

# Wet grip in worn state tyre

## Worn tyre wet test precision improvement test plan proposal

IWG WGWT  
13 September 2022



**JAPAN AUTOMOBILE STANDARDS INTERNATIONALIZATION CENTER**

# 1. Worn tyre wet test precision improvement test plan

## (1) Issues from '21 test campaign

- Test was planned to detect the tyre performance difference, therefore candidate tyres were various but small number to across the test centers.
  - Multiple regression analysis was not processed well because of small number of each candidate tyre.
  - Analytical test data were added on the correlation analysis to increase the number of test data. (Analytical test data were 38% of all the data for regression analysis.)
- Test water depth factor which has high influence on the wet performance was not take into account to the formula.
- Test temperature range at 2021 test campaign were rather narrow. (most of the test were done at 15 - 25°C)

Wet  $\mu$  temperature compensation shows certain variation.

Coefficients ( Temp. items ) by SRTT<sup>worn</sup> reference

	b	c	$\Delta t$ (ref. surface temp - temp. at test)						
			5	10	15	20	25	30	35
Normal	-0.00124	0.00041	/	/	0.02	<b>0.00</b>	0.00	0.03	<b>0.07</b>
M+S	-0.00032	-0.0002	-0.02	0.00	<b>0.00</b>	-0.01	-0.02	-0.05	<b>-0.09</b>
3PMSF	0.00061	-0.0008	-0.02	<b>0.00</b>	-0.02	-0.07	/	/	/

Coefficients ( Temp. items ) by SRTT<sup>new</sup> reference

	b	c	$\Delta t$ (ref. surface temp - temp. at test)						
			5	10	15	20	25	30	35
Normal	0.00251	-0.00028	/	/	-0.02	<b>0.00</b>	0.01	0.00	<b>-0.03</b>
M+S	-0.00025	0.00004	0.01	0.00	<b>0.00</b>	0.00	0.00	0.01	<b>0.01</b>
3PMSF	0.00115	-0.00005	-0.01	<b>0.00</b>	0.00	0.01	/	/	/

SRTT<sup>worn</sup> reference has higher variation than SRTT<sup>new</sup>.

## (2) For test precision improvement

➤ G(T<sub>n</sub>) formula re-evaluation.

Required sample size for multiple regression analysis;

■ General conditions;

- Probability level (  $\alpha$  ) : 0.05
- Desired statistical power level (  $1-\beta$  ) : 0.8

■ Conditions from test campaign;

- Anticipated effect size R<sup>2</sup> : 0.6 ( From 2021 test campaign result )
- Number of predictors (a,b,c,d + water depth) : 5

$$G(T_n) = K_{\text{trailer}} \cdot \left\{ \overline{\mu_{\text{peak}}}(T_n) - \left[ a \cdot \underline{\Delta\mu_{\text{peak}}(R)} + b \cdot \underline{\Delta\theta} + c \cdot (\underline{\Delta\theta})^2 + d \cdot \underline{\Delta\text{MTD}} \right] \right\}$$

· plus Water depth

Minimum required sample size : **n = 28** for each candidate tyres.

Proposal :

- Sufficient sample size test campaign for multiple regression analysis  
n=28 for each candidate tyres.
- Add test water depth factor which has influence on wet  $\mu$ .

### ■ Test plan proposal

- Required test tyres **n: 28** for each candidate tyres.
- The same candidate tyre set shall be tested at all the test centers.
- One of [track surface (Test center)], [Water depth (0.5/1.0/1.5mm)], [Test temp. (3 levels, include close to upper limit) ] condition shall be evaluated as variables.
- Normal, 3PMSF 2category x 4 sizes each; Total **8** candidates, add SRTTnew also in the test sequence.

Test sequence			Test conditions
Normal	Day 1	Molded SRTTw–SRTTn - Candidate 1–Candidate 2–Molded SRTTw –Candidate 3–Candidate 4 –Molded SRTTw	Track surface or water depth or Test Temp.
	Day 2	ditto	
	Day 3	ditto	
3PMSF	Day 4	Molded SRTTw–SRTTn - Candidate 5–Candidate 6–Molded SRTTw –Candidate 7–Candidate 8 –Molded SRTTw	Track surface or water depth or Test Temp.
	Day 5	ditto	
	Day 6	ditto	

### ■ Test centers ( for Trailer test )

Test center	Variables	N of Test center	TTL
A, B, C, D	Water depth	4	9
E, F, G, H, J	Track surface or Test temp.	5	

Request for participation to other test centers.

