RAR X™

Enhanced Elastomeric Asphalt Extender

Reacted and Activated Rubber - The new frontier in improved pavements

Dr. Jorge B Sousa

SHRP Corporation

The Issue:

- *For about 50 years the paving industry has been trying to take advantage of the elastomeric material and of the carbon black and silica included in recycled tires.*
- *Those elastomeric materials are know to improve elastic recovery on bitumen. The carbon black and silica improve aggregate interlock*

The Problem:

- *A crumb rubber alone cannot be placed directly into the mixes (dry method) in significant qualities because it will swell and absorb the bitumen causing raveling in the roads*
- *The wet method (about 20% crumb rubber blended with bitumen and reacted over 1 hour at about 175 C) works well but requires that every contractor buys expensive equipment… around 700 000 USD (only cost effective for large projects)*
- *If crumb rubber is used in terminal blends it is essentially a waste of product because over time it becomes all digested. Actual improvements on mix properties are only a fraction of what they could be*.

The Solution:

- *USE OF REACTED AND ACTIVATED RUBBER…that it can be used directly into the plugmill of a contractor's plant.*
- *A proper reacted and activated treatment will insure that the rubber is already swelled with bitumen so it will not absorb any more bitumen.*
- *It will also be treated to blend well and disperse very well and effectively into bitumen*
- *Large quantities can then be used without any real limitation beyond the need of enough bitumen to wet all surfaces, does really making the binder much more "elastic".*

Reacted and Activated Rubber

(components in optimized proportions and activating environment)

Bitumen

Crumb Rubber

FILLERS

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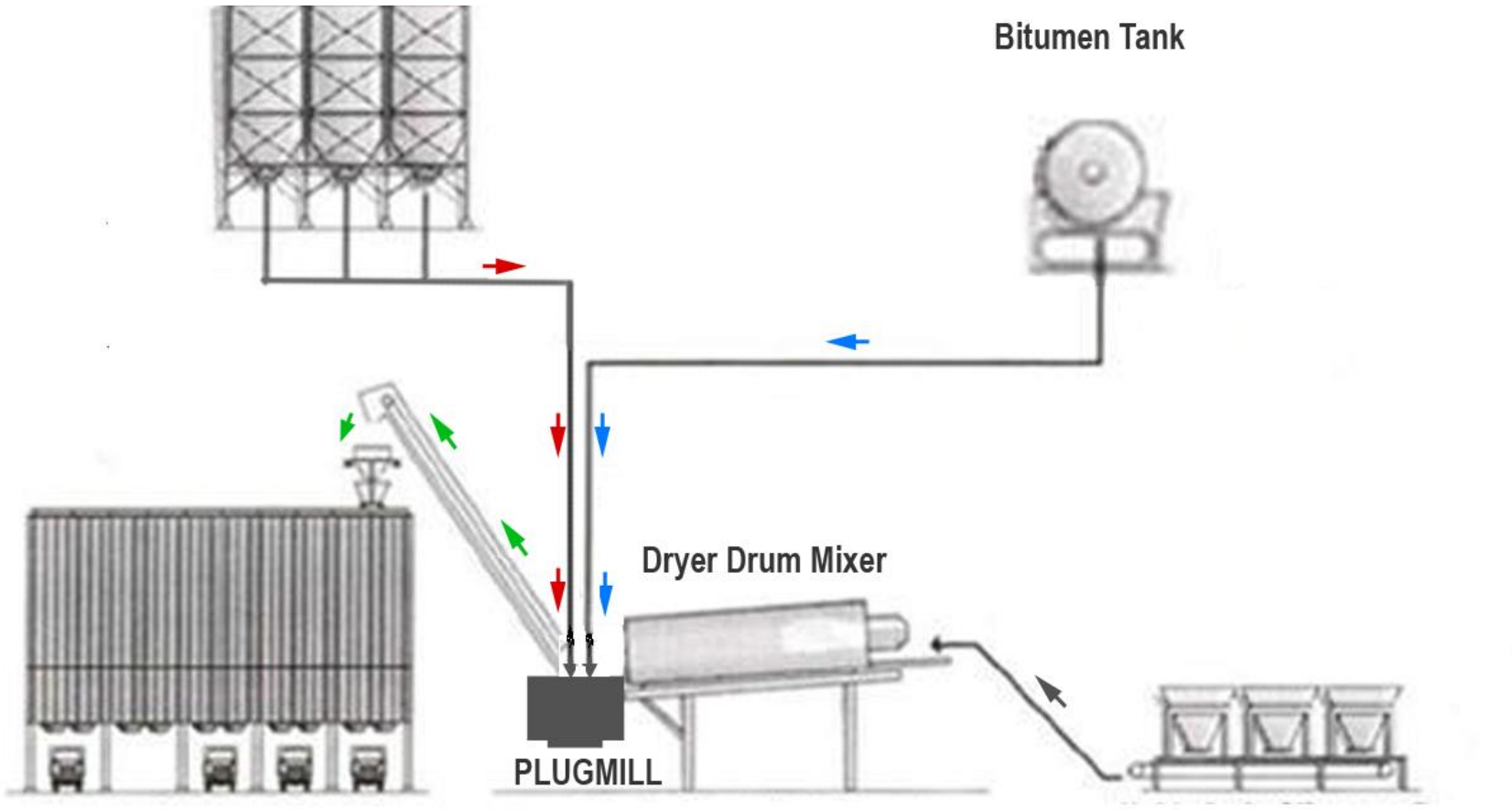
RAR X



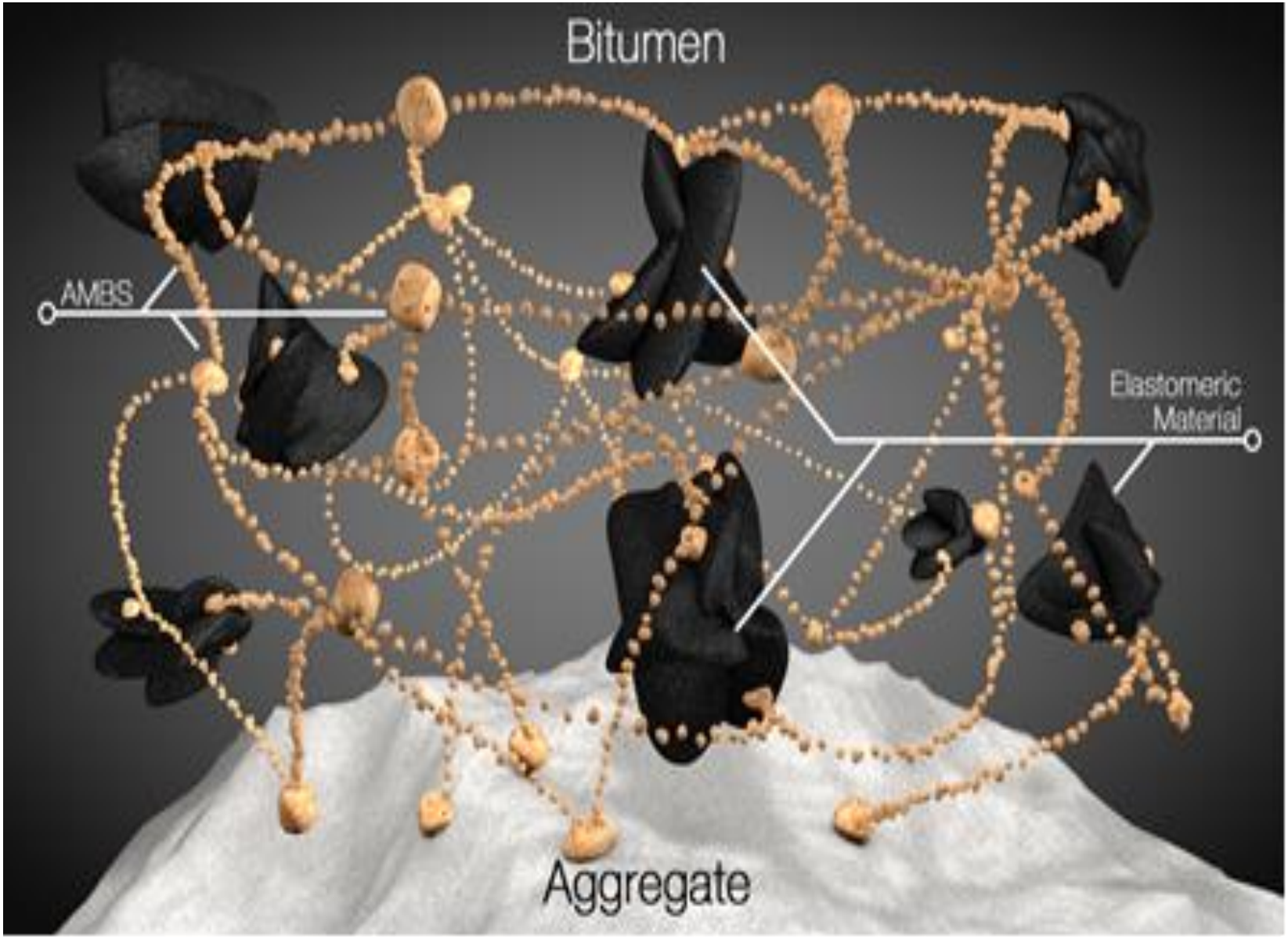
RAR X CAN BE PLACED DIRECTLY INTO THE CONTRACTORS PUGMILL

RAR X Concept

Best of both worlds:

a) Easy to apply and use as in the "dry method"... directly in to the pug mill

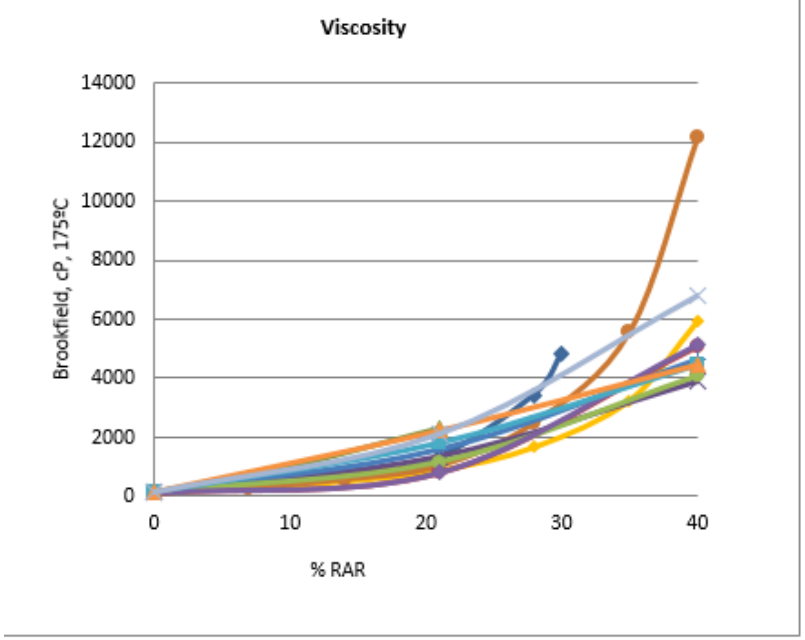
b) Performance and cost effectiveness beyond that of the "wet method"

