RESEARCH RECORD NO: 181

A LIMITED EVALUATION OF THE WET - STRETCHING OPERATION

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C O N T E N T S

A P P E N D I C E S

1. INTRODUCTION

Over the last three or four years the practice of wet stretching or wet spreading has been gaining in popularity. This has stemmed from the fact that the use of the compressive shrinker or compactor for reducing the length of tubular knitted and finished fabrics has fallen out of favour due to the unacceptable effect on apparent depth of shade and fabric surface appearance. This reduction in length, following the wet processing operations, is necessary to ensure that the fabric does not exhibit unduly high levels of length shrinkage.

The broad principle of wet stretching is that the tubular fabric is taken over a driven adjustable spreader the width of which is set to an amount in excess of the final target finished width for that fabric. If considerable length overfeed is applied at the same time, then an interchange of length for width occurs which is detectable by an increase in the linear density of the courses. On leaving the spreader the fabric is passed through a nip to reduce the moisture content prior to drying.

Although there can be a considerable snap - back in the width of the fabric once the constraints of the spreader are removed, the width of the fabric after the wet stretching operation is invariably in excess of the target finished width.

The degree to which wet stretching can be carried out is governed amongst other considerations by the ability to lose this excess width during the subsequent drying operation. The mode of action of some drying machines notably the suction drum dryers does not allow the width to relax to any great degree and therefore these dryers do not permit high levels of width stretch to be imparted prior to the drying stage.

Within the last nine months opportunities have arisen for a limited evaluation of the wet stretching operation to be carried out and this report describes the work carried out and analyses the results obtained.

Trials were carried at Empresa Textil de Barcelos (TEBE) in Portugal and at Martins (Leicester) Ltd in Leicester UK.

2. TRIALS CARRIED OUT AT TEBE

Work is currently being carried out at TEBE to evaluate the Dornier merceriser and to furnish additional data which can be incorporated into the STARFISH predictive model.

A preliminary visit was made to TEBE the purpose of which was to determine the optimum conditions for the merceriser at which the main sets of single jersey would be processed during the second visit to TEBE.

A quantity of 14 gauge 1x1 rib fabric which had been sent from the UK was found to be surplus to requirements and since TEBE have equipment on which wet stretching can be carried out, the opportunity was taken to carry out a range of wet stretching treatments on this one fabric quality.

TEBE'S finishing line consists of a Tubetex TRI-PAD, in line with a Tubetex Super Relax Jet dryer. The calender is also of Tubetex manufacture and is the model incorporating slitting and open width rolling as well as tubular rolling.

The fabric details are given below:-

24" diameter 1x1 Rib purchased from Meridian UK.
Number of needles - 1056
Yarn - 1/30's Ne nominal
Stitch length - 0.285 cm nominal
Grey width - 63 cm

In total 7 pieces of fabric were available for the trials.

Grey test figures for these fabrics are given in Table 1.

Since this is a standard fabric quality processed and used widely in the UK we had finishing targets to hand which were:-

Finished courses /3 cm - 48/49
Tubular width - 55 cm

The fabrics were dyed to a reactive navy shade in a Barriquand "Girostock" dyeing machine. A preliminary scour was given in the dyeing machine and following the dyeing and soaping treatments the fabric was treated with a cationic softener.

The fabrics were unloaded from the dyeing machine into wagons ready for wet stretching. No centrifuging was given. The Tube-tex Tripad has a rotating platform built into the floor in front of it, so that fabrics can be continuously detwisted, wet stretched and squeezed to remove excess moisture.

It was intended to wet stretch by 10% 15% 20% 25% 30% 35% and 40% over the target finished width of 55 cms. However, the width of the spreader on the Tubetex Tripad is adjusted by inserting spacer bars which increase in size in one inch increments.

The actual levels of wet stretch obtained were therefore 11% 15½% 20% 25% 29% 38% and 44% respectively. As much overfeed as possible commensurate with acceptable running and minimum creasing in the padder nip was applied. Measurements of fabric width were taken on all the seven fabric pieces prior to drying.

The fabrics were dried on the Tubetex Super Relax Jet dryer using the conditions normally used by TEBE on fabric qualities such as this. (These may not have been the optimum conditions for maximum fabric relaxation).

After drying, fabric width and courses per 3 cm were again measured.

