

AN INVESTIGATION INTO THE LINE DRY SHRINKAGE TEST
WHEN APPLIED TO KNITTED COTTON FABRICS

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1. INTRODUCTION

Over the past few years a considerable amount of information has been collected in connection with the measurement of shrinkage of knitted cotton fabrics when using the tumble dry method of testing. Although there are obviously some aspects which have not been investigated it is probably fair to conclude that we can be relatively confident that we understand to a large extent the factors which have a bearing on the results delivered by this method of test.

On an increasing scale, the tumble dry test method is being adopted by commercial organisations in Europe and the USA mainly due to the fact that the incidence of tumble dryers in the home is on the increase.

As our work on cotton knitgoods and STARFISH in particular is now reaching a wider audience, questions often arise about shrinkage performance when the only method of measuring shrinkage used is based on line drying. This was particularly the case during the two international workshops in India and Mexico and it was felt that we did not have sufficient information at first hand to answer all the questions authoritatively.

Over the past few months and when windows in the testing programme became available a number of investigations have been carried out to try to breach a few gaps in our understanding and interpretation of shrinkage when using a test method which incorporates line rather than tumble drying. It is emphasised that this has not been a fully systematic investigation which of necessity would have had to have been a lengthy and time consuming project to enable us to fully understand the effect of all the variables.

We know that when using the tumble dry test method that the actual washing treatment used is not a critical factor on the shrinkage results returned. To a large extent, the consolidation of the fabric structure which occurs in the tumble dryer overrides any differences which might exist due to differences in the washing treatment.

The effect of washing temperature and length of washing cycle for example are not critical and one could speculate that other factors such as dimensions of the washing machine drum, liquor to fabric ratio, degree of agitation etc. similarly are not critical. The overriding and critical factor would appear to be the tumble drying operation.

The work carried out so far and reported here was mainly to enable the effect of time and temperature of the washing treatment to be quantified for line dry test methods. These two parameters are inter-related since the testing is carried out in a domestic automatic washing machine where the washing liquor is heated in situ resulting in the highest washing temperatures also having the longest cycle times. The parameters of washing machine dimensions, and liquor to fabric ratio have been standardised by using a particular model of machine and a constant wash load weight.

During the investigation an anomaly arose connected with a particular wash cycle (minimum iron) which warranted further investigation and this is reported separately.

As well as the parameters of time and temperature, another factor which is anticipated will have a bearing on the results returned by a line dry test, is the direction in which the samples are hung out on the line. The various aspects already discussed have been investigated to varying degrees and to avoid confusion are dealt with separately for the purposes of this report.

The various investigations are categorised as follows:

Part 1 The influence of the individual washing machine programmes on the shrinkage results obtained from a line dry test.

Part 2 The influence of fabric direction on the shrinkage results obtained from a line dry test.

Part 3 A comparison of the Minimum Iron wash programme with the Fast Coloured programme with respect to fabric shrinkage when measured by line drying and also tumble drying test methods.

2. PART 1 - EFFECT OF WASHING CONDITIONS

2.1. Experimental Details

A number of fabric samples (6) were collected at random from the many fabrics held in stock. They included greige fabrics as well as finished fabrics and the three main constructions, viz single jersey, interlock and 1 x 1 rib. The samples were coded A-F and details of the fabrics used are given in Table 1. The shrinkage samples of size 25cm x 25cm were prepared in accordance with the procedures outlined in Methods of Test of knitted fabrics KT1. A number of sets of samples were prepared.

The usual procedure for assessing shrinkage by the line dry method was employed with the exception that the washing programme on the Hoover automatic machine was altered for the individual sets of samples.

The programmes used were:-

- the rinse only cycle which is carried out entirely with cold water (R)
- the non-fast coloureds cycle (designated E) which is a 40°C wash
- the minimum iron cycle (designated J) which is a 50°C wash
- the fast coloureds cycle (designated D) which is a 60°C wash
- the whites cycle (designated C) which is a 90°C wash

Precise details of the individual programmes are given in Table 1a which is taken from the manufacturers handbook. The approximate cycle times are also indicated, but these are subject to variations for the reasons outlined.