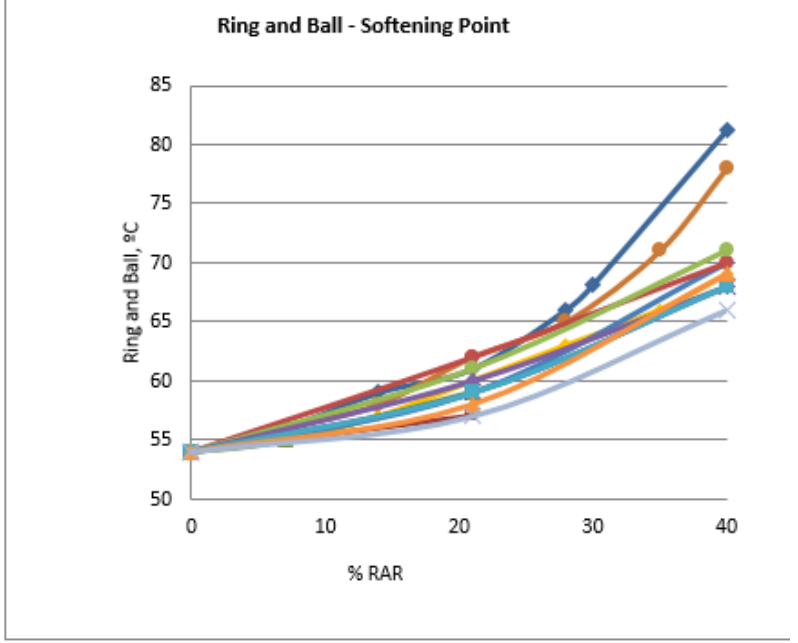


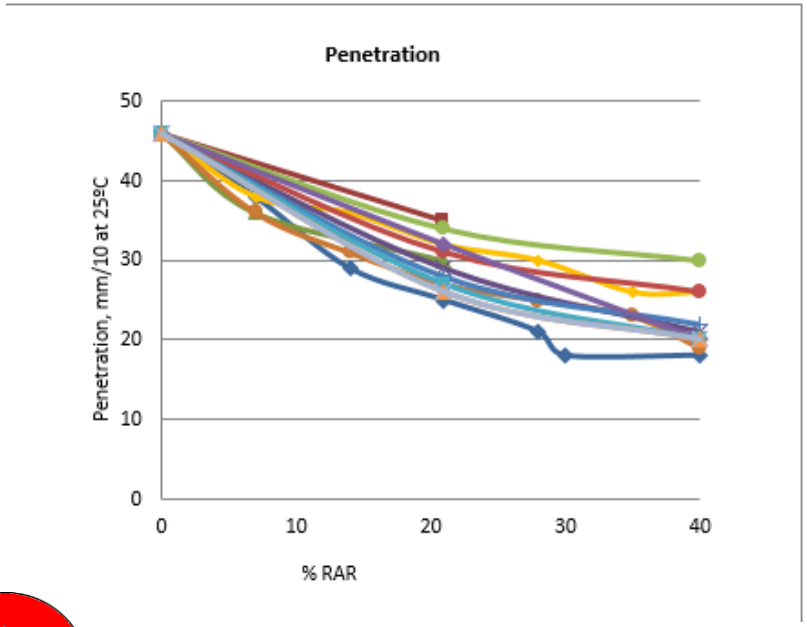
RAR CREATES AN ELASTOMERIC NETWORK IN THE BINDER

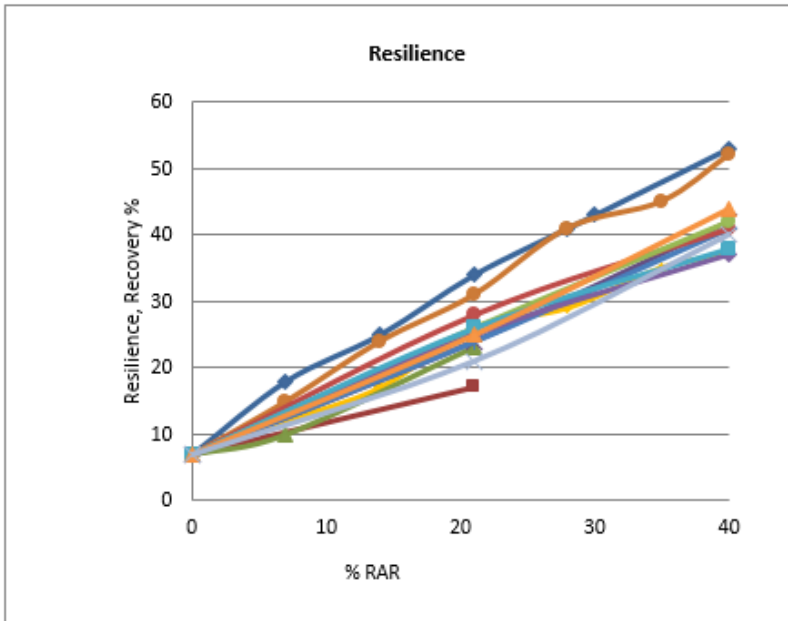
BINDER EVALUATIONS

- Traditional
- PG Graded (USA)









Hundreds of formulations have been evaluated

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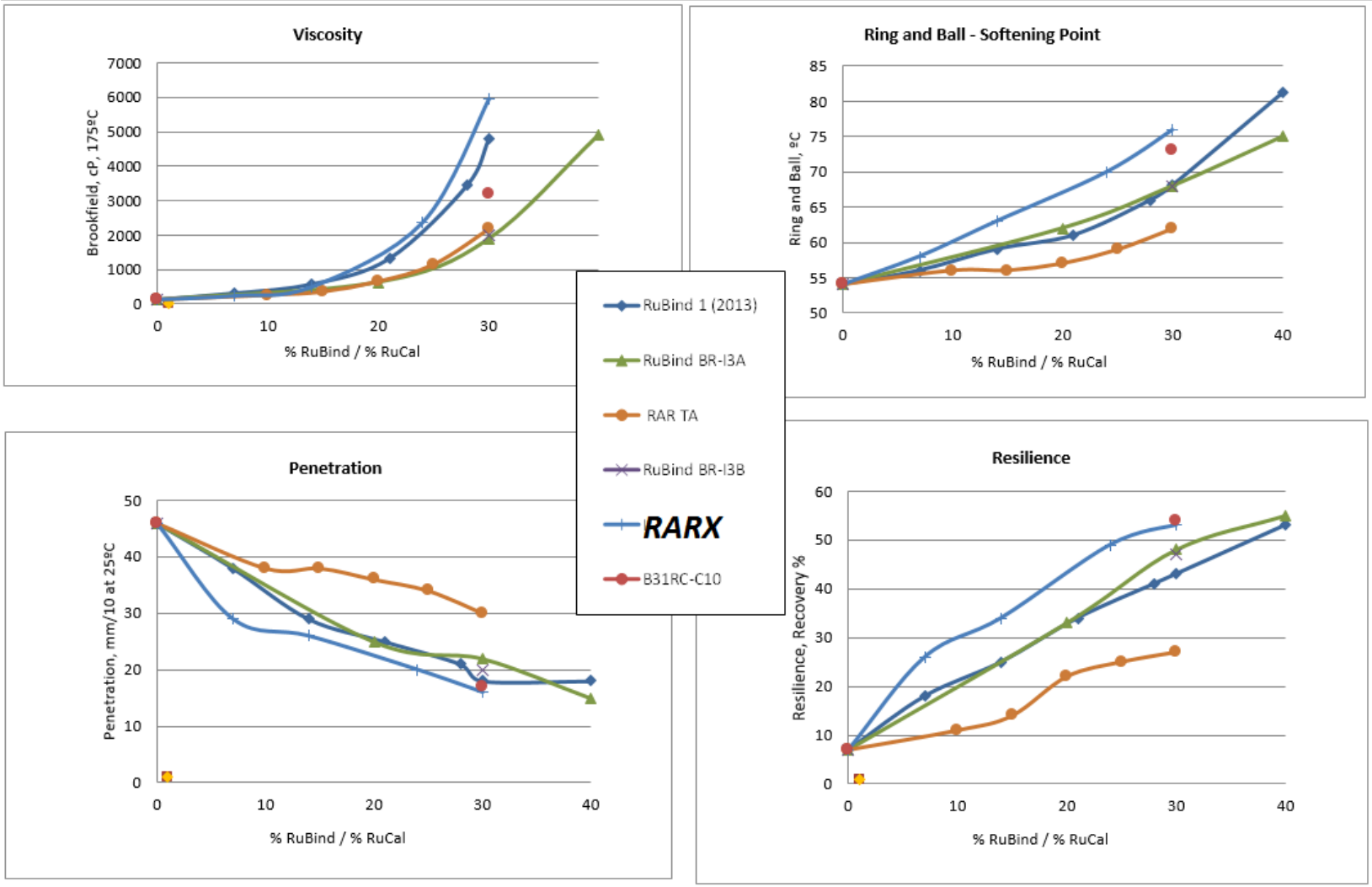
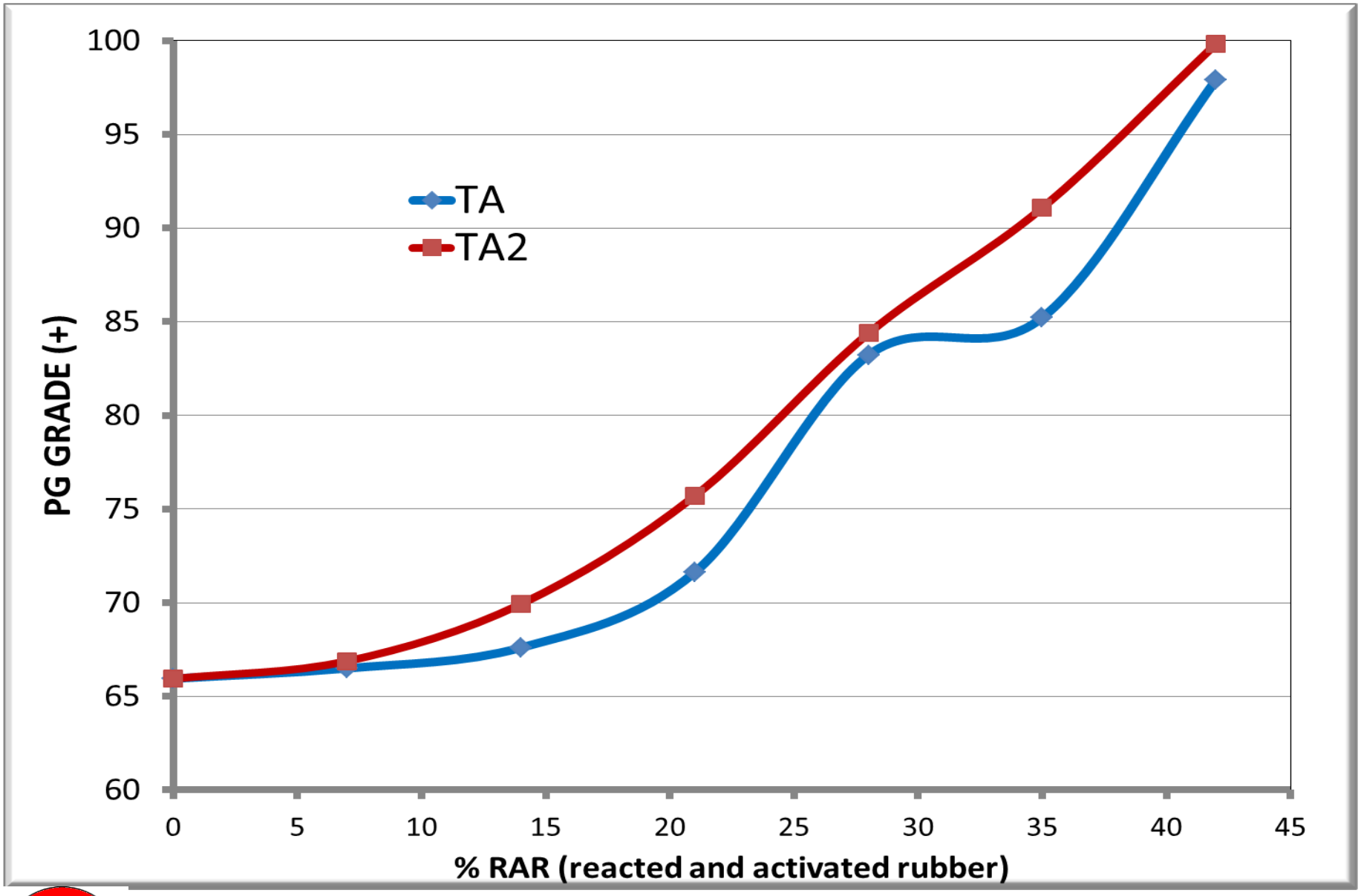
New Formulations