Calendering was carried out to a width of 57cm to allow for some creep-back and the fabric was rolled onto a tube. This is common practice at TEBE. Once again the calendering conditions could not be considered ideal since it appears that batcher tension is used to a limited extent by the operative to adjust fabric width.

Immediately after calendering, fabric width and courses were obtained.

After a delay period of approximately three months fabrics were submitted for full testing.

The in- process measurements and relevant test results are given in Table 2.

3. OBSERVATIONS

The measurements given in Table 2 are shown graphically in Fig 1.

The effect of increasing the degree of wet stretch can be seen by comparing the linear density of the courses after the stretching treatment. The optimum stretch level on the Tri-pad for this fabric quality would appear to be around 30%. At stretch levels above this, tension between the stretching frame and the nip was developed which resulted in a loss in courses.

With a 1x1 rib fabric, considerable width snap - back occurs once the fabric leaves the stretcher and in the optimum range is only 16% over finished width prior to drying.

After drying, the reduction in length brought about by wet stretching is largely maintained whilst the excess width is readily lost.

After calendering, considerable length stretching occurred due to the way in which this machine was operated. On other makes of calender this stretching would not be expected to occur.

The residual length shrinkage values given in Table 2 do not therfore give a true indication of the benefits of wet stretching. If the reduction in length due to wet stretching had been maintained at the calendering stage, very good residual length shrinkage levels would have been the outcome.

Table 2 also clearly shows that wet stretching does not have a permanent effect on fabric structure. The relaxed courses and wales are more or less the same for all the different levels of stretching.

4. TRIALS CARRIED OUT AT MARTINS (Leicester)Ltd

Martins have recently installed a Kiefer Rotoswing dryer. This is one of the new generation of drying machines which subject the fabric to mechanical agitation during the drying treatment. This enables fabric consolidation to occur which reportedly results in low residual shrinkage, particularly to a shrinkage test procedure incorporating tumble drying.

Martins also possess two Calator Airtex machines on which the operation of wet stretching can be carried out. We were therefore interested to carry out trials combining wet stretching and relaxed drying to determine whether the wet stretching conditions are still important in ensuring low residual shrinkage values are obtaine

A quantity of greige state fabric was purchased for this exercise. Five pieces of interlock fabric were purchased from Meridian and five pieces of 1x1 rib were purchased from Klynton Davis.

Fabric details were as follows:-

Interlock

Quality - FW 1007
20 gauge 24" diameter
1488 needles
Yarn - 1/38's Ne nominal
Stitch length 0.338 cm nominal

1x1 Rib

Quality - 7/514
14 gauge 19" diameter
840 needles
Yarn - 1/30's Ne nominal
Stitch length - 0.282 cm nominal

Grey test results for these qualities are given in Table 3.

The STARFISH model was used to obtain finishing targets based on a winch bleached processing route with target residual shrinkage values of :-

Interlock - Length 12% Width 10%
1x1 Rib - Length 8% Width 8%
These targets were :-
Interlock 40/41 C/3 cm, Width 56 cm
1x1 Rib 50 C/3 cm, Width 42 cm

The two fabric qualities were loaded together into a Horrocks deep draught winch and were peroxide bleached using the standard Martins procedure. This includes application of an OBA and also a cationic softener and a paraffin wax lubricant.

Total time in the winch was of the order of 3 hours , the liquor ratio was 18 to 1. The fabrics were unloaded from the winch ready for wet stretching.

Unlike the Tubetex Tripad it is relatively easy to set and adjust the size of the stretching frame on the Calator "Airtex". Five levels of wet stretch were carried out on each fabric quality. These corresponded to 0%, 20%, 30%, 40% and 50% over the respective target finished widths.

Maximum overfeed was applied during wet stretching and no difficulty was experienced at any of the stretching levels. Fabric width and courses/3cm were obtained immediately following the stretching operation.

Within thirty minutes of wet stretching the fabrics were dried on the Kiefer Rotoswing dryer which was operated at a temperature of 170-175°C. The overfeed of fabric onto the lower conveyer band was set to 40% and was kept at this level for all the fabric pieces. Fabric width as it entered the dryer was also measured to obtain some idea of the amount of creep-back in width which occurs following wet stretching.

At the exit of the dryer fabric courses/3cm and width were again obtained.

