Wet grip in worn state tyre

Worn tyre wet test precision improvement test plan proposal ver.2

46th IWG WGWT

13th October 2022

(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℃)

  Wet μ temperature compensation shows certain variation.

Coefficients (Temp. items) by SRTTworn reference

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

Coefficients (Temp. items) by SRTTnew reference

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

SRTTworn reference has higher variation than SRTTnew.

(2) For test precision improvement

➢ G(Tn) formula re-evaluation.
Required sample numbers for multiple regression analysis;
■ General conditions;
  - Probability level (α)   : 0.05
  - Desired statistical power level ($1-\beta$)   : 0.8

■ Conditions from test campaign;
  - Anticipated effect size R2   : 0.6   (From 2021 test campaign result)
  - Number of predictors (a,b,c,d + water depth) : 5

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

· plus Water depth

Minimum required sample numbers per each candidate tyres : **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 μ.

Test plan proposal

- Required minimum test sample data : **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.
Normal	Day 2	ditto	
Normal	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.
3PMSF	Day 5	ditto	
3PMSF	Day 6	ditto	

Test centers (for Trailer test)

Test center	Variables	N of Test center	TTL
CATARC, GY, JASIC-1、2*[1]	Water depth	4	10
TuV, RDW*[2],~~UTAC~~, BS, HK, Michelin, Pirelli	Track surface or Test temp.	6	

With RDW participation, necessary number of N (=28) can be fulfilled

*[1] JASIC will add one more test center for water depth evaluation.
*[2] RDW made a comment to join the 2023 test campaign in the 45th IWG WGWT

Magnitude of Test Plan
Compared to 2021 test campaign: (vs all tests) 50% less / (vs screening test only) 30% less

Test center		Test conditions			
	Water depth control capability	Test track		Water depth	Test Temp.
				0.5/ (1.0)/ 1.5 ㎜	Temp. (Low/Mid/High*: 3 levels)
A	Y	✓	+	✓	
B	Y	✓		✓	
C	Y	✓		✓	
D	Y	✓		✓	
E		✓			✓
F		✓			✓
G		✓			✓
H		✓			✓
J		✓			✓
K		✓			✓
				12	18

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

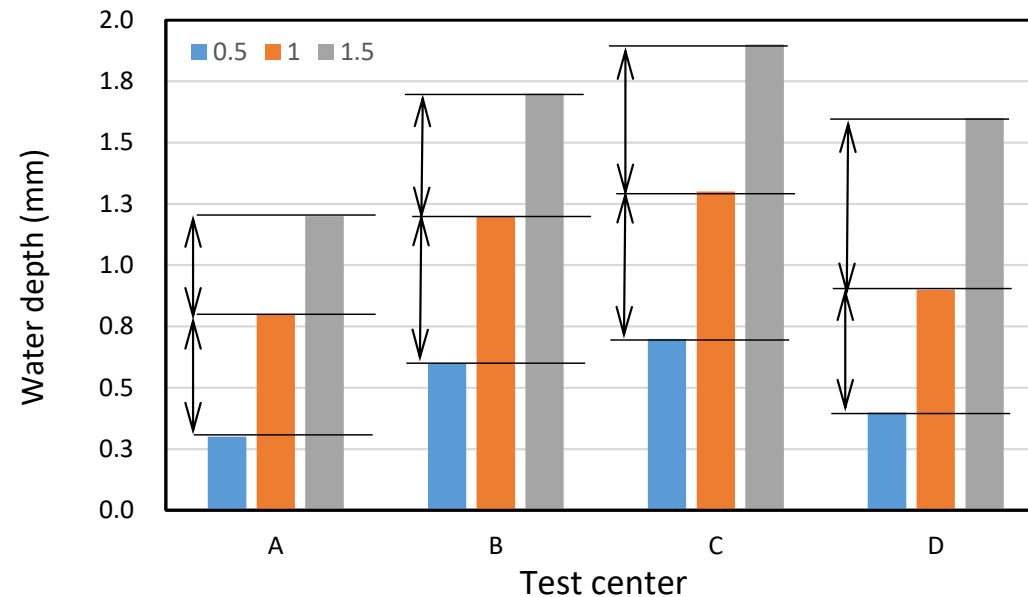One more test center addressed for participation at IWG WGWT #45. It makes to fill Sample numbers.