Test center		Test conditions			
		Test track		Water depth	Test Temp.
Water depth control capability				0.5/ (1.0)/ 1.5 mm	Temp. (Low/Mid/High*: 3 levels )
A	Y	✓	+	✓	
B	Y	✓		✓	
C	Y	✓		✓	
D	Y	✓		✓	
E		✓			✓
F		✓			✓
G		✓			✓
H		✓			✓
J		✓			✓
				12	15

\* Include max. temperature allowance for wet test ( as close as upper limit. [ref. Appendix ])

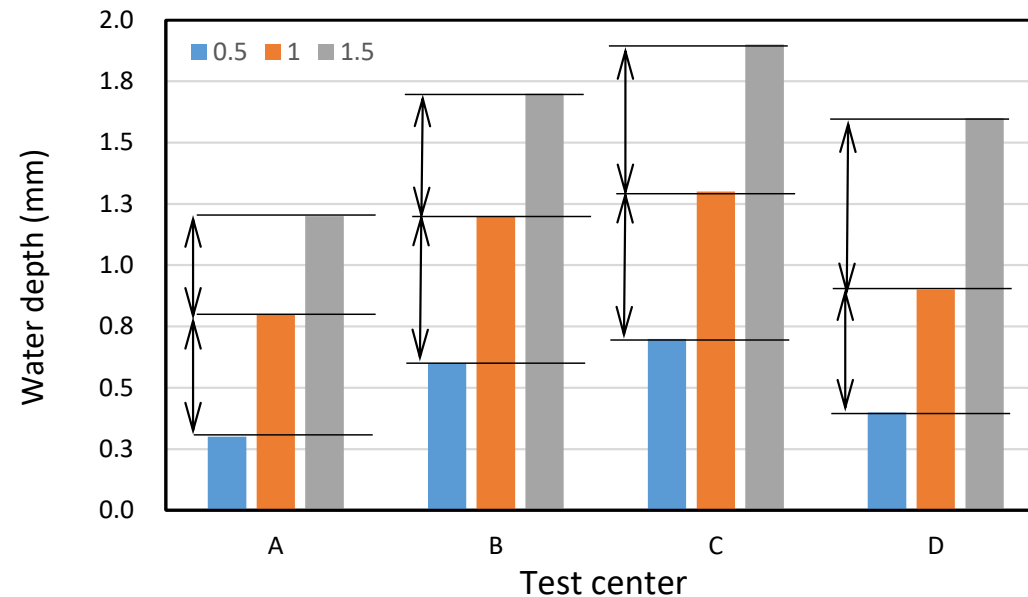
One test still missing to fill Sample size.

- There is no precise water depth measuring method.
- Water depth measured value might be variable by test centers, however relative values have constant gap, these data are worth to use for analysis



We would like to have wet  $\mu$  data on the different test water depth at various test centers

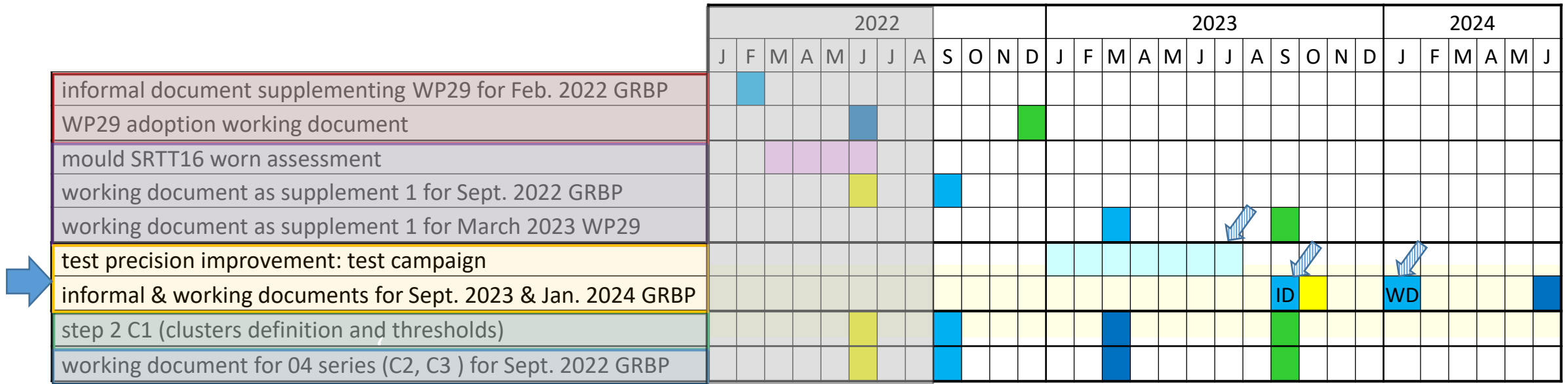
(Example)