After the washing sequence the samples were hung on the line with the wales in a vertical direction. The whole operation was carried out five times and shrinkage measurements recorded after the first and fifth cycles.

Five samples were tested from each fabric at each washing programme and the whole exercise was replicated.

2.2. Discussion of Results

After a preliminary analysis of the results it was found that a number of the samples which had been given the Minimum Iron (J) cycle exhibited a rather different shrinkage behaviour pattern which could not be explained. It was therefore decided that this particular wash cycle warranted further investigation and this additional work is reported as Part 3 of this report. The results of the Minimum Iron cycle have therefore not been included in the Part 1 analysis.

The shrinkage results of the two replications together with the averaged results are given in Table 2. The results are shown graphically in Figure 1.

The combined effect of time/temperature on length shrinkage is fairly clear both after one cycle and also after five cycles. The more severe the wash, the higher is the length shrinkage returned by the test. What is surprising however are the relatively small differences. If the rinse only results are ignored the difference between a 90°C wash and a 40°C wash is only at a maximum of 2.5 percentage points and this is on a length shrinkage of 14-15%. At lower length shrinkage values and in the one case where the test recorded an extension in length, the differences are very much lower. As far as width shrinkage is concerned a reverse situation exists. Overall, the more severe the washing treatment, the lower is the width shrinkage. Again the differences are surprisingly small. One sample however (sample F) which was a 14 gauge 1 x 1 rib construction showed a much bigger difference between the rinse only cycle and the low temperature (40°C) cycle. This effect was present after one and also after five wash cycles. Because no detergent is used on this programme and the fabrics have not been given a preliminary wash, they may not have been completely wetted out particularly if they have been treated with a fatty type softening agent as was the case with this particular fabric.

3. PART 2 - EFFECT OF FABRIC DIRECTION DURING LINE DRYING ON SHRINKAGE

3.1. Experimental Details

A number of fabrics were collected from stock and coded 1-10. These included single jersey, 1 x 1 rib and interlock constructions and also included greige and finished fabrics. Details of the fabrics are given in Table 3.

Shrinkage samples of size 25cm x 25cm were prepared in accordance with the procedures outlined in Methods of Test of knitted fabrics KT1. Five samples for each fabric were used and two complete testing sets were prepared. Both sets of samples were washed using the fast coloureds programme but were hung out differently at the drying stage. In one case the samples were hung on the line with the wales in a vertical direction and in the other case with the wales in a horizontal direction. The procedure was repeated four times and shrinkage measurements recorded after the first and fifth cycle.

3.2. Discussion of Results

The test results are given in Table 4.

Figure 2 shows the effect of direction of hanging on the length shrinkage after one and five cycles. With the wales in a vertical direction the effect of gravity will work against shrinkage and it would seem logical to expect to see lower length shrinkage figures than if the wales had been in a horizontal direction. This is in fact the case but the differences are rather small, within a maximum 1% even after five cycles. In fact, in the majority of cases the differences are within 0.5%.

Figure 3 shows the effect on the width shrinkage after one and five cycles. With the wales in a vertical direction it would seem logical that the effect of gravity would be to accentuate width shrinkage and it would seem that this is the case, particularly with interlock and 1 x 1 rib constructions. The observed differences are somewhat larger and the direction in which the sample is hung on the line can change a width shrinkage into a width extension.

4. PART 3 - AN EXAMINATION OF THE MINIMUM IRON (J) PROGRAMME

4.1. Experimental Details

During the investigation reported in Part 1 an anomaly was found which needed further investigation. This anomaly was associated with the Minimum Iron programme on the Hoover Automatic washing machine. This programme is different from the other programmes in that the cycle is designed to cause the minimum of creasing to fabrics. The washing temperature is 50°C but following the rinsing operations the fabrics are allowed to stand in water until the "crease-guard" button is pressed. This causes the pump to empty the machine whilst the samples are redistributed. An 800 rpm spin follows for a time of 2 minutes. In this respect the programme is different since the other main programmes continue to spin to give a total time of four minutes.