Calendering was carried out on a Weiss machine equipped with precision plaiting. It has been the experience of Martins that following Rotoswing drying they need to calender somewhat wider than target width to allow for creep-back and their suggestions for these two qualities were:-

	Target	Calendered Width
Interlock	56 cm	59 cm *
1x1 Rib	42 cm	44 cm

* This was reduced to 58 cm after calendering one piece.

Fabric courses/3 cm and width were obtained immediately after calendering and again after a delay of one week to ascertain the degree of creep-back.

The in - process measurements and relevant test results are given in Tables 4 and 5.

OBSERVATIONS

The in - process measurements given in Tables 4 and 5 are shown graphically in Figs 2 and 3.

The effect of increasing the level of wet stretch on the course density is once again very clear. The amount of immediate width snap back following wet stretching is as might be expected lower in the case of interlock than it is with 1x1 rib.

Following drying on the Kiefer Rotoswing a number of points are apparent:-

- considerable extra length reduction is achieved.
- the differences in fabric length due to the wet stretching treatment are largely eliminated.
- excess width due to wet stretching is eliminated.
- all fabrics are better than target in terms of course density.
- the interlock fabrics which were stretched the highest have remained slightly wider.
- the 1x1 rib fabrics have more or less a consistent width.

Following calendering, some loss of length has occurred probably due to the reduction in fabric thickness brought about by calendering, but even so the interlock fabrics are on target in terms of courses whilst the rib fabrics are marginally better than target.

After one weeks storage, the course levels have remained the same whilst some width creep back has occurred bringing the fabrics to target width.

The shrinkage figures given in Tables 4 and 5 are generally very good but there is a suggestion that the width target figures may have been slightly too low in the case of the interlock quality and slightly too high in the case of the rib quality.

As far as the relaxed dimensions of the rib quality are concerned wet stretching appears to have no permanent effect.

With the interlock quality there is a suggestion that wet stretching is slightly altering the relaxed wales from 44 wales/3 cm for 0% wet stretch to 42.3 wales/3 cm for 50% wet stretch

5. CONCLUSIONS

These two rather limited exercises carried out in Portugal and the UK have clearly demonstrated the advantages which can be obtained by wet stretching. In factories which do not have the newer types of dryer this can be extremely useful in achieving lower residual shrinkage levels provided the existing dryer is able to maintain the length reduction but it is equally capable of eliminating the excess width brought about by the wet stretching operation.

In plants where the newer types of dryer are installed, the wet stretching stage is perhaps not as critical in terms of attaining a reduction in fabric length but some degree of width stretch may be desirable to ensure that the calender is not expected to adjust fabric width on dry fabric to an unrealistic extent.

The optimum conditions for wet stretching will obviously vary depending on fabric type and tightness and would have to be ascertained for each particular quality in a systematic manner.

ROLLS 11 - 17 ONLY.

TEBE PROJECT 1x1 RIB GREY FABRICS - TEST DATA

Sample no.	1	2	3	4	5
Length shrinkage	19.61	18.74	18.36	19.19	13.26
Width shrinkage	20.31	21.06	20.95	21.67	31.79
Weight (gsm) BW	148.71	149.45	147.86	144.12	142.14
Weight (gsm) AW	230.49	241.83	239.80	229.81	233.42
Courses per 3cm BW	45.10	45.90	46.10	45.70	51.00
Courses per 3cm AW	56.40	57.10	57.00	56.30	58.70
Wales per 3cm BW	26.00	25.70	26.10	25.40	23.20
Wales per 3cm AW	33.00	33.30	33.00	33.00	33.00
Stitch length (mm) BW	2.92	2.88	2.88	2.92	2.82
Stitch length (mm) AW	2.87	2.82	2.82	2.87	2.80
Burst strength BW	543.50	524.00	525.90	506.80	503.60
Burst strength AW	508.50	536.30	537.70	491.50	495.40
Distension at burst, mm. BW	13.91	13.78	14.25	14.83	14.57
Distension at burst, mm. AW	16.37	16.27	16.59	16.20	16.16
Spiral angle BW					
Spiral angle AW					
Width BW (open-width)	1056.00	1056.00	1056.00	1056.00	1056.00
Yarn strength, BW	233.10	252.97	260.59	250.44	232.44
Yarn strength, AW	232.25	247.65	226.07	234.56	236.78
Yarn extension at break, BW	6.61	7.23	7.40	7.46	6.49
Yarn extension at break, AW	8.51	8.54	8.08	8.11	8.14
Yarn count, tex BW	20.18	20.67	20.50	19.99	20.33
Yarn count, tex AW	19.60	20.22	20.42	19.64	19.92
Fabric thickness, BW	814.20	808.60	775.70	828.00	817.40
Fabric thickness, AW	1206.90	1205.00	1281.90	1257.90	1277.30
ROLL NUMBER	11	12	13	14	15