# 3. IWG WGWT timeline



ref. Status report to 76<sup>th</sup> GRBP (September 2022)



- New 03 series: C1 tyres in worn state
- C1 tyres in worn state – second step (clusters)
- 04 series: C2-C3 tyres in worn state
- Update: moulded SRTT16 worn
- Update: test precision improvement

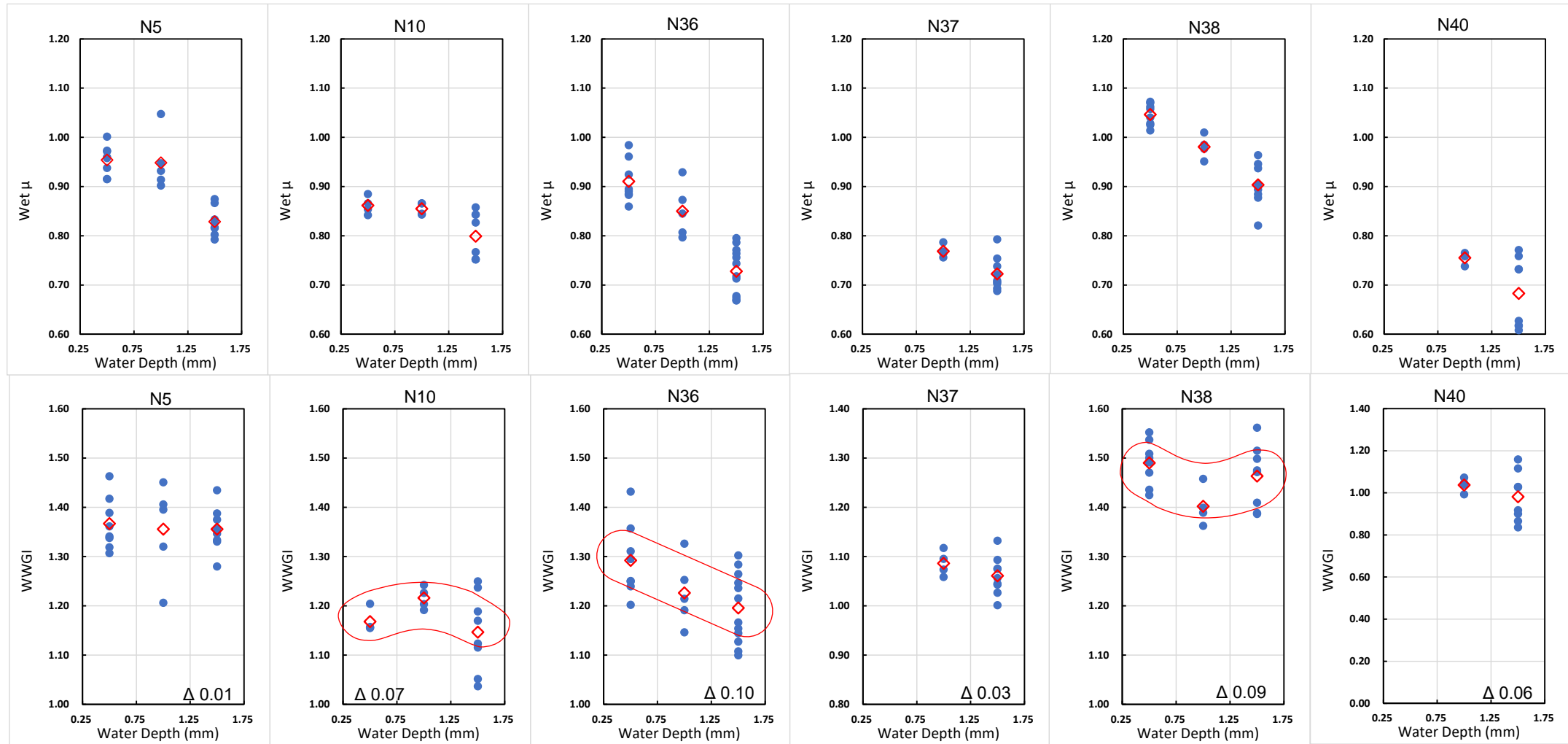


- document submission timeline
- document adoption timeline GRBP
- document adoption timeline WP29
- entry into force
- moulded SRTT16 worn assessment
- additional test campaign (test precision)

- Complete test campaign by July. 2023.
- Informal document adoption in September. 2023.
- Working document adoption in October. 2023.

# APPENDIX





The influence of water depth is not compensated enough for N10, N36, N38