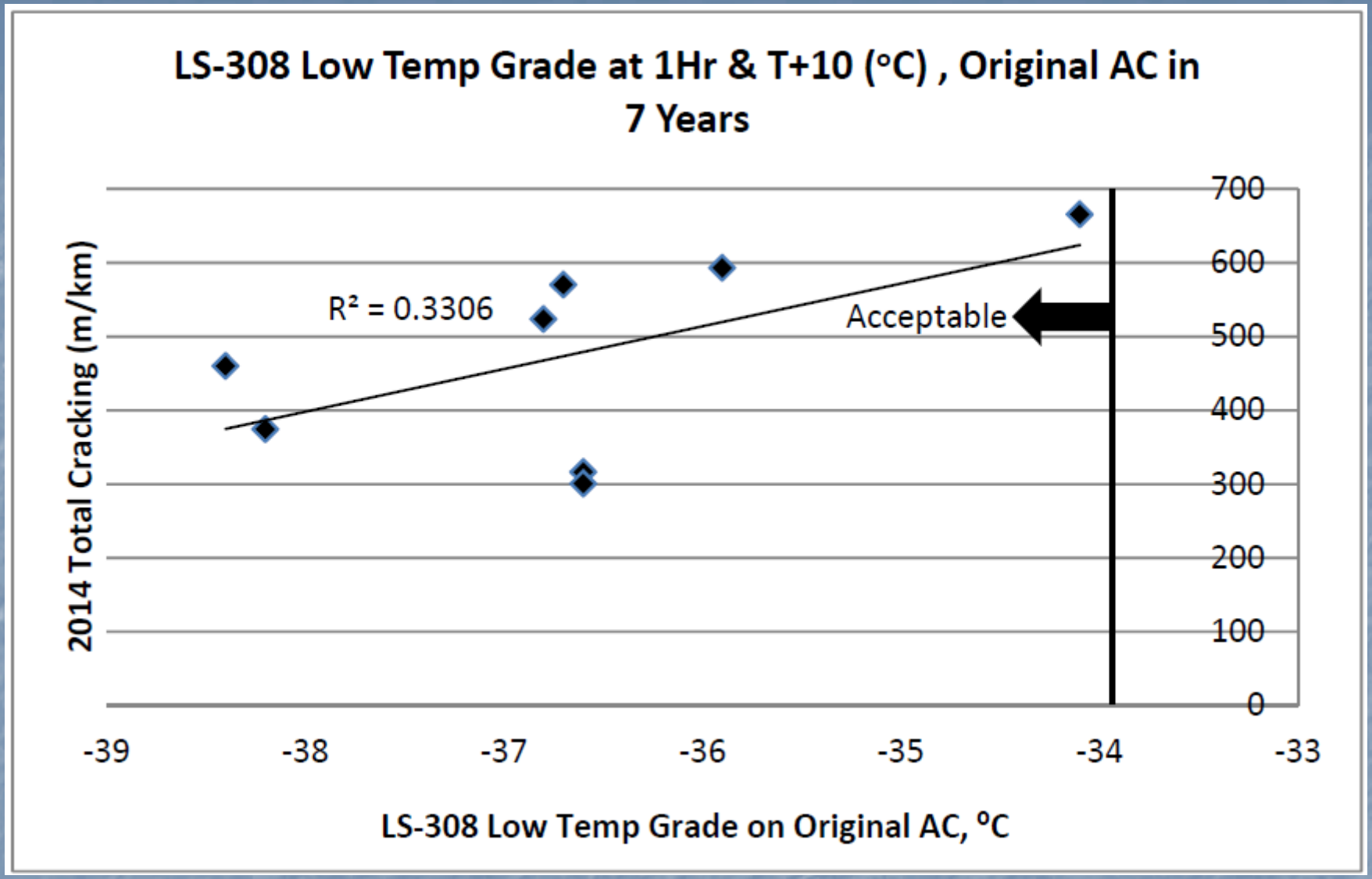
Summary of the cracking at 3 years based on MTO monitoring and testing

- Industry's analysis of preliminary data
- On Mill and Pave with 2 lifts
  - The standard 1 hr BBR test shows better correlation than 72 hr Extended BBR test
  - Loss doesn't correlate – engineering control
    - Asking for DENT or MSCR seemed to control Loss
  - Ash (REOB/VTAE) doesn't correlate – engineering control
  - MSCR has poor correlation (trends correctly)
  - DENT doesn't correlate (trends incorrectly)
- These charts will change – it has only been three years