BINDERS IMPROVE WITH INCREASED RAR CONTENT

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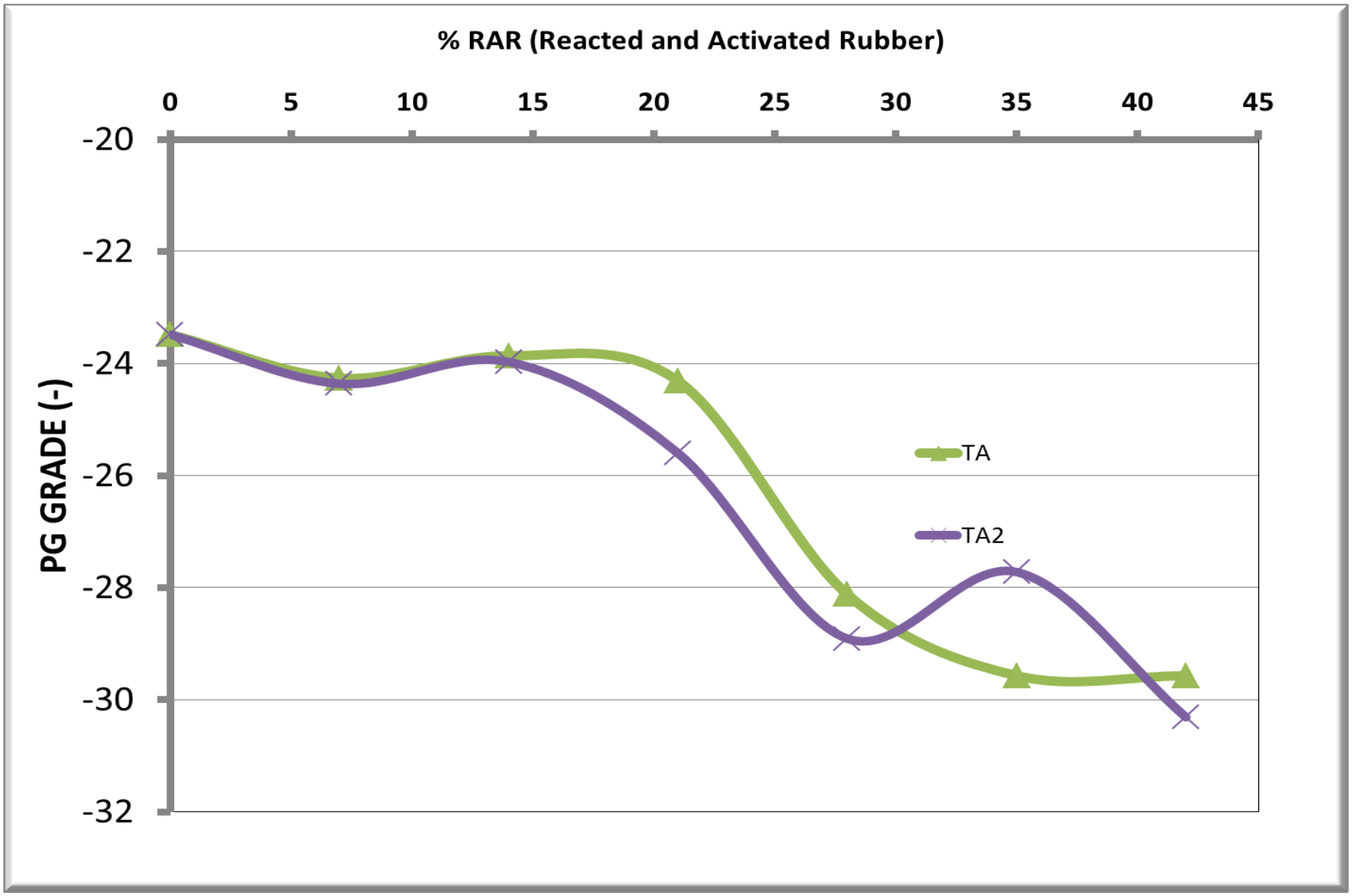

LOW TEMPERATURE PROPERTIES IMPROVE WITH INCREASE RAR CONTENT

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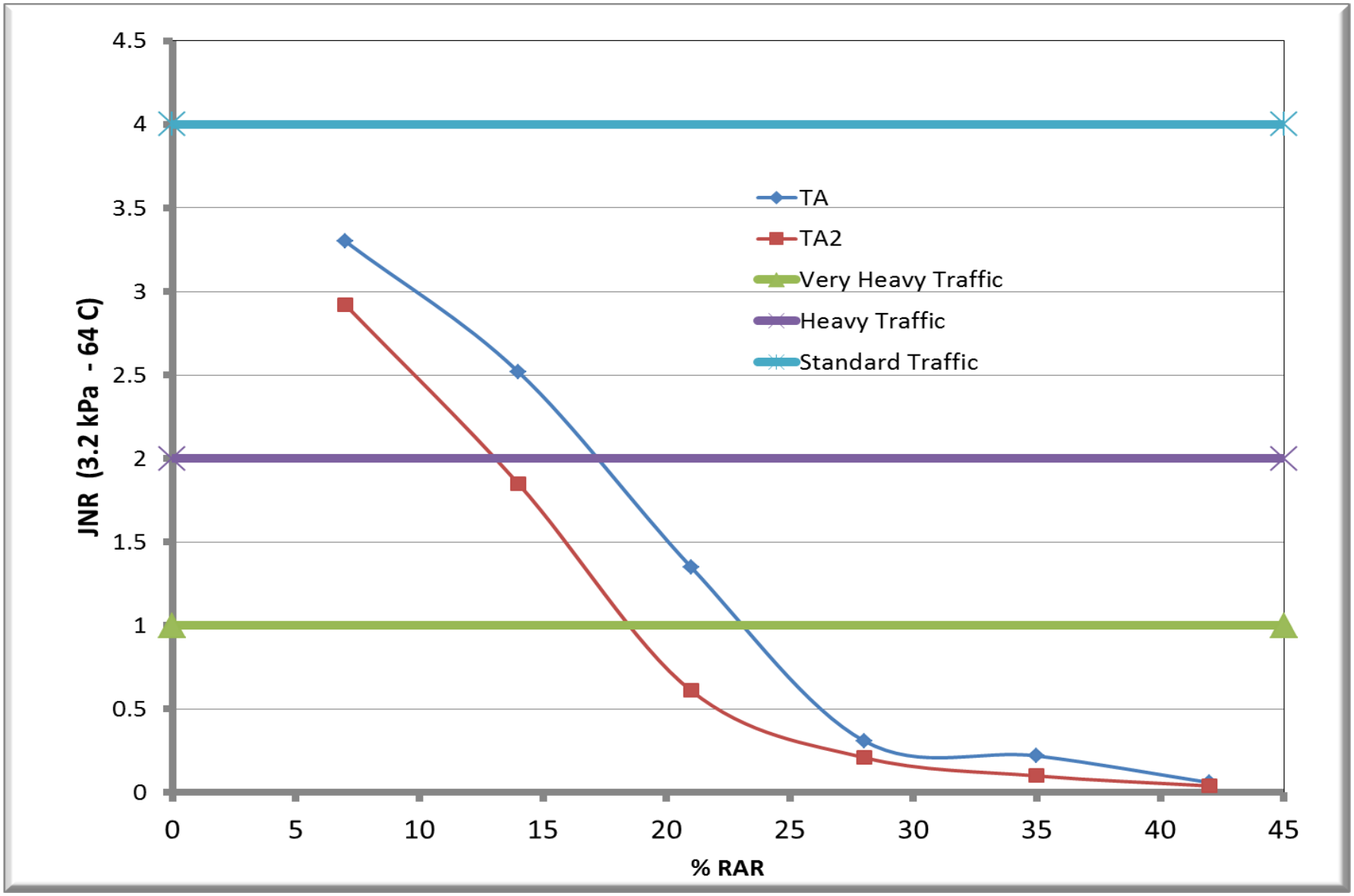
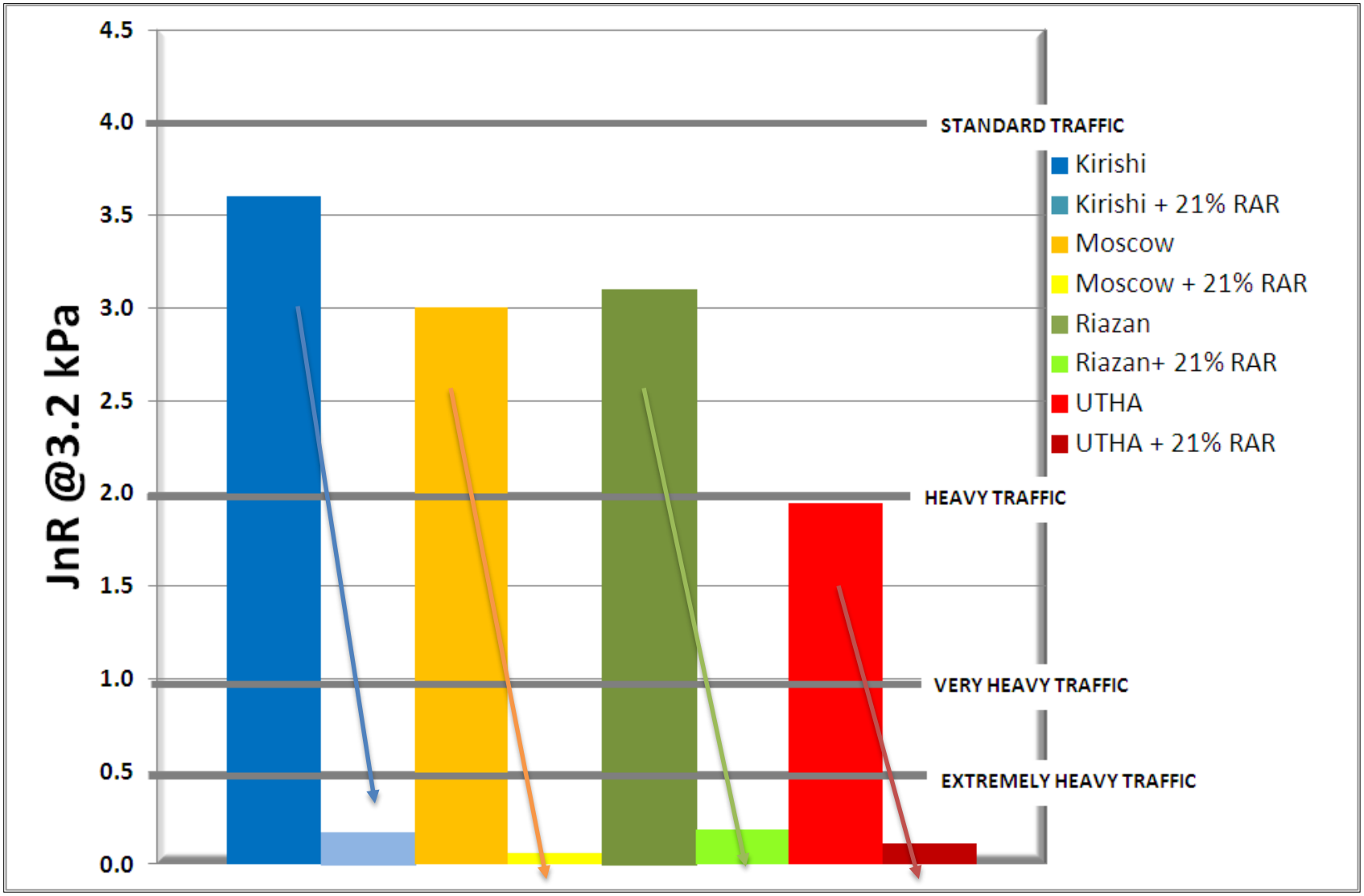
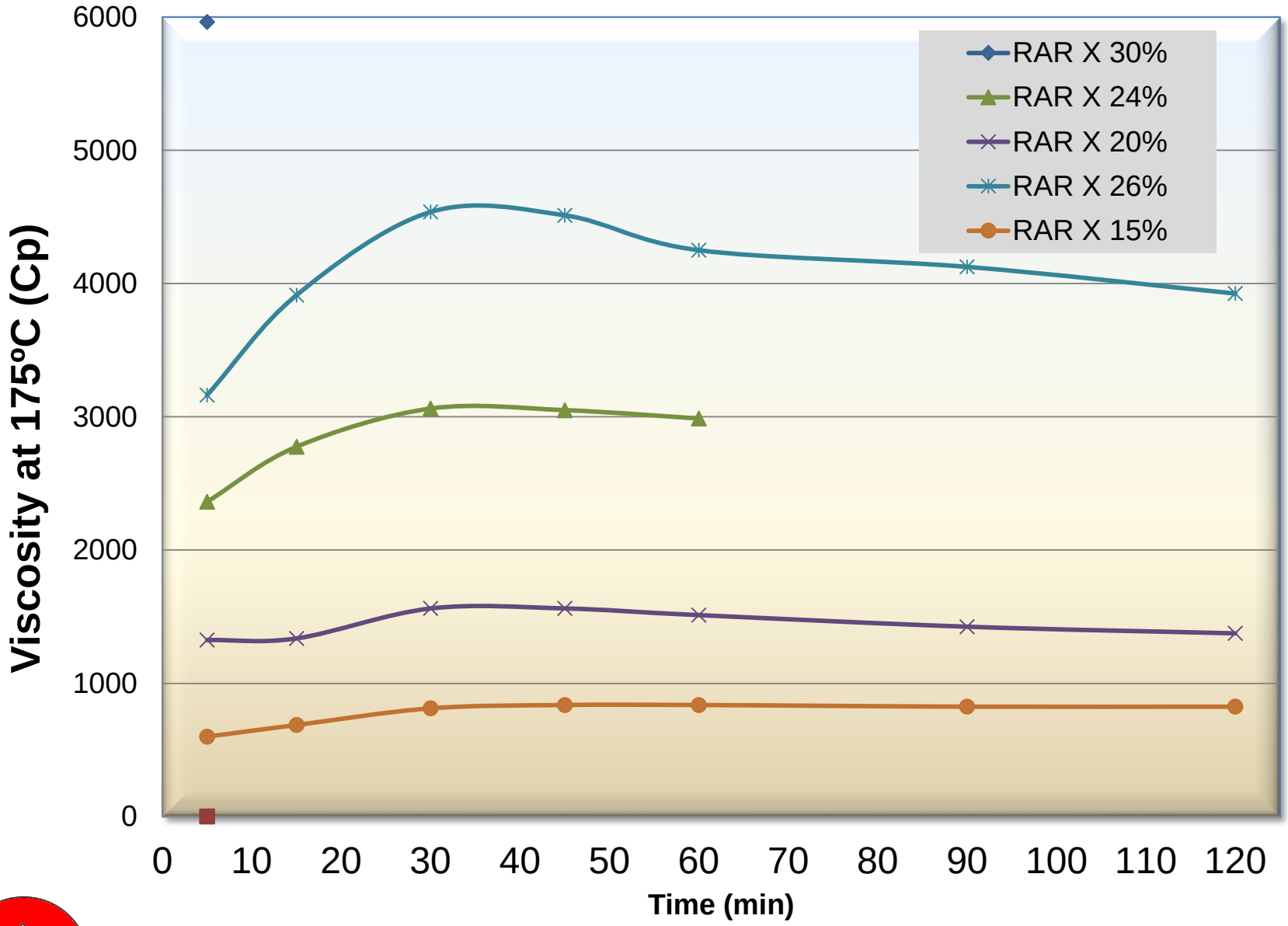