TEBE PROJECT 1x1 RIB - GREY FABRICS - TEST DATA

Sample no.	6	7	8	9	10
Length shrinkage	19.82	19.00	17.59	18.63	18.01
Width shrinkage	20.24	19.43	21.70	18.66	19.32
Weight (gsm) BW	149.96	155.37	149.90	167.82	160.24
Weight (gsm) AW	235.19	236.92	231.68	235.70	234.11
Courses per 3cm BW	45.60	45.30	46.70	45.70	46.20
Courses per 3cm AW	56.40	56.10	57.00	55.60	55.70
Wales per 3cm BW	25.80	26.20	25.80	26.60	26.60
Wales per 3cm AW	33.20	33.20	33.30	32.80	32.80
Stitch length (mm) BW	2.92	2.92	2.87	2.93	2.91
Stitch length (mm) AW	2.86	2.86	2.83	2.87	2.87
Burst strength BW	514.10	529.40	491.60	535.20	483.60
Burst strength AW	535.80	520.10	533.60	528.10	522.20
Distension at burst, mm. BW	13.87	14.33	14.48	14.58	14.07
Distension at burst, mm. AW	16.55	16.58	16.33	16.63	16.50
Spiral angle BW					
Spiral angle AW					
Width BW (open-width)	1056.00	1056.00	1056.00	1056.00	1057.00
Yarn strength, BW	260.84	239.00	224.29	226.87	244.48
Yarn strength, AW	243.31	246.63	226.11	237.54	245.05
Yarn extension at break, BW	7.86	6.67	6.37	6.33	6.85
Yarn extension at break, AW	8.37	8.64	7.89	8.18	8.39
Yarn count, tex BW	20.20	20.69	19.82	20.23	20.38
Yarn count, tex AW	20.07	20.24	19.82	20.27	20.11
Fabric thickness, BW	773.80	794.50	827.50	837.90	861.30
Fabric thickness, AW	1281.40	1216.10	1241.80	1262.50	1258.80
ROLL NUMBER	16	17	18	19	20

TABLE 1

TEBE TRIAL IN-PROCESS MEASUREMENTS

TABLE 2

FABRIC Ref	Finished Targets		TRI-PAD Settings		After TRI-PAD		After Dryer		After Cal		Residual * Shrinkage		Relaxed * Dimensions	
	C/3	Width cm	Width	% over finished	C/3	Width	C/3	Width	C/3	Width	Length %	Width %	C/3	W/3
17/2	48.5	55	61	11%	47.5	59	46.5	48	45.5	57	15.4%	10.4%	53.9	32.8
17/1	↓	↓	61	11%										
16/3			63.5	15.5%										
16/2			63.5	15.5%	47.5	59	46.5	48.5	45	57	14.5%	10%	55	33.4
16/1			63.5	15.5%										
15			66	20%	48	61	50	49.5	46	57	13.3%	10.7%	54.5	33.1
14			68.5	25%	49	64	49	50	47	57	14.3%	10.5%	53.6	33.3
13			71	29%	51	64	50	50	48.5	57	13.3%	11.9%	54.9	33.2
12			76	38%	50	64	50	50.5	48	57	13.6%	12.5%	53.7	31.8
11			79	44%	46	63	49	50.5	46.5	56.5	12.2%	10.3%	53.7	33.2