Hwy 655 Phase II

- Located about 25 km N of Timmins
- 8 test sections paved in 2008 as a follow-up to the Phase I study
  - All specified PG xx-34 with a formula for elastomeric modification
  - All but control used a 300/400 Pen Cold Lake asphalt
  - 5 sections with elastomer (formula), one control and two with fibre (mix)
- Results presented in the MTO paper given at the CTAA conference in 2015

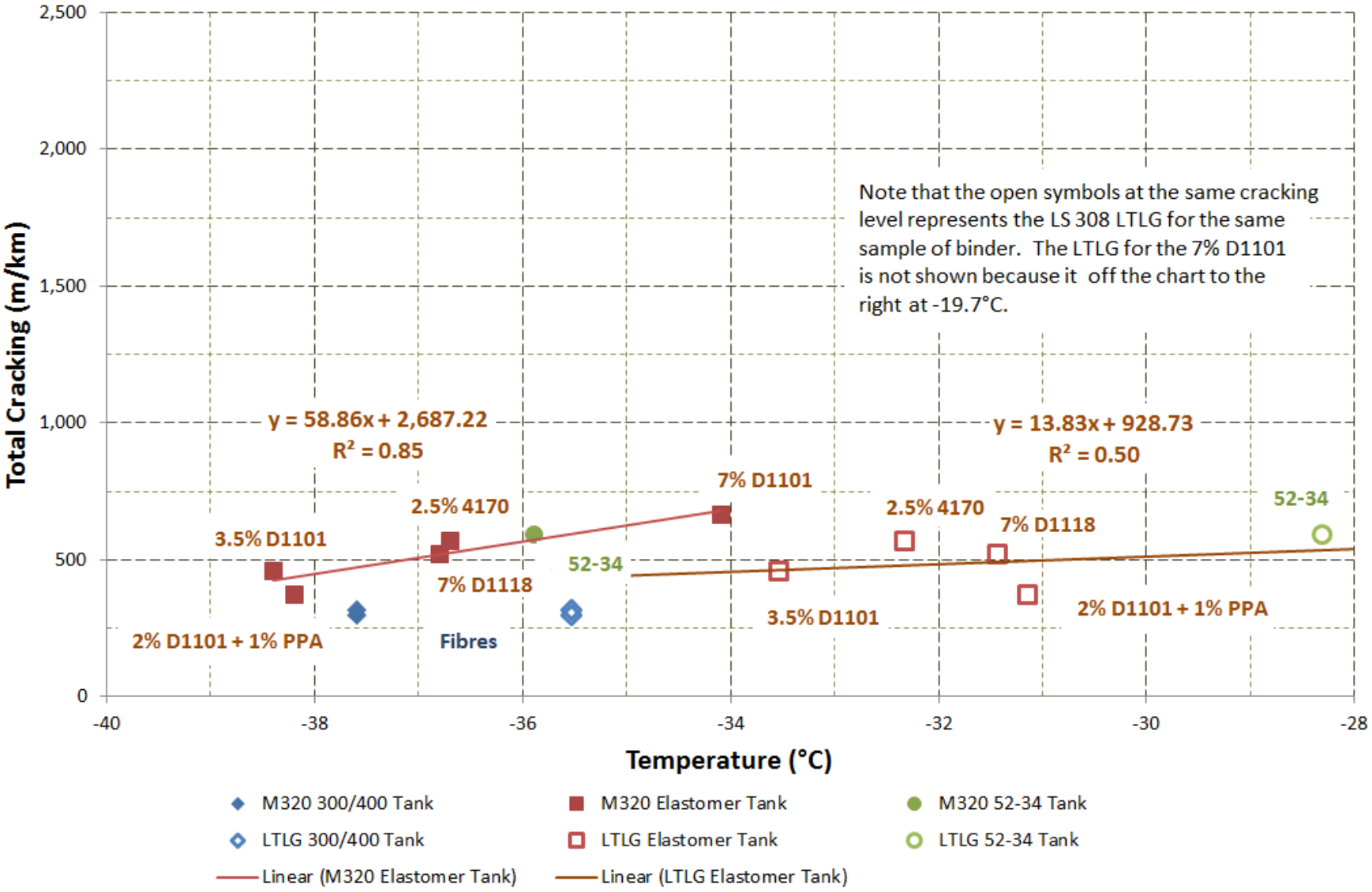
LTPPBind v3.1	
Lat =	48.72°N
Lon =	81.30°W
T_{air} =	-39.4°C
T_{pav} =	-31.0°C
Low_{StdDev} =	2.5°C
$T_{pav}98\%$ =	-36.1°C