The observed anomaly was associated with width shrinkage. This particular programme gave width shrinkage figures which were lower than those given by any other programmes.

In light of these observations it was decided to compare the Minimum Iron programme with the Fast Coloureds programme on a wider range of fabric samples.

Additionally it was decided that the two programmes should also be compared when the testing procedure included tumble drying. A range of fabrics was taken from stock and these were coded 1-10. Table 5 lists of the fabrics used for this particular evaluation.

The standard procedures for shrinkage for line drying and tumble drying were carried out. The shrinkages were measured after one and five cycles.

4.2. Discussion of Results

Table 6 gives the test results for line dry shrinkage returned by the two methods and these are shown graphically in Figures 4 and 5.

No major differences are apparent which can be attributable to the method of washing. The width shrinkage figures obtained from the two sets of fabric are very similar across a wide range. This extends from width extensions of 12% to width shrinkages of 18%. The anomalies previously observed were not apparent in this more comprehensive comparison.

Table 7 gives the test results for tumble dry shrinkage returned by the two methods and these are shown graphically in Figures 6 and 7.

To all intents both methods are returning very similar results although after five cycles the minimum iron programme is returning slightly higher length shrinkage figures than the fast coloureds programme.

5. CONCLUSIONS

This report has attempted to bring together and to record the findings of a number of separate evaluations associated with the measurements of shrinkage of knitted cotton fabrics. In particular the evaluations were intended to try to broaden our understanding and interpretation of shrinkage when measured by a test method specifying line drying.

The conclusions are summarised as follows:-

1. The combined effect of time/temperature which exists with a domestic automatic washing machine when different wash programmes are selected does have an influence on the shrinkage when this is measured after line drying. In general, the more severe the washing treatment the higher the length shrinkage will be and the lower the width shrinkage will be.

These differences however are considerably lower than might on reflection be expected considering the differences in the severity of the washing operations.












2. The direction in which the samples are hung on the line does have an influence on the shrinkages measured. The differences are higher in the case of width shrinkage and are more apparent on interlock and 1 x 1 rib constructions.
3. The Minimum Iron programme does not appear to have an undue effect on line dry shrinkage as was previously suspected. This programme and the Fast Coloureds programme return essentially the same shrinkage figures whether the drying method be line or tumble.

EFFECT OF WASHING CONDITIONS ON LINE DRY SHRINKAGE

Key To Fabrics

- A = Bleached only 20 gauge interlock, 38/338
- B = Mercerised (Tebe) single jersey 24/2-56/354
- C = Bleached (Martins) 14 gauge 1 x 1 rib 30/285
- D = Mercerised (Tosi) single jersey 24/2-56/321
- E = Greige-state 14G 1 x 1 rib feeder stripe knitted by Meridian
- F = 14G 1 x 1 rib Central Project Lot 22 26/350










hot water supply of 50°C and a cold water supply of 15°C.