* Average of 3 samples

MARTINS WET-STRETCHING TRIAL 1x1 RIB, GREY - TEST DATA

Sample no.	1	2	3	4	5
Weight (gsm)BW	155.19	154.52	159.79	156.22	157.27
Weight (gsm)AW	225.27	225.05	224.17	226.43	225.71
Courses per 3cm BW	42.80	45.40	45.60	45.20	46.30
Courses per 3cm AW	56.20	57.70	57.20	57.40	57.20
Wales per 3cm BW	29.54	27.80	28.00	28.00	27.40
Wales per 3cm AW	34.80	34.60	34.40	34.50	34.20
Stitch length (mm) BW	2.77	2.77	2.77	2.78	2.77
Stitch length (mm) AW	2.73	2.73	2.73	2.73	2.73
No. of Needles	840.00	840.00	840.00	840.00	840.00
Yarn strength, BW	238.73	251.52	242.51	248.31	247.55
Yarn strength, AW	236.25	243.61	233.39	240.28	238.88
Yarn extension at break, BW	6.13	6.62	6.72	6.51	6.74
Yarn extension at break, AW	7.62	7.67	7.44	7.74	7.76
Yarn count (tex), BW	19.65	19.75	19.68	19.85	19.83
Yarn count (tex), AW	19.34	19.47	19.42	19.50	19.54

TABLE 3A

INTERNATIONAL INSTITUTE FOR COTTON KNITT. REF. LAB. REF. 4611 SUBMITTED BY. JTE DATE. 24.8.83

TESTS REQUIRED			1	95%CL	2	95%CL	3	95%CL	4	95%CL	5.	95%CL
FABRIC WEIGHT	BW	✓	162.8	4.2	165.8	3.6	160.9	4.6	164.3	4.8	161.2	4.3
G.S.M.	AW	✓	241.8	3.0	245.2	5.5	239.6	6.2	239.4	7.2	235.2	5.4
C/3 CM	BW	✓	37.1	0.4	36.6	0.4	36.4	0.5	37.0	0.6	36.4	0.4
	AW	✓	48.5	0.5	48.4	0.4	47.6	0.6	50.4	0.6	47.7	0.4
W/3 CM	BW	✓	36.4	0.4	35.5	0.4	36.8	0.5	37.2	0.5	37.4	0.4
	AW	✓	43.6	0.6	43.0	0.6	43.2	0.6	42.0	0.6	43.5	0.8
STITCH LENGTH	BW	✓	3.48	0.01	3.44	0.01	3.43	0.02	3.48	0.01	3.42	0.01
MM	AW	✓	3.47	0.01	3.42	0.01	3.43	0.01	3.46	0.01	3.38	0.01
BURST STRENGTH	BW											
Kn/m²	AW											
DISTENSION	BW											
mm	AW											
SPIRALITY ANGLES	BW											
	AW											
NO OF NEEDLES IN TUBE	BW	✓	1486		1489		1487		1485		1469	
THICKNESS	BW											
	AW											
YARN COUNT	BW	✓	15.9		16.1		15.8		15.8		15.5	
TEX	AW	✓	15.2		15.6		15.4		15.0		14.8	
L.E.S. g	BW	✓	190.4	11.2	195.4	11.2	192.6	11.1	186.8	10.3	178.7	7.7
	AW	✓	175.7	9.3	186.6	11.1	188.0	11.1	184.5	9.0	177.9	10.3
% EXT	BW	✓	7.1	0.6	7.2	0.2	7.1	0.3	6.8	0.4	6.4	0.3
	AW	✓	7.0	0.4	7.1	0.3	7.4	0.3	7.8	0.4	7.2	0.4