JNR VALUES SHOW IMPROVED ELASTIC RECOVERY PROPERTIES



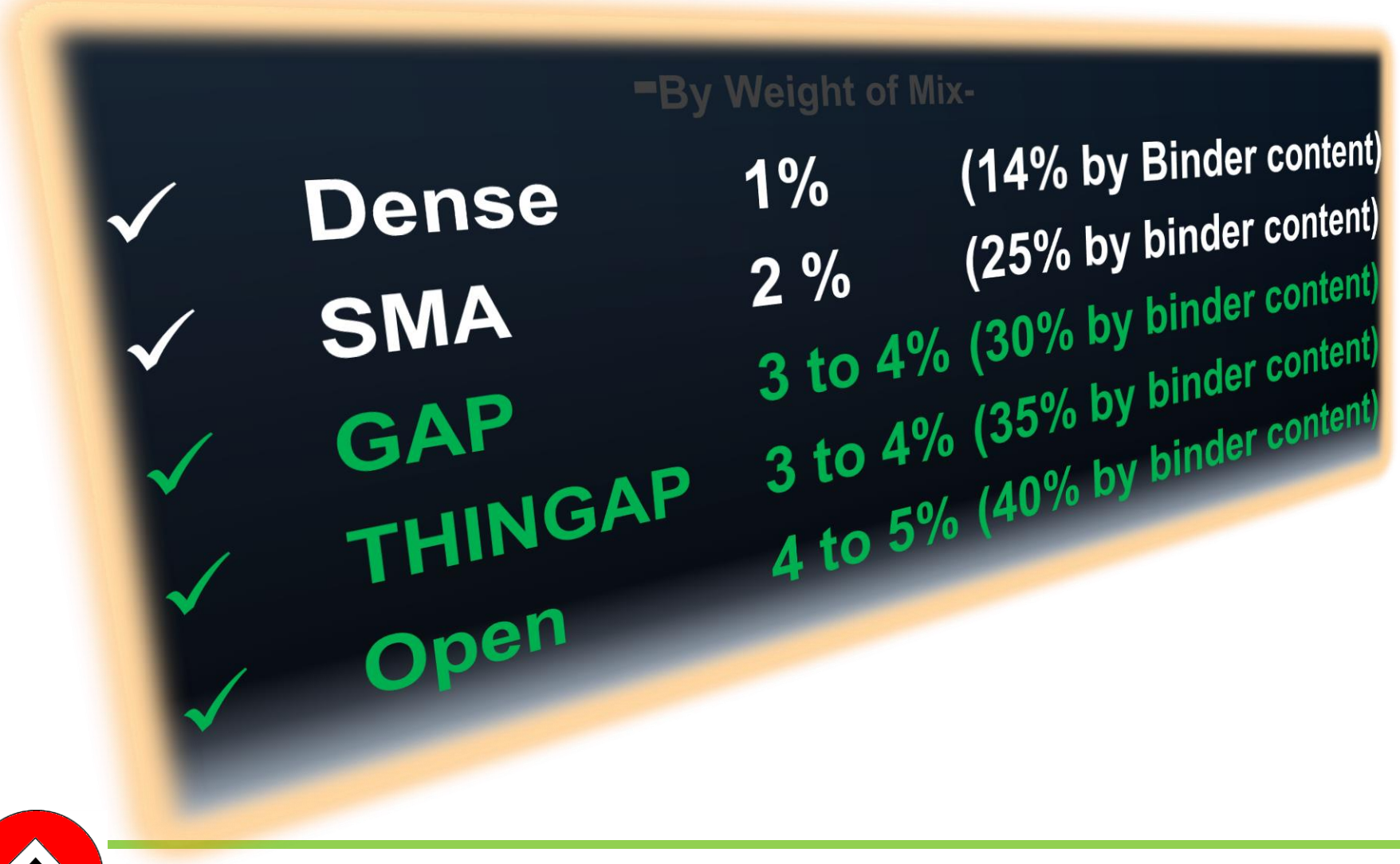
EVEN HARD TO MODIFY BITUMENS SHOW AMAZING PROPERTIES WITH 21% RAR CONTENT

Viscosity - Bitumen 35/50 + RAR X

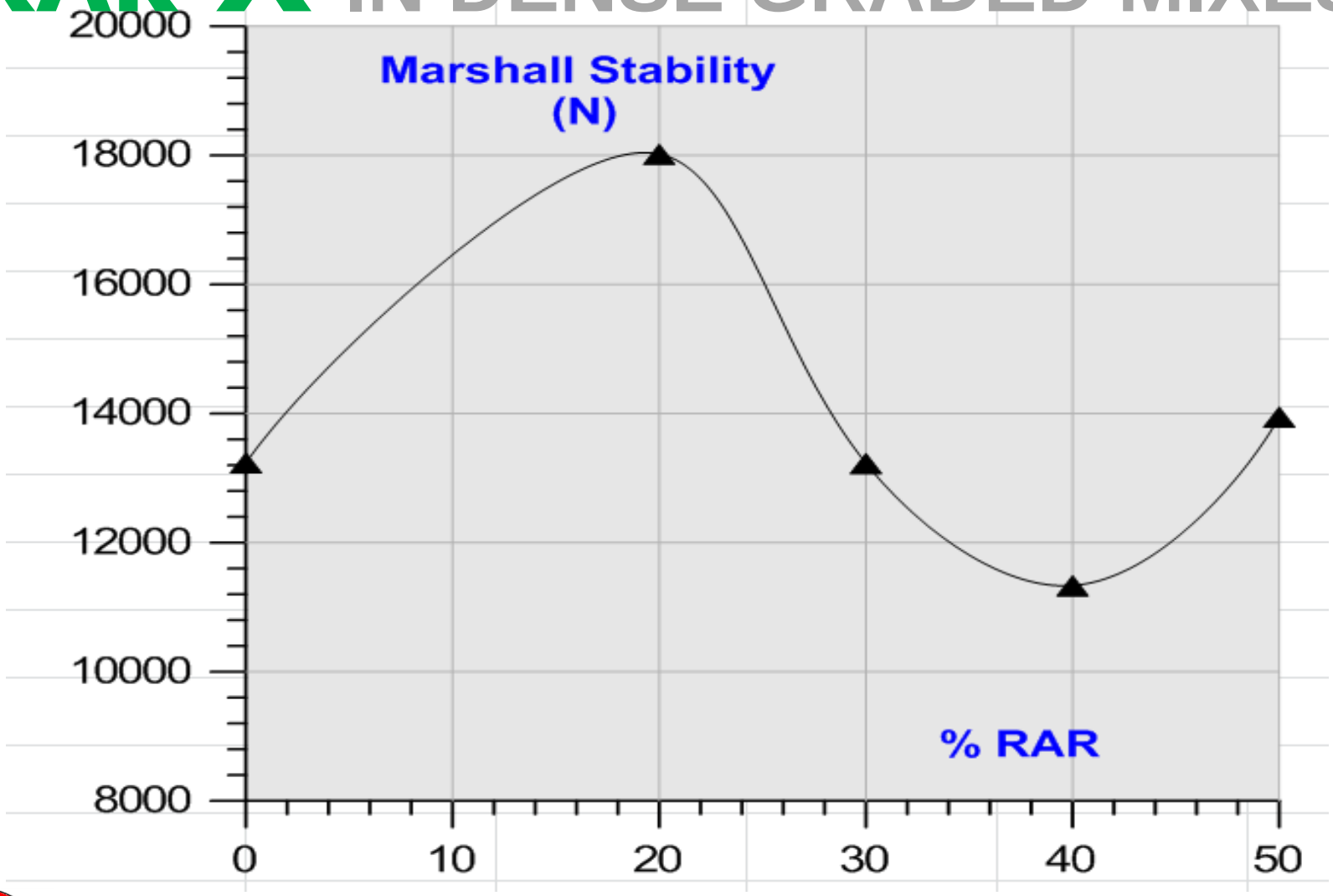


MIX EVALUATIONS

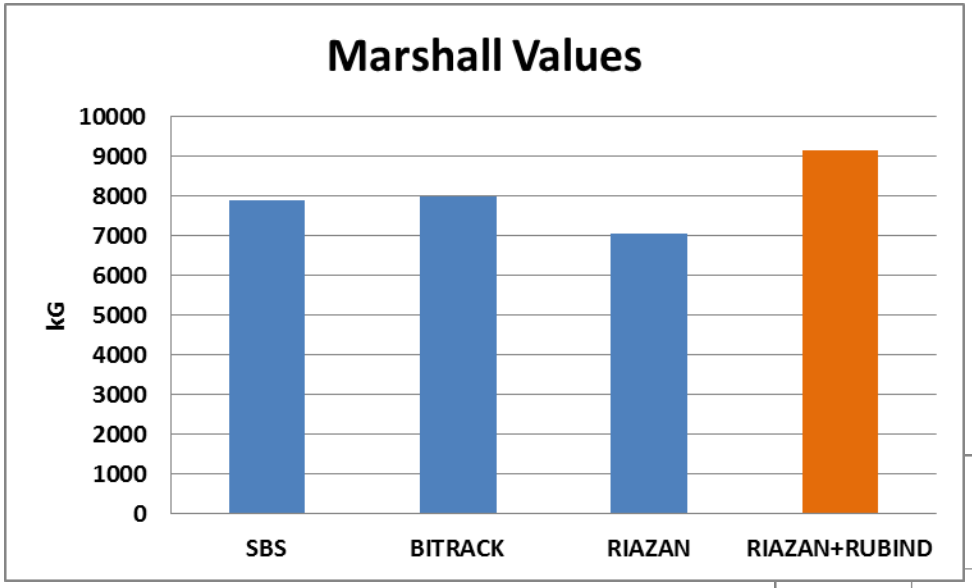
RAR X content in mixes:



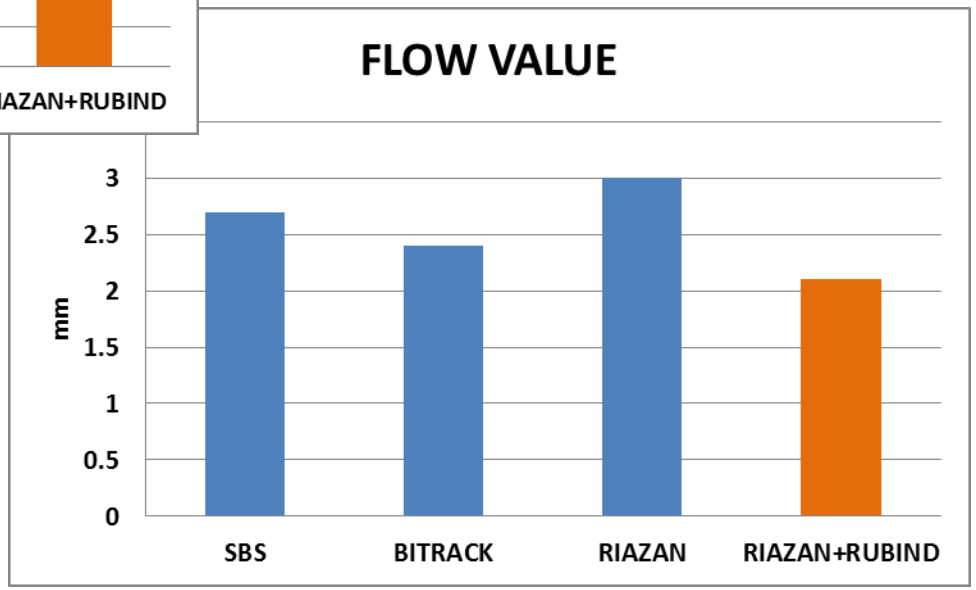
RAR X IN DENSE GRADED MIXES



RAR X in SMA

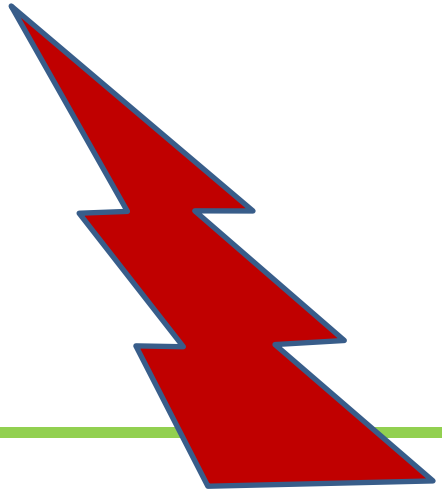


30% RARX modification



	5.9			6.4			6.6			7.5		

	Samples iB0-1TA160iB0-1-H-C						Samples IB0-0.5STA160IB0-0.5HC					
	4	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**
Air Voids	6.0	5.9	5.9	6.8	6.9	5.4	7.0	6.5	6.3	8.1	7.0	7.5
Density	**2414**						**2418**					
	ITS						**ITS**					
	ITS dry (kPa)			ITS wet (kPa)			ITS dry (kPa)			ITS wet (kPa)		
	705	712	699	554	623	739	854	796	793	576	656	550
	Average:		705	Average:		639	Average:		814	Average:		594
	TSR: 90.5						**TSR: 73.0**					



RAR X in

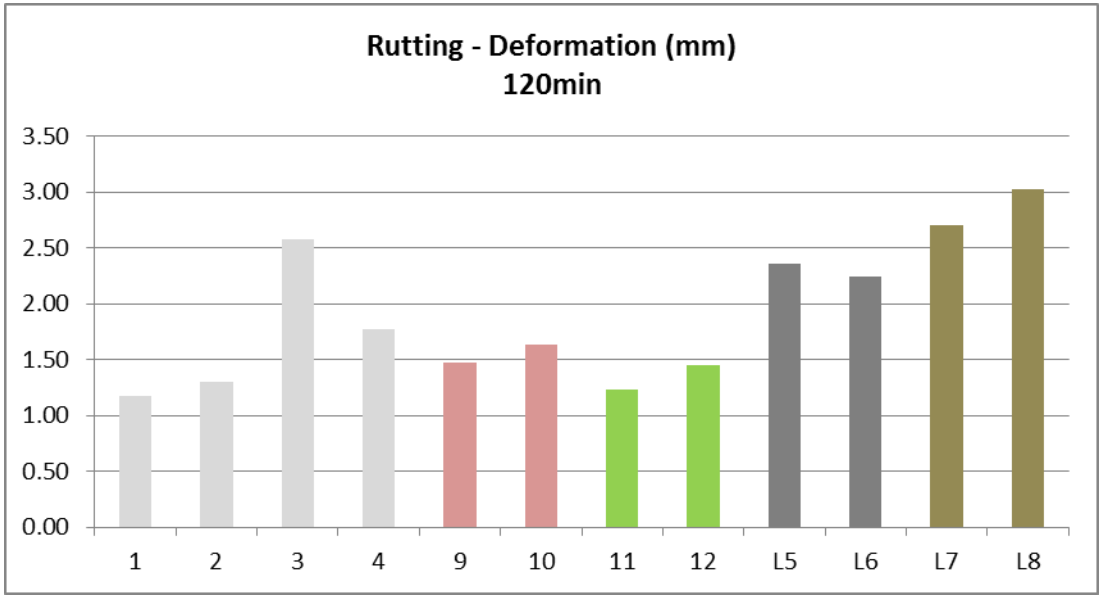
GAP and THINGAP

GRADED MIXES

(about 30 to 40% of binder content….!!!)