I.T.C.L. code	Programme and Max. wash load	Fabric	Control setting	Dispenser compartment
	PREWASH 4.5 kg. (10 lbs)	Separate pre-wash for heavily soiled or dusty articles before the normal programme.	A	 FABRIC CONDITIONER IF REQUIRED
	WHITES HEAVY SOIL 4.5 kg (10 lbs)	Heavily soiled cotton or linen articles which are white or colour-fast to boiling e.g. bed and table linen.	B	 FABRIC CONDITIONER IF REQUIRED
	WHITES 4.5 kg. (10 lbs)	Cotton or linen articles which are white or colour fast to boiling, e.g. bed and table linen	C	 FABRIC CONDITIONER IF REQUIRED
	WHITES ECONOMY 4.5 kg. (10 lbs)	Lightly soiled cotton or linen articles which are colour fast to boiling.	C + Econ button	 FABRIC CONDITIONER IF REQUIRED
	FAST COLOURED 4.5 kg. (10 lbs)	Cotton, linen or viscose (rayon) articles without special finishes, which are colour fast at 60°C.	D	 FABRIC CONDITIONER IF REQUIRED
	NON FAST COLOURED 4.5 kg. (10 lbs)	Cotton, linen or viscose (rayon) articles which are colour fast at 40°C but not at 60°C, e.g. some denim articles.	E	 FABRIC CONDITIONER IF REQUIRED

Programme content	* Programme time (approx)
Hot fill, 40°C. Wash at low level. Pump and distribute.	21 mins
Cold fill, 40°C low level pre-wash followed by Hot fill 90°C low level main wash. Safety rinse high level, rinse, rinse. 800 r.p.m. spin for 2 minutes. Rinse, rinse. Pump and distribute clothes. 800 r.p.m. spin for 4 minutes	90 mins
Hot fill 90°C low level main wash. Safety rinse high level, rinse, rinse. 800 r.p.m. spin for 2 minutes. Rinse, rinse. Pump and distribute clothes. 800 r.p.m. spin for 4 minutes	70 mins
Hot fill 60°C low level main wash. Safety rinse high level, rinse, rinse. 800 r.p.m. spin for 2 minutes. Rinse, rinse. Pump and distribute clothes. 800 r.p.m. spin for 4 minutes	54 mins
Hot and Cold fill, 60°C low level main wash. Safety rinse high level, rinse, rinse. 800 r.p.m. spin for 2 minutes. Rinse, rinse. Pump and distribute clothes. 800 r.p.m. spin for 4 minutes.	52 mins
Hot and Cold fill, 40°C low level main wash. Safety rinse high level, rinse, rinse. 800 r.p.m. spin for 2 minutes. Rinse, rinse. Pump and distribute clothes. 800 r.p.m. spin for 4 minutes.	37 mins

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PROGRAMME GUIDE

I.T.C.L. code	Programme and Max. wash load	Fabric	Control setting	Dispenser compartment
	WOOLLENS 2 kg. (4 lbs)	Machine washable woollens. Wool mixtures with cotton or viscose, refer to page 25.	F	 FABRIC CONDITIONER IF REQUIRED
	SPIN DRY 800 r.p.m. 2 kg. (4 lbs) 2 kg. (4 lbs) 4.5 kg. (10 lbs)	Any hand washed fabrics which need a spin. For synthetic articles For woollen articles. For cotton, linen and rayon articles.	G	
	WHITE NYLON 2 kg. (4 lbs)	White nylon or white polyester/cotton mixtures. See also note on drip drying on page 18.	H	 FABRIC CONDITIONER IF REQUIRED
	MINIMUM IRON 2 kg. (4 lbs)	Coloured nylon, polyester cotton and viscose articles with special finishes; acrylic/cotton mixtures; coloured polyester/cotton mixtures. See also note on drip drying on page 18.	J	 FABRIC CONDITIONER IF REQUIRED
	DELICATES 2 kg. (4 lbs)	Acrylics, acetates, triacetates including mixtures with wool. Polyester/wool blends. See also note on drip dry on page 18.	K	 FABRIC CONDITIONER IF REQUIRED
	SPECIAL TREATMENTS Depends on fabric	Separate fabric conditioner cycle or extra rinse.	L	

* Variations of the times given can be caused by a number of factors including voltage, size and absorbency of the wash load, the temperature and rate of flow of the water supply. The times given are based upon a hot water supply of 50°C and a cold water supply of 15°C.