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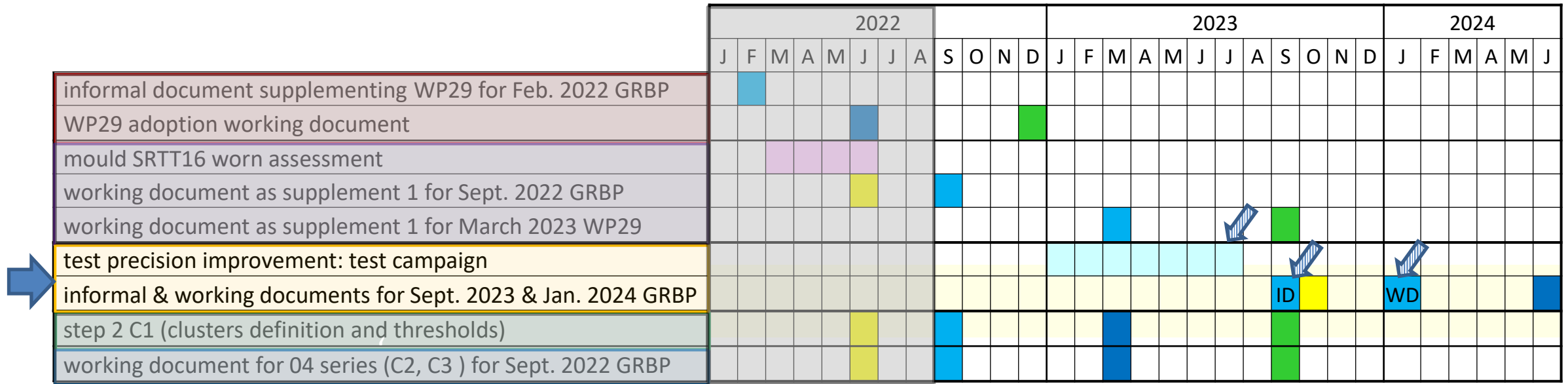 however relative values have constant gap, these data are worth to use for analysis

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

(Example)

ref. Status report to 76th GRBP (September 2022)

		2022												2023												2024				
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
informal document supplementing WP29 for Feb. 2022 GRBP																														
WP29 adoption working document																														
mould SRTT16 worn assessment																														
working document as supplement 1 for Sept. 2022 GRBP																														
working document as supplement 1 for March 2023 WP29																														
test precision improvement: test campaign																														
informal & working documents for Sept. 2023 & Jan. 2024 GRBP																						ID			WD					
step 2 C1 (clusters definition and thresholds)																														
working document for 04 series (C2, C3) for Sept. 2022 GRBP																														

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

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

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

Following the opinion of the IWG WGWT on 13 September that both ETRTO/JASIC proposals are important, JATMA propose to conduct both plans in parallel in 2023.

Concurrent tests of Water depth measurement and test precision improvement

	Q3 2022	Q4 2022	Q1 202	Q2 2023	Q3 2023	Q4 2023	Q1 2024	Q2 2024
Test condition variability parameters definition	▨							
Standardization of water depth measurement		▨	▨	▨	▨			
Interaction for water depth with track characteristics		▨	▨	▨	▨			
Precision improvement test campaign			▨	▨	▨			
Combine standardization of new water depth measurement and precision improvement test campaign					▨			
GRBP informal document					ID Sep.			
GRBP working document							WD Jan.	

APPENDIX

	Q3 2022	Q4 2022	Q1 2023	Q2 2023	Q3 2023	Q4 2023	Q1 2024
test condition variability parameters definition	🟩						
standardisation of waterdepth measurement		🟩	🟩	🟩	🟩		
Interaction of waterdepth with track characteristic		🟩	🟩	🟩	🟩		
GRBP informal document					🟩		
GRBP Working document							🟩

- Improvement of the water depth measurement: how to standardise water depth measurement procedure? Differences in watering system(s) (external versus self watering)

- Interaction of water depth with track characteristic (with MTD)

ToR (GRBP #75)

D. Timeline
15. IWG shall aim to present

- on wet grip of tyres of class C1 in worn state to supplement the initial proposal (GRBP/2021/12) to improve the precision of test procedure with the introduction of moulded SRTT worn and to refine the C1 threshold for clusters if any.

An informal document at the 78th session of GBRP in September 2023 and a working document for adoption at the 79th session of GRBP in January 2024 at the latest on wet grip of C1 class tyres in worn state to improve the precision of test procedure.