RUTTING

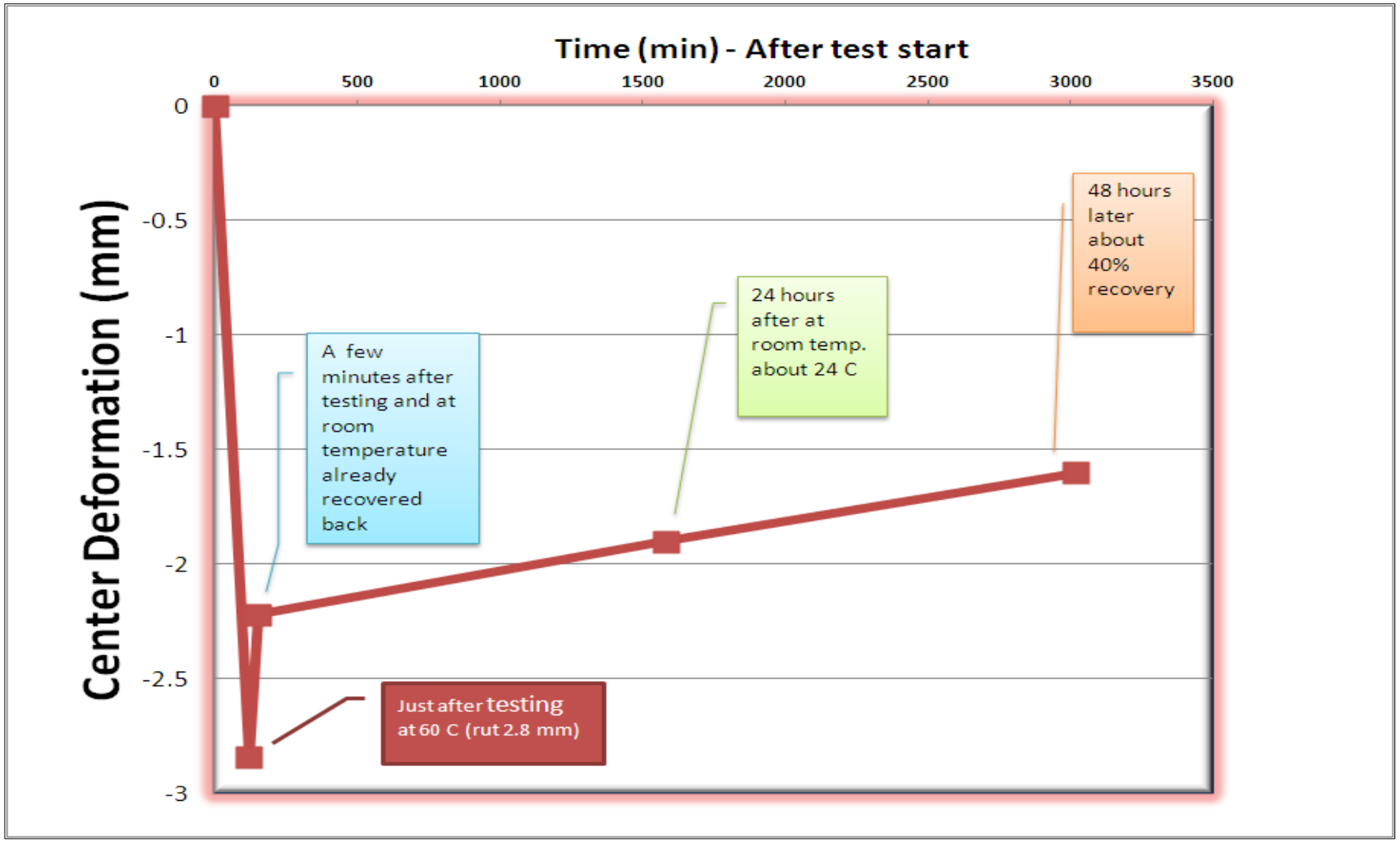
		B6.19RAR3.04				B5.45RAR3.78		B4.71RAR4.52		iBind		Fibers	
		1	2	3	4	9	10	11	12	L5	L6	L7	L8
	Air Voids	4.3	3.9	4.7	5.6	5.3	5.4	6.0	6.7	3.9	4.9	4.1	4.8
	Density Gr/cm^3	2418				2446		2452		2547		2527	
		Rutting				Rutting		Rutting		Rutting		Rutting	
	Deformation at 120 min (mm)	1.17	1.30	2.58	1.77	1.47	1.64	1.23	1.45	2.36	2.24	2.71	3.03
	AVG. Deformation at 120 min (mm)	1.24		2.18		1.56		1.34		2.30		2.87	
Average Deformation Speeds	V30/45 (10-3mm.min-1)	7.5		12.8		7.5		9.5		13.0		14.0	
	V75/90 (10-3mm.min-1)	6.0		6.5		6.2		6.0		11.2		10.5	
	V105/120 (10-3mm.min-1)	5.5		5.8		5.0		5.2		10.0		10.0	



RAR MIXES RUT LESS THEN ANY OTHER MIX EVER TESTED

Results of Laboratory Tests														
Slab			Bulk Specific Gravity (g.cm^{-3})	BMT	Porosity	AVERAGE DEFORMATION SPEEDS (10^{-3}mm.min^{-1})			Deformation (rutting) (mm)			Hours at 60ºC	% of permanent deformation	% RECOVERY