Programme content	* Programme time (approx)
Hot and Cold fill, 40°C high level main wash. Rinse, rinse. 800 r.p.m. spin for 2 minutes. Rinse, rinse. Pump and distribute clothes. 800 r.p.m. spin for 4 minutes.	45 mins
Pump and distribute clothes, followed by 800 r.p.m. spin for 4 minutes.	6 mins.
Hot and Cold fill, 60°C low level main wash. Safety rinse high level. Rinse, rinse, rinse and hold. Press Creaseguard >> button. Pump and distribute clothes, followed by 800 r.p.m. spin for 2 minutes.	39 mins
Hot and Cold fill, 50°C low level main wash. Safety rinse high level. Rinse, rinse, rinse and hold. Press Creaseguard >> button. Pump and distribute clothes. 800 r.p.m. spin for 2 minutes.	36 mins.
Hot and Cold fill, 40°C high level main wash. Rinse, rinse, rinse and hold. Press Creaseguard >> button. Pump and distribute clothes. 800 r.p.m. spin for 2 minutes.	39 mins
Cold fill, High level rinse with fabric conditioner. Rinse hold. Press Creaseguard >> button. Pump and distribute clothes. 800 r.p.m. spin for 2 minutes.	10 mins

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SHRINKAGE MEASUREMENTS
LINE DRY - 5 CYCLES

SAMPLE REF.	REPLICATION 1		REPLICATION 2		AVERAGE		
	LENGTH	WIDTH	LENGTH	WIDTH	LENGTH	WIDTH	
PROG. R	A	16.09	1.96	14.81	1.67	15.20	1.82
	B	-8.63	15.50	-1.87	15.77	-2.75	15.64
	C	4.54	3.04	3.42	4.60	3.98	3.32
	D	13.23	6.50	12.46	7.29	12.84	6.89
	E	15.25	2.24	14.96	-0.65	15.10	0.79
	F	12.47	5.08	14.50	-0.08	13.49	2.50
PROG. E	A	17.58	1.68	14.93	4.63	16.26	3.16
	B	-2.27	15.68	-2.73	16.83	-2.50	16.26
	C	3.43	4.64	4.40	3.88	3.92	4.26
	D	14.23	4.61	13.76	5.29	14.0	4.95
	E	14.60	2.20	15.80	-0.25	15.20	0.96
	F	13.10	-0.36	16.34	-4.78	14.72	-2.57
PROG. D	A	18.36	-0.22	15.52	3.41	16.94	1.60
	B	-1.94	15.35	-1.97	16.80	-1.96	16.07
	C	4.47	4.15	4.01	3.25	4.24	3.70
	D	14.85	4.71	14.44	5.04	14.65	4.86
	E	15.24	2.07	16.05	-1.00	15.65	0.54
	F	14.75	-1.19	14.63	-4.89	14.69	-3.04
PROG. C	A	19.03	-3.06	16.66	1.28	17.85	-0.89
	B	0.02	14.97	-2.45	16.48	-1.22	15.73
	C	5.13	2.20	4.99	2.80	5.06	2.50
	D	15.04	4.16	14.42	5.13	14.73	4.65
	E	14.29	0.42	16.25	-2.54	15.27	-1.06
	F	15.48	-4.41	15.41	-3.99	15.49	-4.2