TRIAL

INTERLOCK FABRIC

GREY TEST RESULTS

TABLE 3R

MARTINS TRIAL IN-PROCESS MEASUREMENTS

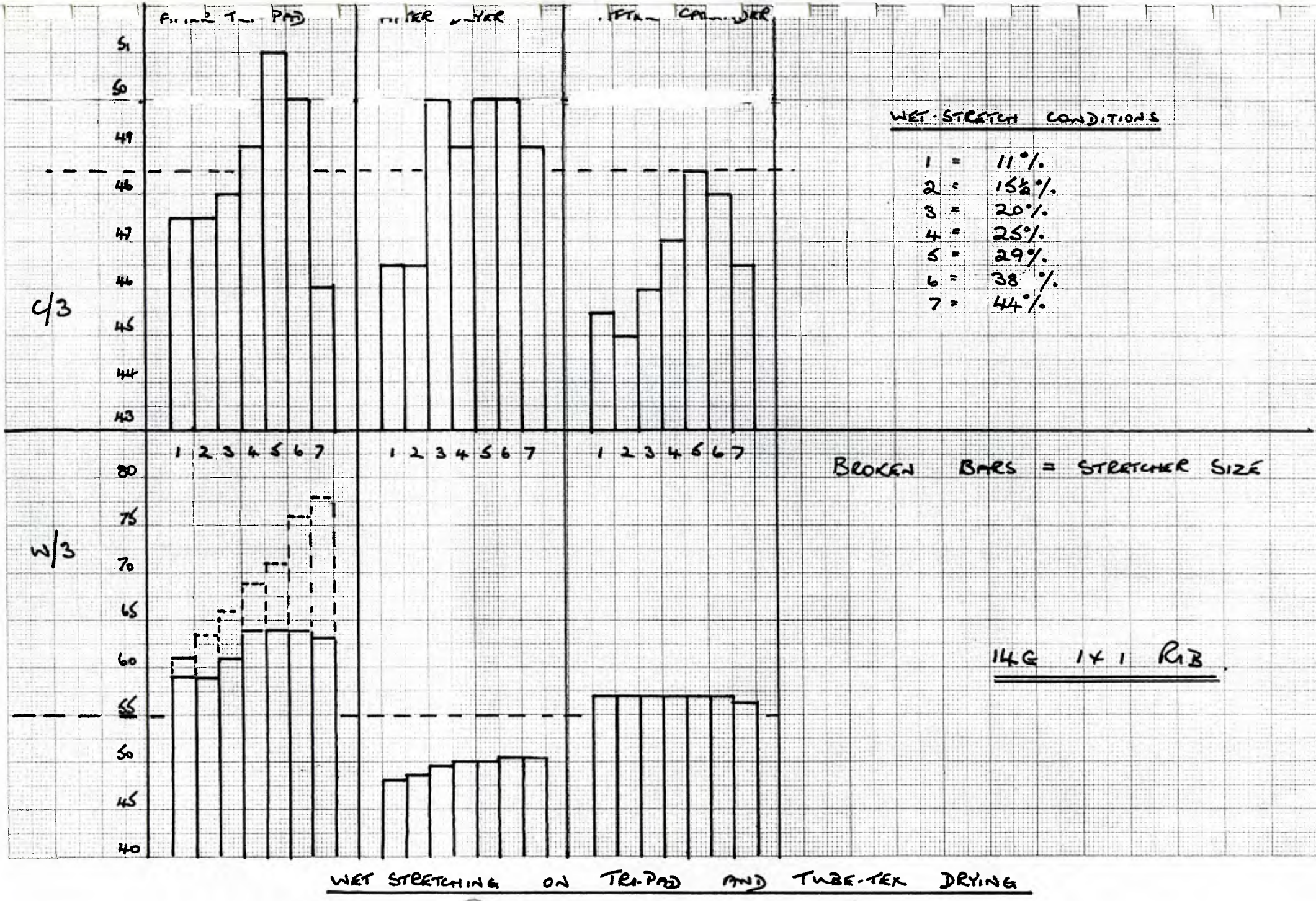
( ) After 30 mins approx
1. Immediately
2. After 1 week

TABLE 4 INTERLOCK

FABRIC REF	Finished Targets		After Winch		Airtex Setting		After Airtex		After Dryer		After Calender				Residual Shrinkage		Relaxed Dimensions	
	C/3	Width	C/3	Width	Width	% over fin	C/3	Width	C/3	Width	C/3 1	C/3 2	Width 1	Width 2	Length %	Width %	C/3	W/3
1	40/41	56	35	-	56	0%	35	55.5(54)	41	50	40	40	59	57	12.4%	8.7%	45.5	44.0
2			36	-	67	20%	36	64(63)	42	52	40.5	40	58.5	57	13.0%	6.0%	46.1	43.3
3			-	-	73	30%	38	69.5(68)	41	54	40.5	41	58	56	11.1%	6.6%	45.6	42.9
4			-	-	78½	40%	39	74.5(72)	42	55	40	41	58	57	11.1%	6.6%	45.7	42.8
5			36	-	84	50%	39	78.5(73)	42	55	41	40.5	58	57	11.7%	5.8%	46.7	42.3