						V35/46	V75/91	V105/121	120 min	After Test	After hours at 60ºC			
1	REACTED AND ACTIVATED RUBBER	B6.19RA R3.04	2.314	2.418	4.3	7.5	6.0	5.5	1.17	4	3	37	75	25
2			2.324		3.9				1.30	3	2	37	67	33
3			2.305		4.7	12.8	6.5	5.8	2.58	5	5	24	100	0
4			2.282		5.6				1.77	5	4	24	80	20
5	Asphalt Rubber	18% Rubber	2.253	2.401	6.2	19.0	9.8	8.2	3.06	5	5	24	100	0
6			2.245		6.5				4.39	6	6	24	100	0
7	SMA -0.4% iBind	5.2% Bitumen	2.362	2.534	6.8	17.0	14.0	11.3	3.07					
8			2.350		7.2				2.12					
9	SMA - 0.4% Fibers	6.4% Bitumen	2.346	2.525	7.1	10.0	7.5	6.8	3.46					
10			2.359		6.6				2.72					

MIXES WITH HIGH RAR PERCENTAGE SHOW RECOVERY AFTER DEFORMATION



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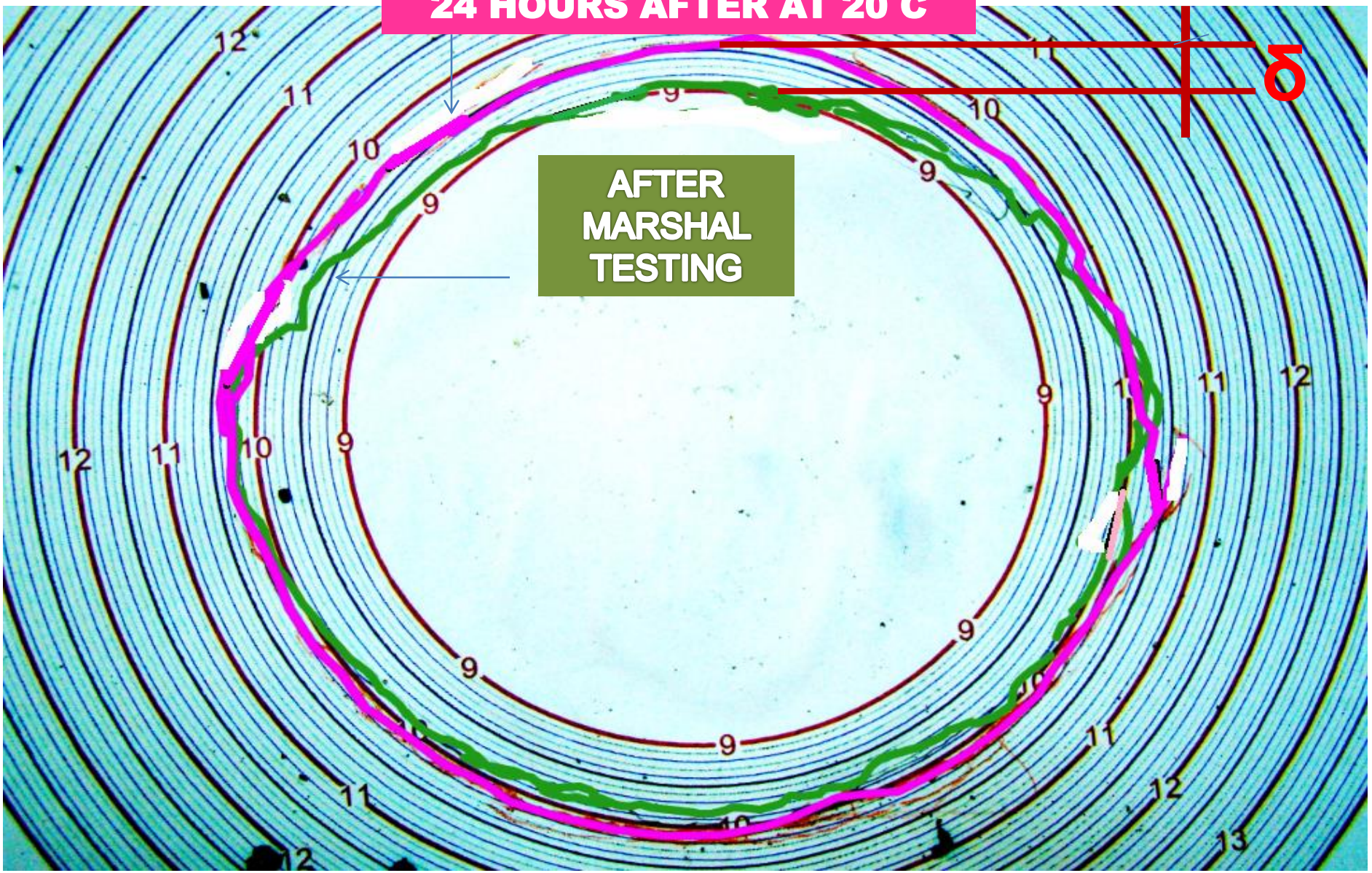
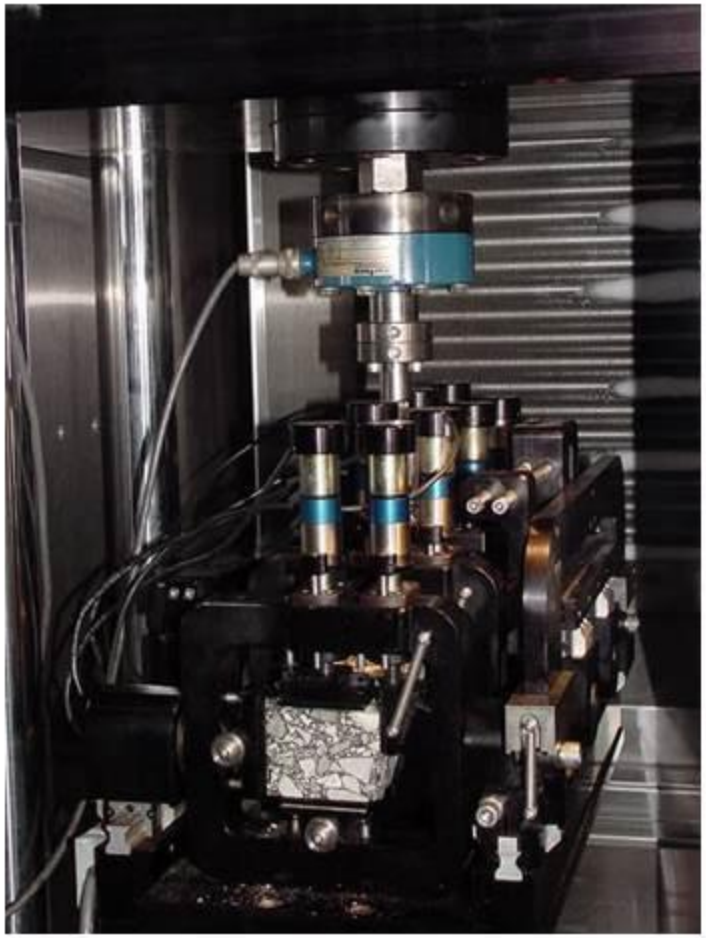
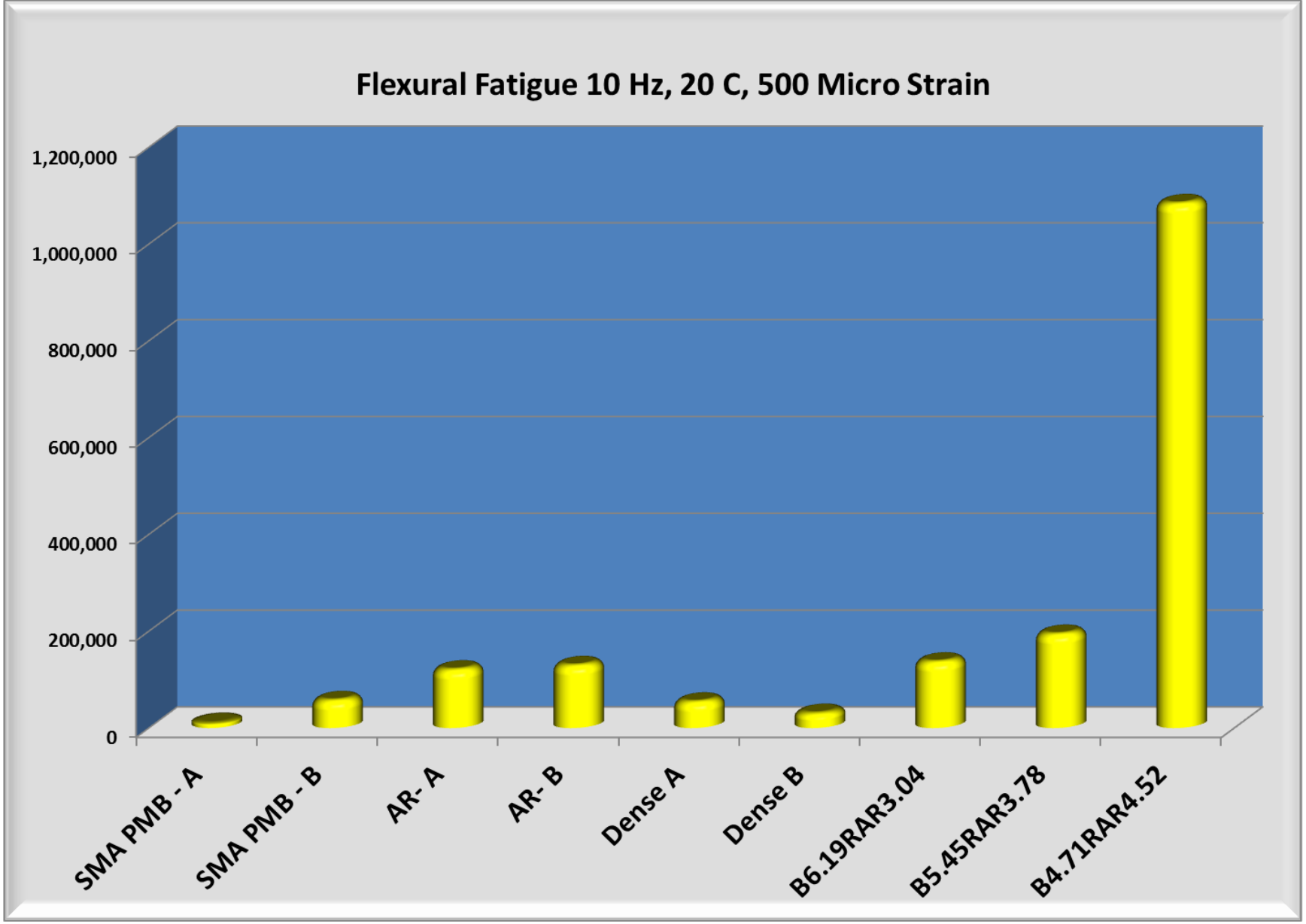