SHRINKAGE MEASUREMENTS
LINE DRY - 1 CYCLE

SAMPLE REF.	REPLICATION 1		REPLICATION 2		AVERAGE		
	LENGTH	WIDTH	LENGTH	WIDTH	LENGTH	WIDTH	
PROG. R	A	11.25	5.19	11.38	5.08	11.32	5.13
	B	-2.42	13.71	-1.67	14.54	-2.05	14.13
	C	3.01	3.48	2.81	4.90	2.92	4.19
	D	10.87	7.47	11.28	8.35	11.08	7.91
	E	11.22	4.05	11.79	2.11	11.51	3.08
	F	9.44	8.80	10.67	8.20	10.06	8.65
PROG. E	A	13.65	4.62	11.81	6.98	12.59	5.80
	B	-2.49	13.78	-2.83	16.40	-2.66	15.09
	C	2.72	4.32	2.82	5.63	2.77	4.98
	D	11.52	6.52	11.97	7.20	11.75	6.86
	E	12.35	4.39	14.12	2.64	13.24	3.52
	F	9.92	6.09	12.69	3.51	11.31	4.80
PROG. D	A	14.82	4.04	12.33	5.49	13.58	4.77
	B	-2.39	14.25	-1.63	15.95	-2.01	15.10
	C	2.47	5.12	3.54	4.16	3.00	4.64
	D	12.80	5.93	12.69	7.59	12.75	6.75
	E	14.28	3.38	14.73	2.64	14.51	3.01
	F	12.33	2.42	10.89	2.60	11.61	2.51
PROG. C	A	15.43	2.55	13.84	5.23	14.64	3.89
	B	-1.00	14.08	-2.84	16.58	-1.92	15.31
	C	3.30	5.08	3.69	4.57	3.50	4.83
	D	12.33	6.75	13.10	6.80	12.72	6.78
	E	12.97	3.33	15.10	1.97	14.04	2.65
	F	12.29	3.88	12.89	2.53	12.59	3.21

EFFECT OF FABRIC DIRECTION DURING LINE DRYING ON FABRIC SHRINKAGEKey to Fabrics

1. Dyed single jersey, 24 gauge 24/330
2. Dyed single jersey, 28 gauge 32/273
3. Bleached 1 x 1 rib, 14 gauge 30/285
4. Greige state single jersey, 28 gauge 36/259
5. Dyed interlock (Springfield), 20 gauge 38/338
6. Bleached interlock (Martins), 20 gauge 38/338
7. Mercerised single jersey (Tebe), 24 gauge 2-56/354
8. Mercerised single jersey (Tosi), 24 gauge 2-56/321
9. Dyed single jersey (Tebe), 28 gauge 2-72/259
10. Mercerised single jersey (Tebe), 18 gauge 2-40/399

LENGTH SHRINKAGE-----FAST COLOURS (D) PROGRAMME
ONE CYCLE

	VERT. WALES	HORIZ. WALES
1	7.39	7.87
2	7.73	8.11
3	3.43	4.18
4	12.72	12.87
5	13.4	14.76
6	6.2	5.84
7	-2.5	-0.95
8	-0.45	0.04
9	8.58	8.56
10	4.35	5.17

WIDTH SHRINKAGE-----FAST COLOURS (D) PROGRAMME
ONE CYCLE

	VERT. WALES	HORIZ. WALES
1	5.97	4.78
2	11.62	11.61
3	2.21	-0.99
4	18.66	18.47
5	5.2	2.13
6	0.2	-2.81
7	16.65	15.25
8	19.56	19.65
9	10.11	10.14
10	7.84	6.41

LENGTH SHRINKAGE-----FAST COLOURS (D) PROGRAMME
FIVE CYCLES

	VERT. WALES	HORIZ. WALES
1	8.17	8.92
2	8.78	8.92
3	4.06	5.86
4	12.76	14.33
5	16.84	17.68
6	8.21	8.73
7	-2.85	-1.78
8	-0.93	0.28
9	8.5	9.11
10	5.93	6.92

WIDTH SHRINKAGE-----FAST COLOURS (D) PROGRAMME
FIVE CYCLES

	VERT. WALES	HORIZ. WALES
1	5.71	4.17
2	12.48	12.33
3	1.89	-2.61
4	19.6	19.05
5	3.53	-0.59
6	-1.05	-5.96
7	17.36	16.41
8	21.44	20.64
9	10.7	10.38
10	7.79	5.56