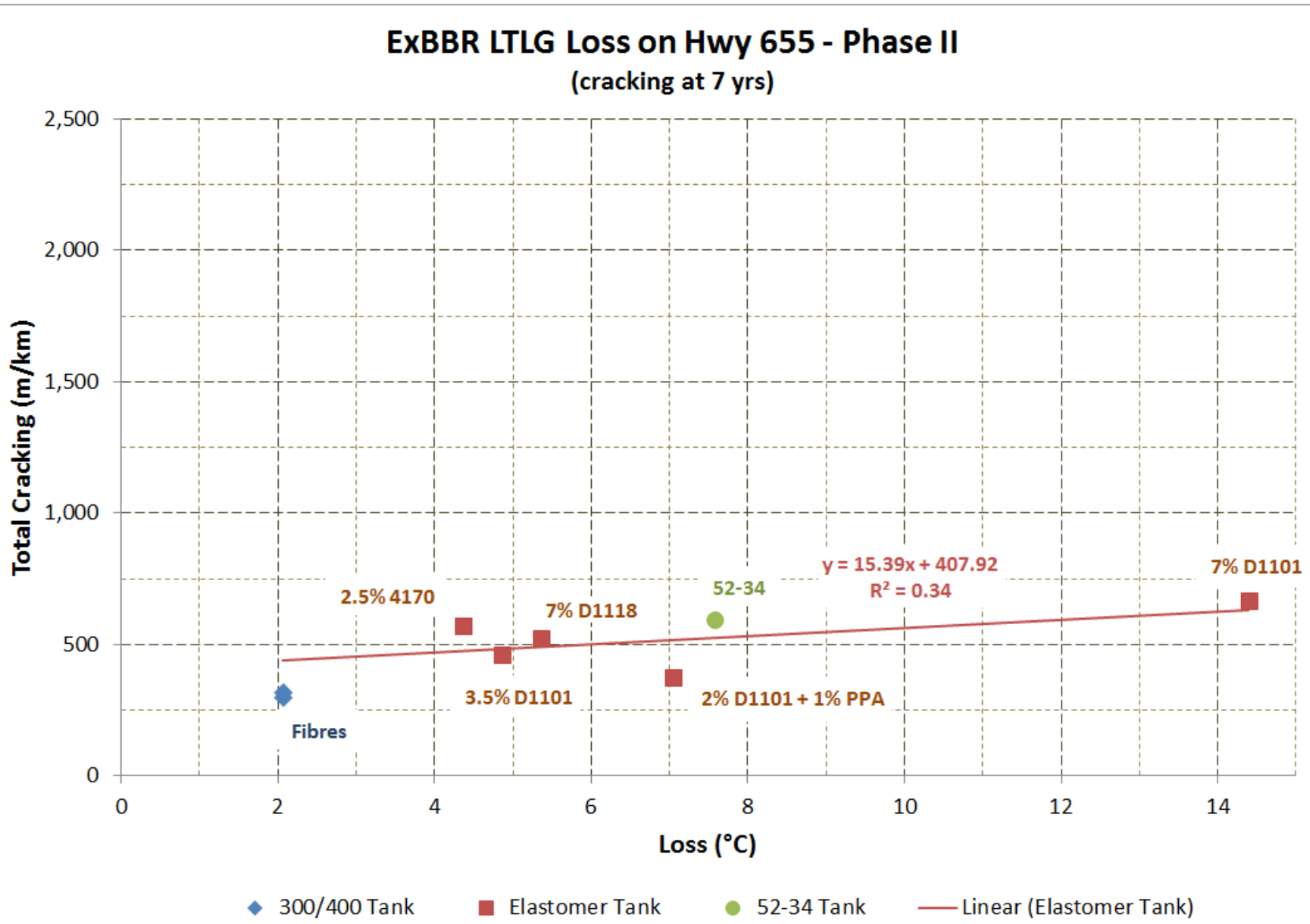


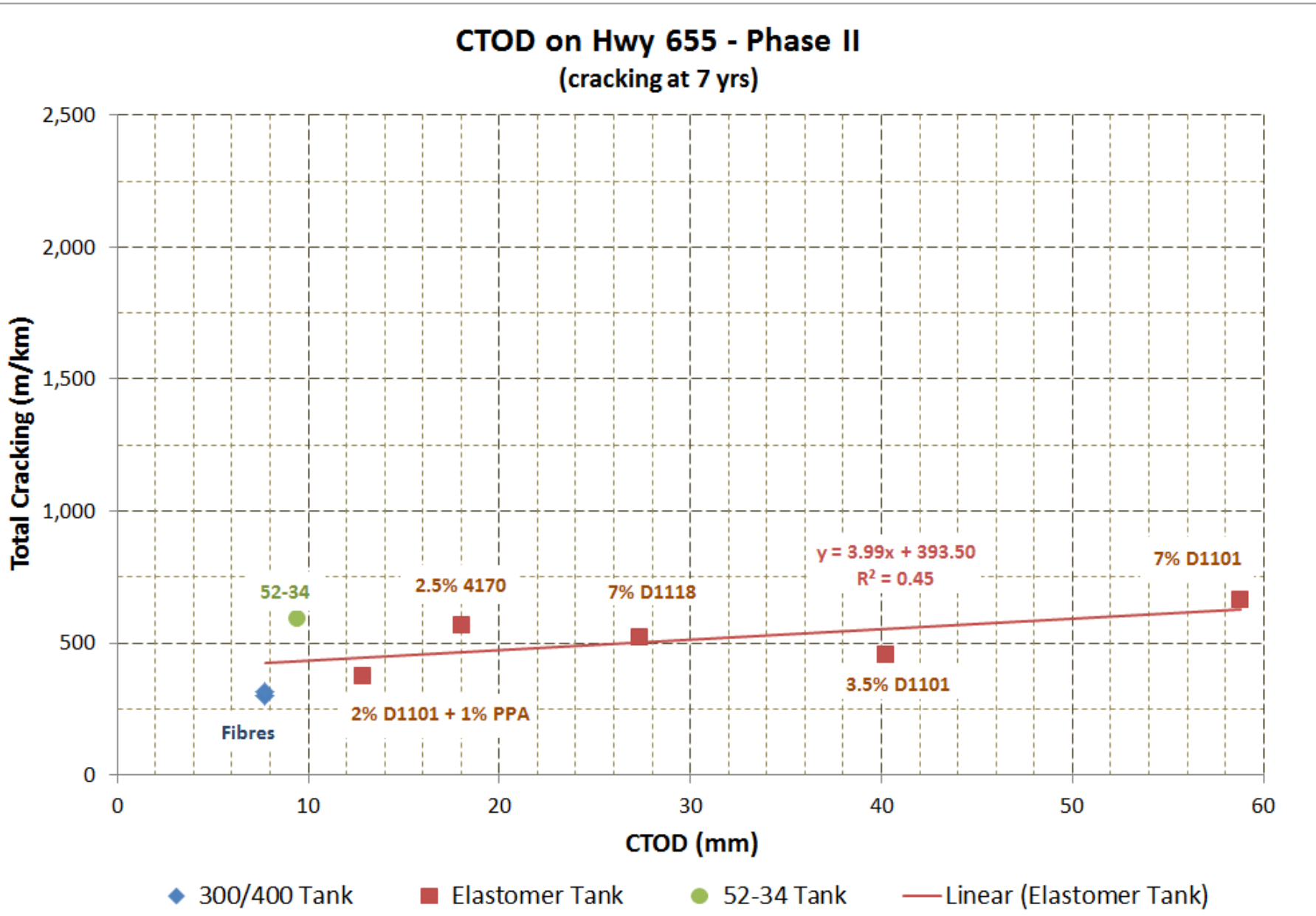
MTO, *Ontario's Strategy to Enhance Asphalt Cement Quality* – CTAA 2015