MIXES WITH HIGH RAR PERCENTAGE SHOW RECOVERY AFTER DEFORMATION

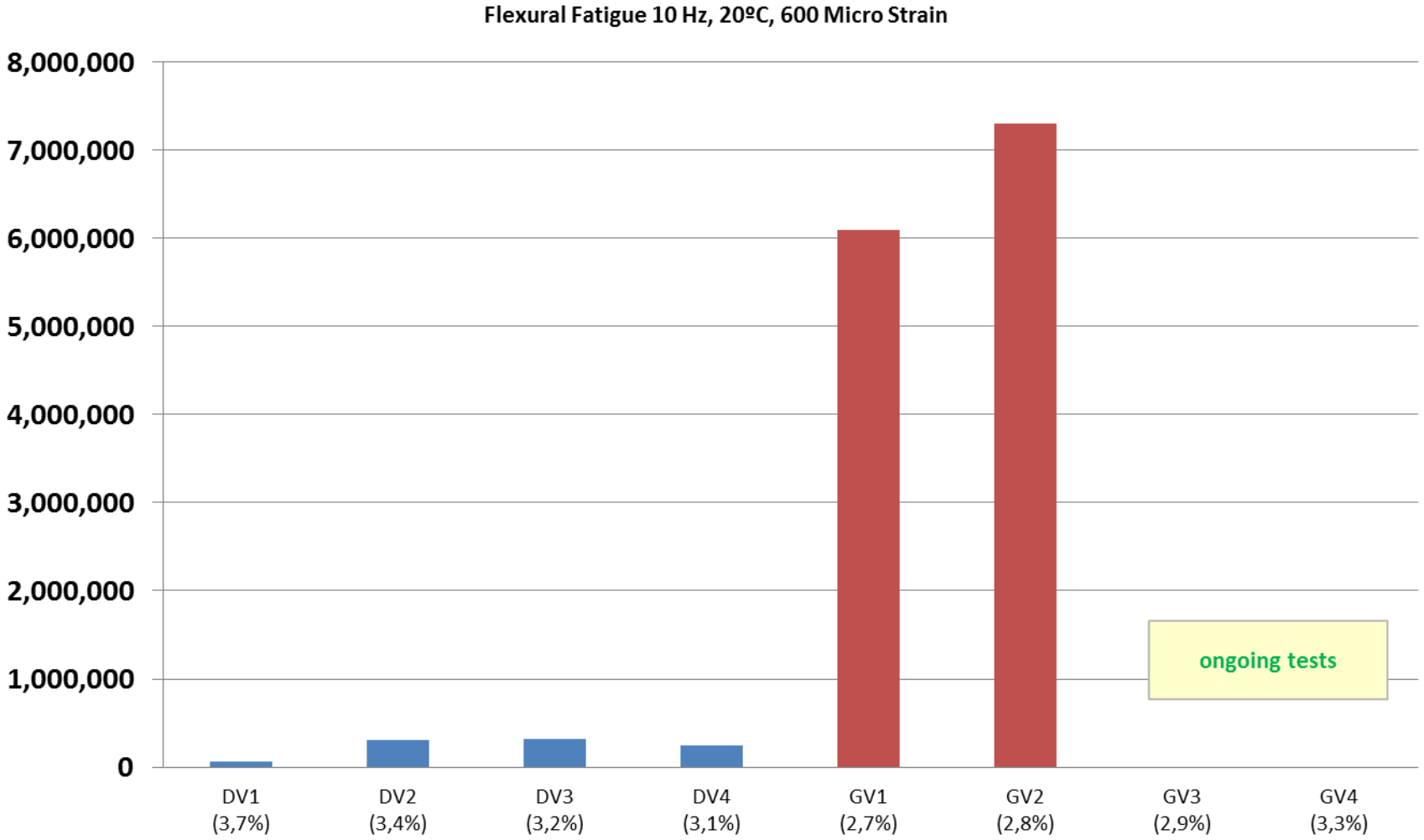
FATIGUE





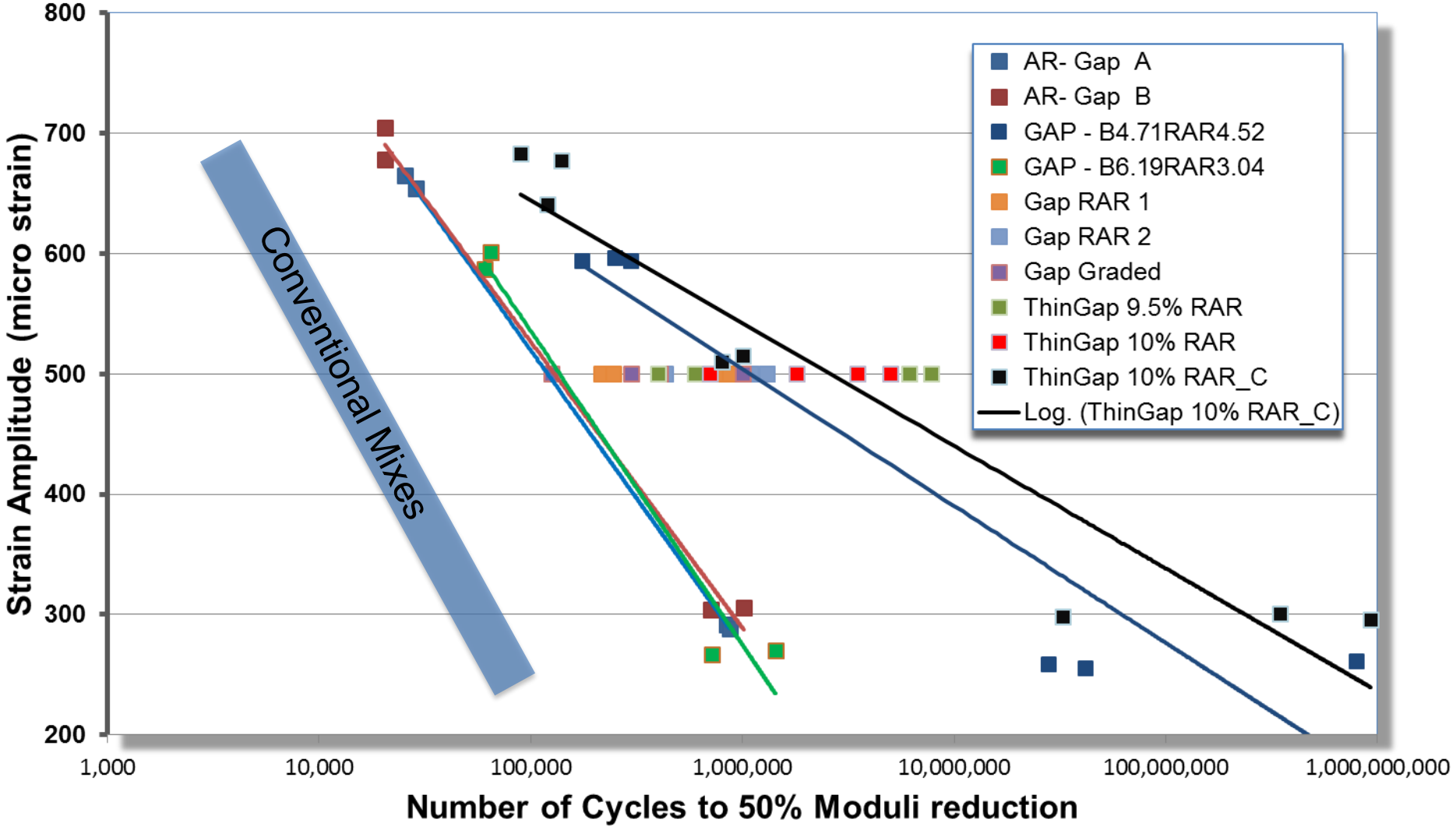
RAR MIXES HAVE BETTER FATIGUE LIFE THEN ANY OTHER MIX EVER TESTED

Russian Bitumen



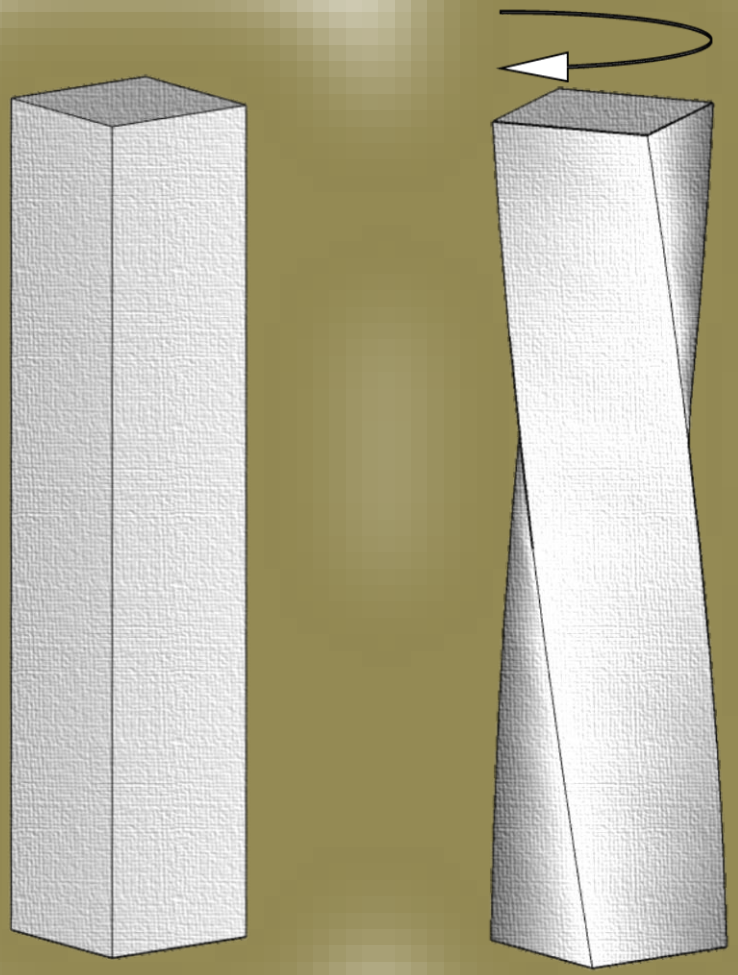
RAR MIXES HAVE BETTER FATIGUE LIFE THEN ANY OTHER MIX EVER TESTED

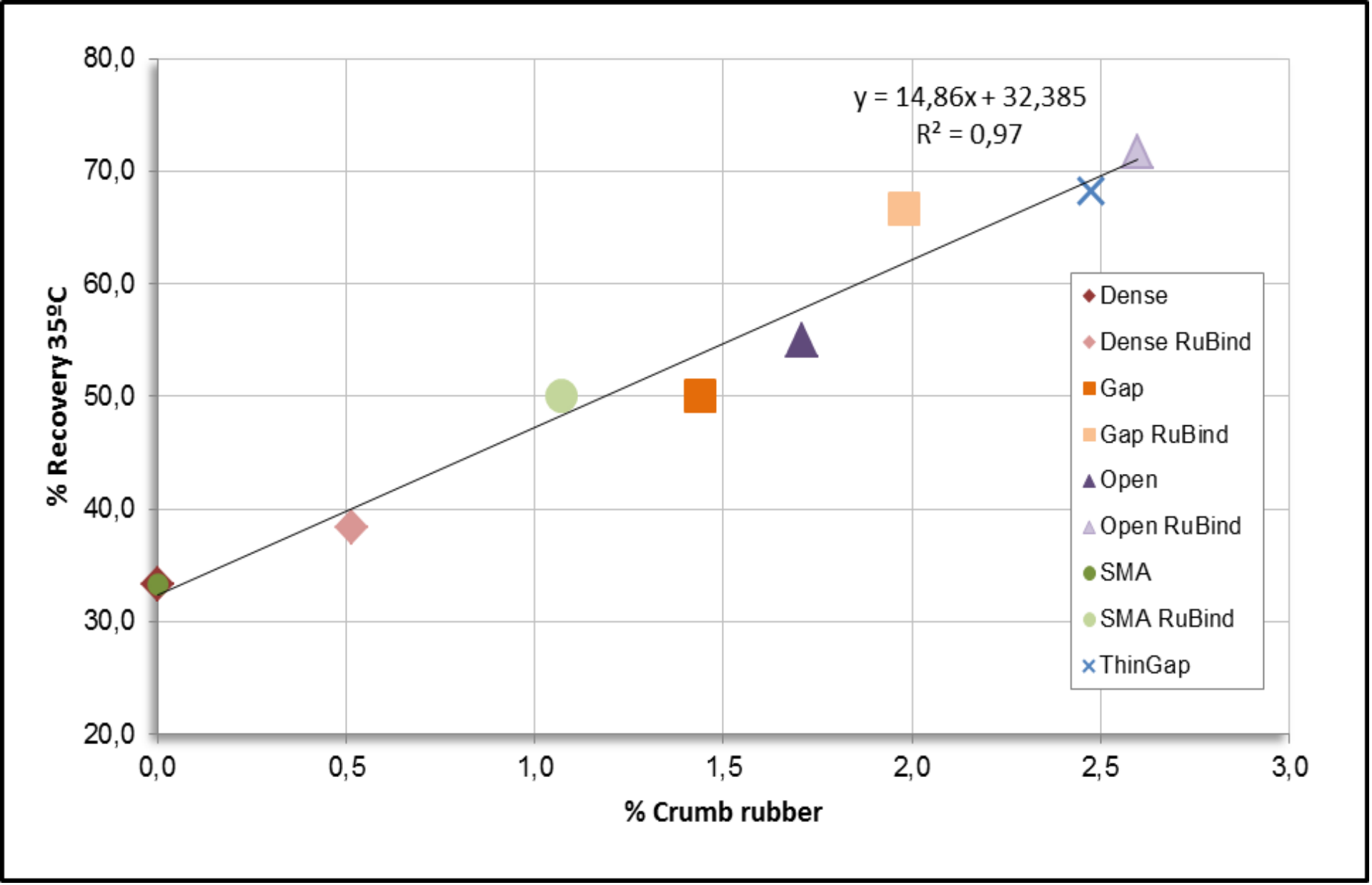
Flexural Fatigue Life (20 C, 10Hz)

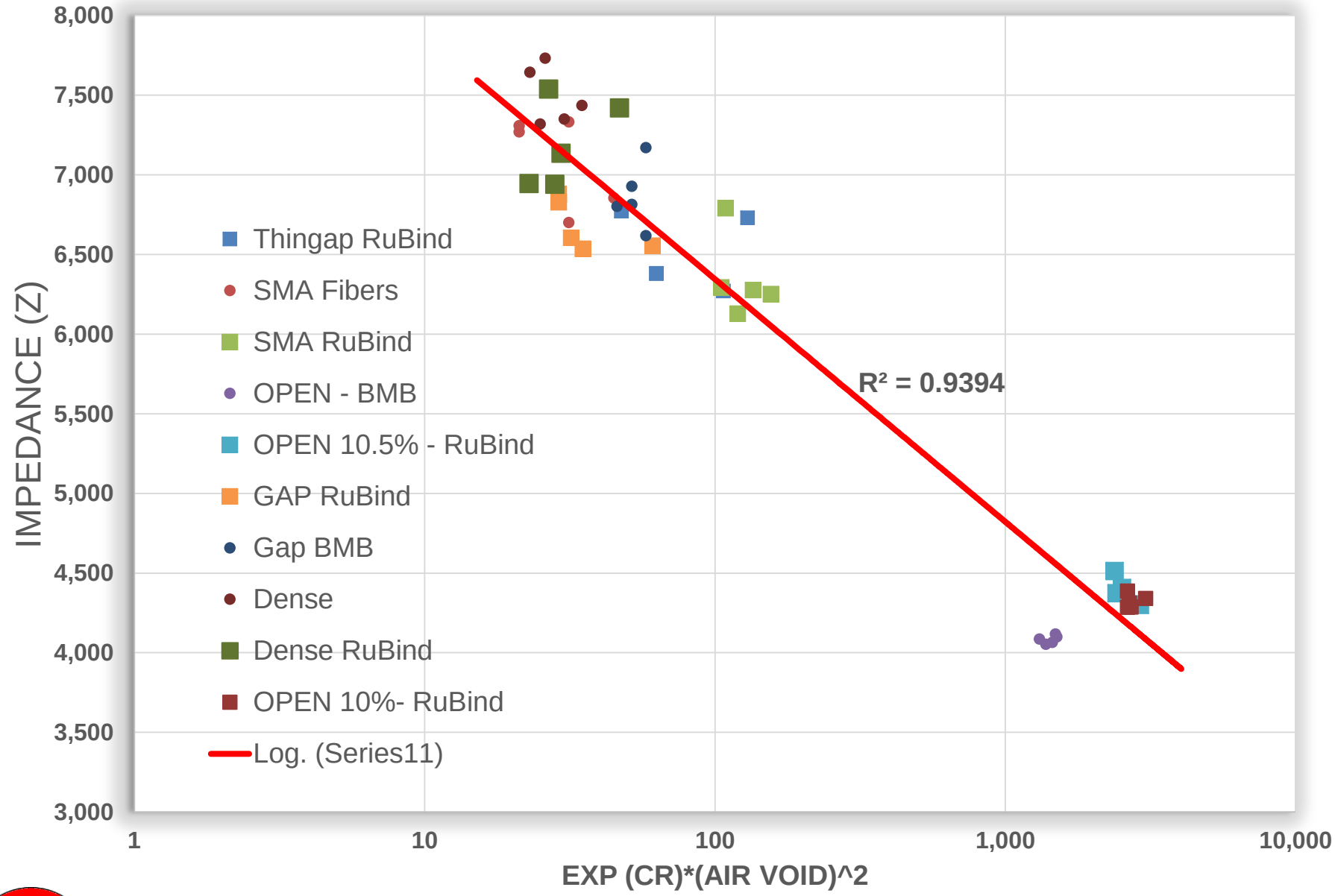


THINGAP with RARX has incredible fatigue life !!!!

Torsional Device (30 Degrees)




y = 14,86x + 32,385
R² = 0,97
% Recovery 35ºC
% Crumb rubber
80,0
70,0
60,0
50,0
40,0
30,0
20,0
0,0
0,5
1,0
1,5
2,0
2,5
3,0
Dense
Dense RuBind
Gap
Gap RuBind
Open
Open RuBind
SMA
SMA RuBind
ThinGap


8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
IMPEDANCE (Z)
1
10
100
1,000
10,000
EXP (CR)*(AIR VOID)^2
Thingap RuBind
SMA Fibers
SMA RuBind
OPEN - BMB
OPEN 10.5% - RuBind
GAP RuBind
Gap BMB
Dense
Dense RuBind
OPEN 10%- RuBind
Log. (Series11)
R² = 0.9394

18 Demonstration Projects with RAR

- 2 in Russia (1 Dense and 1 Gap)
- 7 in Italy (3 Dense, 2 SMA, 2 Gap)
- 3 in Israel (1 SMA, 2 dense mix)
- 2 in France (2 SMA)
- 1 in Bulgaria (SMA)
- 3 in Sweden (3 THINGAP)