TABLE 5 1x1 RIB

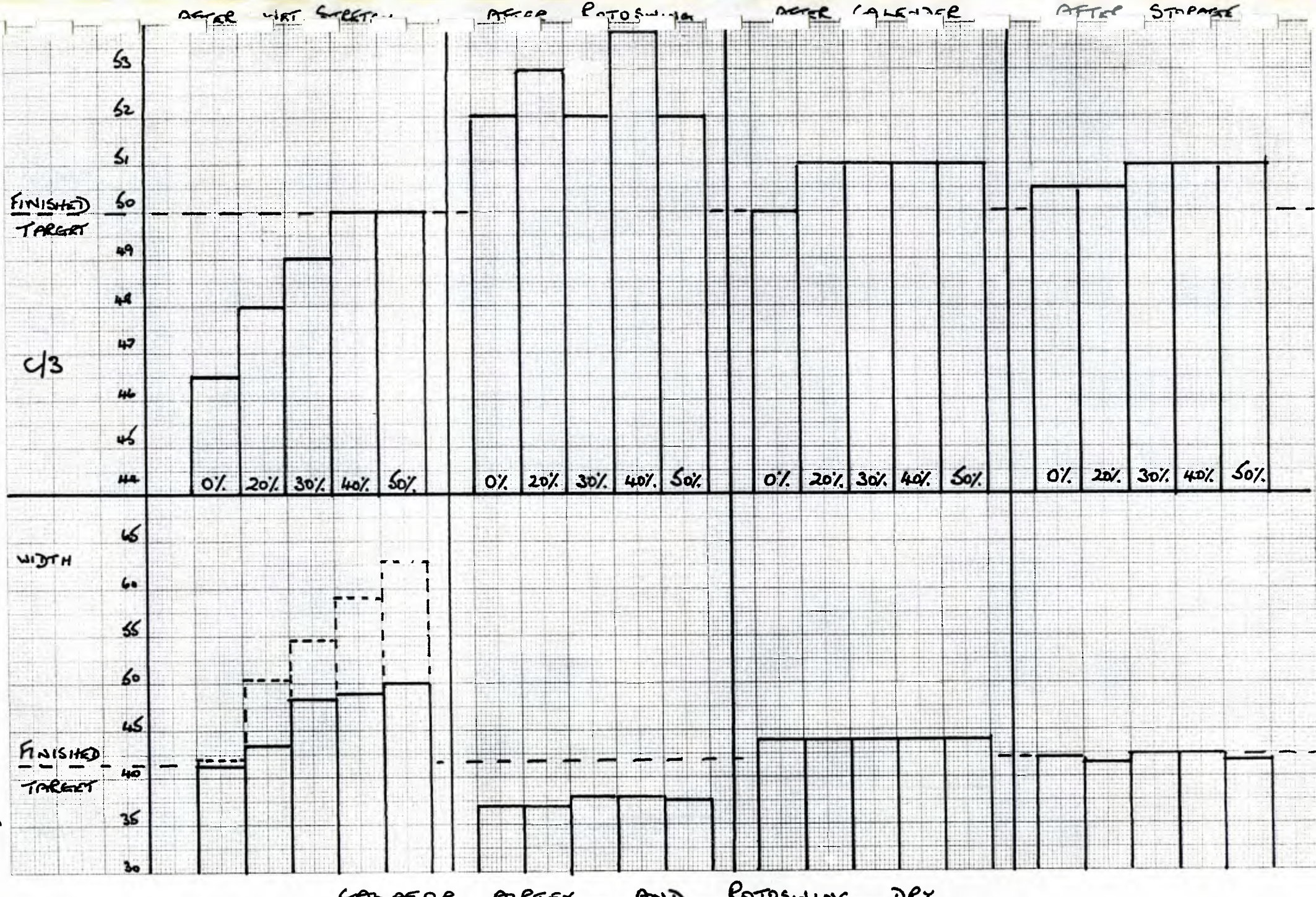
FABRIC REF	Finished Targets		After Winch		Airtex Setting		After Airtex		After Dryer		After Calender				Residual Shrinkage		Relaxed Dimensions	
	C/3	Width	C/3	Width	Width	% over fin	C/3	Width	C/3	Width	C/3 1	C/3 2	Width 1	Width 2	Length %	Width %	C/3	W/3
1	50	42	50	-	42	0%	46/47	42(41.5)	52	37	50	50.5	44	42.5	7.5%	11.7%	55	34.4
2			-	-	50.5	20%	48	47.5(43.5)	53	37	51	50.5	44	42	7.1%	10.4%	55.2	34.3
3			50	-	54.5	30%	49	50(48)	52	37.5	51	51	44	42.5	7.3%	10.8%	54.9	34.1
4			-	-	59	40%	50	52.5(49)	54	36.5	51	51	44	42.5	6.9%	13.9%	55.2	34.8
5			51	-	63	50%	50	55(50)	52	37	51	51	44	42	6.5%	10.5%	54.6	34.5



WET STRETCHING ON TRI-PAD AND TUBE-TEX DRYING

FIG 1.