COMPARISON OF THE FAST COLOURS AND THE MINIMUM IRON WASH PROGRAMMES ONFABRIC SHRINKAGEKey to Fabrics

1. Mercerised (Omez) single jersey 24/2-56/321/7
2. Mercerised (Tebe) single jersey 28/1-36/287
3. Bleached (Martins) 14 gauge 1 x 1 rib 30/285
4. Dyed 20 gauge interlock (Springfield) 38/338 - IIC stock No. I18
5. Bleached (Martins) 20 gauge interlock 38/338 - IIC stock No. I2
6. Dyed 28 gauge interlock I28/1-70/236
7. Dyed 14 gauge 1 x 1 rib Central Project Lot No. 22 - R34/326/22
8. Dyed single jersey 18/1-16/344
9. Dyed (Tosi) single jersey 24/1-28/306
10. Mercerised (Tebe) 14 gauge 1 x 1 rib Pce. No. 19

LENGTH SHRINKAGE-----LINE DRY TEST
ONE CYCLE

	FAST COLS(D)	MIN. IRON(J)
1	-0.06	0.75
2	-0.2	0.56
3	3.68	3.26
4	14.35	16.67
5	7.34	7.22
6	13.88	12.73
7	16.17	15.85
8	3.62	4.46
9	5.94	6.41
10	5.69	5.31

WIDTH SHRINKAGE-----LINE DRY TEST
ONE CYCLE

	FAST COLS(D)	MIN. IRON(J)
1	19.06	18.87
2	14.71	15.04
3	5.65	5.49
4	7.11	5.97
5	-2.91	-1.36
6	8.96	9.75
7	1.82	1.36
8	10.95	10.76
9	4.3	5.12
10	7.47	7.75

LENGTH SHRINKAGE-----LINE DRY TEST
FIVE CYCLES

	FAST COLS(D)	MIN. IRON(J)
1	0.39	0.79
2	0.81	0.24
3	4.43	4.3
4	19.08	20.89
5	9.18	10.33
6	18.1	15.03
7	20.22	20.35
8	4.47	4.93
9	6.18	7.02
10	7.29	6.89

WIDTH SHRINKAGE-----LINE DRY TEST
FIVE CYCLES

	FAST COLS(D)	MIN. IRON(J)
1	18.71	18.99
2	14.83	14.7
3	3.83	2.7
4	0.99	-0.56
5	-6.79	-7.33
6	5.5	8.21
7	-11.85	-12.29
8	11.86	11.12
9	3.86	4.14
10	4.66	4.44

TABLE 7

LENGTH SHRINKAGE-----TUMBLE DRY TEST
ONE CYCLE

	FAST COLS (D)	MIN. IRON (J)
1	6.96	8.21
2	13	13.59
3	6.01	5.77
4	17.85	16.79
5	9.95	9.56
6	13.75	13.97
7	17.95	16.86
8	6.76	6.66
9	9.66	9.56
10	14.74	14.91

WIDTH SHRINKAGE-----TUMBLE DRY TEST
ONE CYCLE

	FAST COLS (D)	MIN. IRON (J)
1	20.03	18.98
2	15.47	15.86
3	9.52	7.45
4	11.38	10.83
5	3.8	4.24
6	13.04	13.28
7	15.55	13.95
8	11.61	11.4
9	7.8	8
10	15.91	15.56

LENGTH SHRINKAGE-----TUMBLE DRY TEST
FIVE CYCLES

	FAST COLS (D)	MIN. IRON (J)
1	9.15	10.27
2	17.26	19.02
3	7.73	8.05
4	21.88	21.72
5	12.43	13.51
6	17.04	18.12
7	21.57	21.45
8	7.73	8.19
9	11.13	11.45
10	17.19	18.26

WIDTH SHRINKAGE-----TUMBLE DRY TEST
FIVE CYCLES

	FAST COLS (D)	MIN. IRON (J)
1	19.72	18.85
2	14.89	13.91
3	8.67	8.85
4	10.11	7.36
5	3.53	3.65
6	13.36	13.03
7	8.31	5.6
8	12.67	12.18
9	7.92	8.64
10	14.05	14.41