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COMO, Italy, DEC 2014 (gap graded)

COMO, ITALY, Dec, 2014

FRANCE

FRANCE

FRANCE

FRANCE (dense graded 1.5% weight of mix)

Advantages of RAR X

(With GAP or THINGAP graded gradations)

- ✓ MORE RUT RESISTANT THEN ANY SMA MIX
- ✓ MORE FATIGUE LIFE THEN ANY ASPHALT RUBBER MIX.
- ✓ IMPROVES NOISE REDUCTION

Advantages of RAR X

- ✓ Easy storage and Easy transport.
- ✓ No need for AR blenders or SBS blenders
- ✓ Improve on asphalt and mix properties.
- ✓ Less energy spent in the production of Asphalt Rubber.
- ✓ No more Re-heat cycles on the job site.
- ✓ Can make new improved mixes with even more crumb rubber. Great fatigue and rutting resistance, great recovery, self healing.
- ✓ At other lower percentages can reach just about any PG grade (*positive side as negative side controlled by the base crude*).
- ✓ COST EFFECTIVE!!!

RAR X

- A product that can REPLACE and improve bitumen with great economical and environmental advantages

- Profitable business producing RAR X and selling it at 5% below normal bitumen prices

THANK YOU

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Enhanced Elastomeric Asphalt Extender

THANK YOU

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