TEBE TCAR



C/3

SG 29.

14G. 1x1 RIB.

MARTINS TRIAL

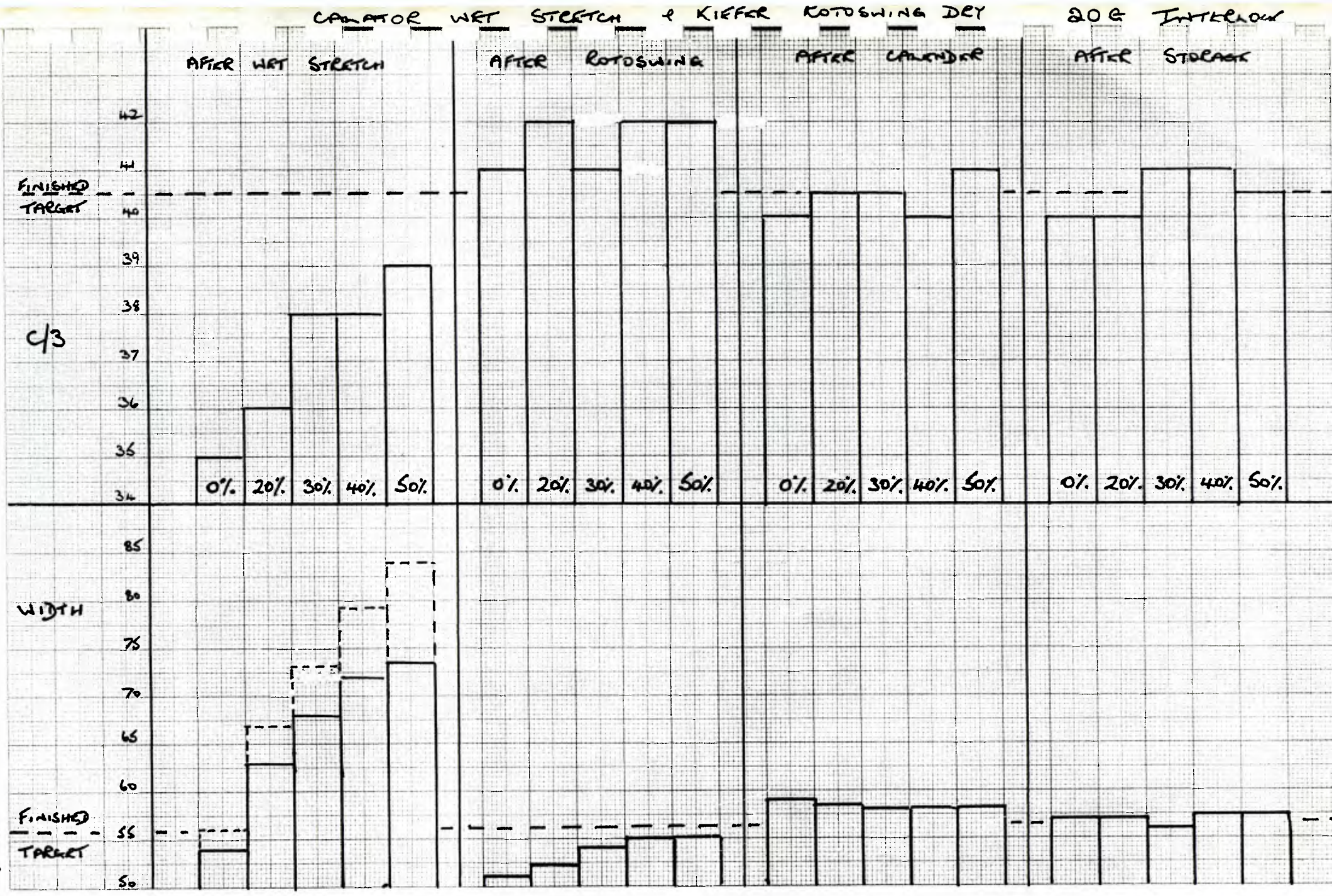


FIG. 3

MARTINS TRIAL.