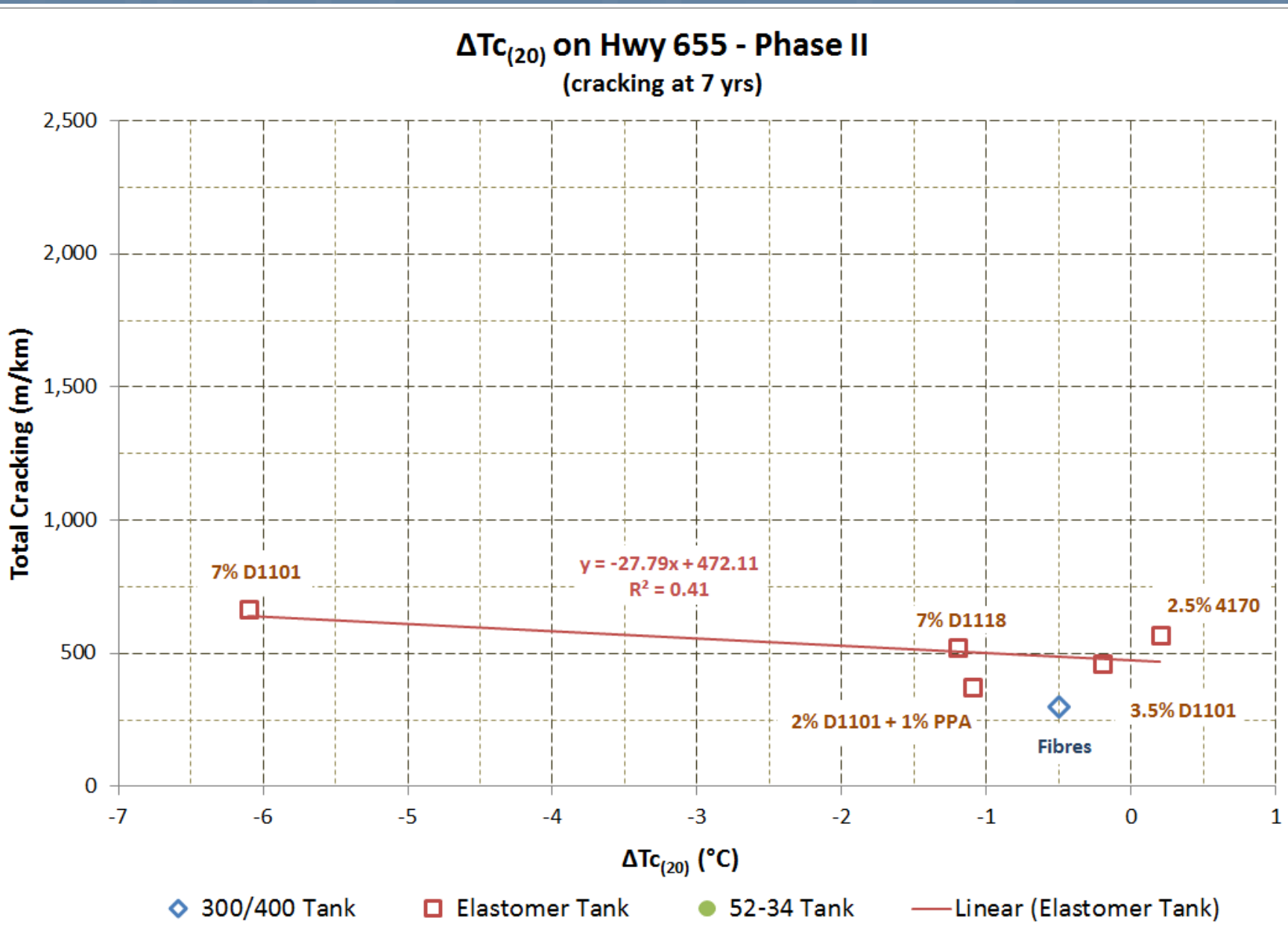
Comparison of M320 LTG and ExBBR LTLG on Hwy 655 - Phase II

(cracking at 7 yrs)




ExBBR LTLG Loss on Hwy 655 - Phase II
(cracking at 7 yrs)
Total Cracking (m/km)
2,500
2,000
1,500
1,000
500
0
0
2
4
6
8
10
12
14
Loss (°C)
y = 15.39x + 407.92
R² = 0.34
2.5% 4170
7% D1118
52-34
7% D1101
3.5% D1101
2% D1101 + 1% PPA
Fibres
300/400 Tank
Elastomer Tank
52-34 Tank
Linear (Elastomer Tank)


CTOD on Hwy 655 - Phase II
(cracking at 7 yrs)
Total Cracking (m/km)
2,500
2,000
1,500
1,000
500
0
0
10
20
30
40
50
60
CTOD (mm)
52-34
2.5% 4170
7% D1118
y = 3.99x + 393.50
R² = 0.45
7% D1101
3.5% D1101
2% D1101 + 1% PPA
Fibres
300/400 Tank
Elastomer Tank
52-34 Tank
Linear (Elastomer Tank)


ΔTc(20) on Hwy 655 - Phase II
(cracking at 7 yrs)
Total Cracking (m/km)
2,500
2,000
1,500
1,000
500
0
-7
-6
-5
-4
-3
-2
-1
0
1
ΔTc(20) (°C)
7% D1101
y = -27.79x + 472.11
R² = 0.41
7% D1118
2.5% 4170
2% D1101 + 1% PPA
Fibres
3.5% D1101
300/400 Tank
Elastomer Tank
52-34 Tank
Linear (Elastomer Tank)

Thank you