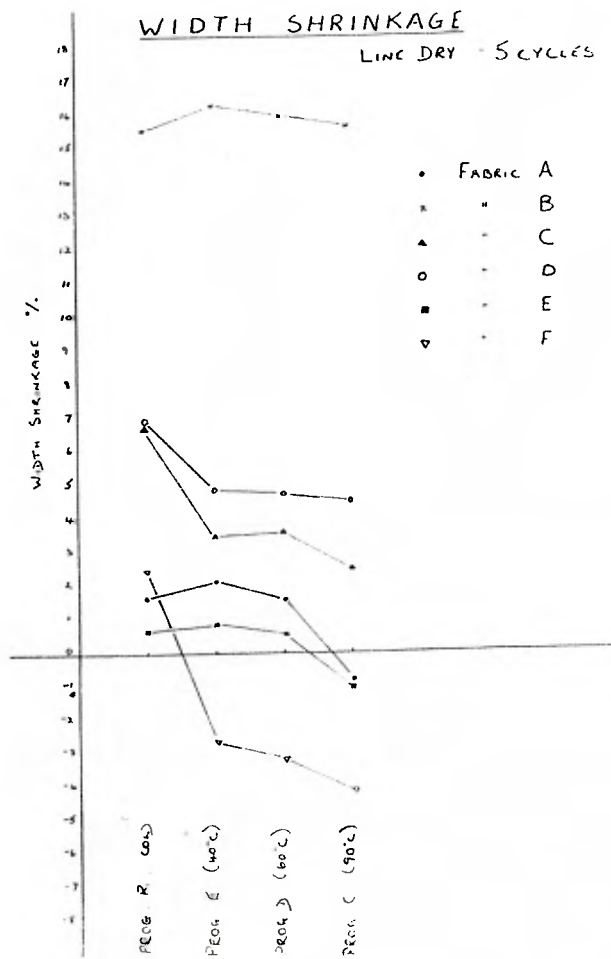
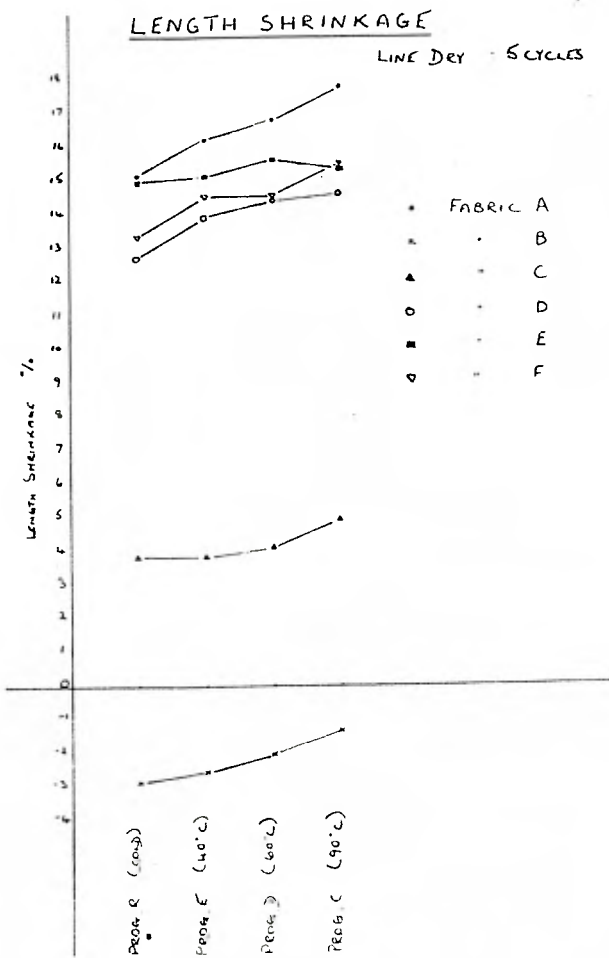
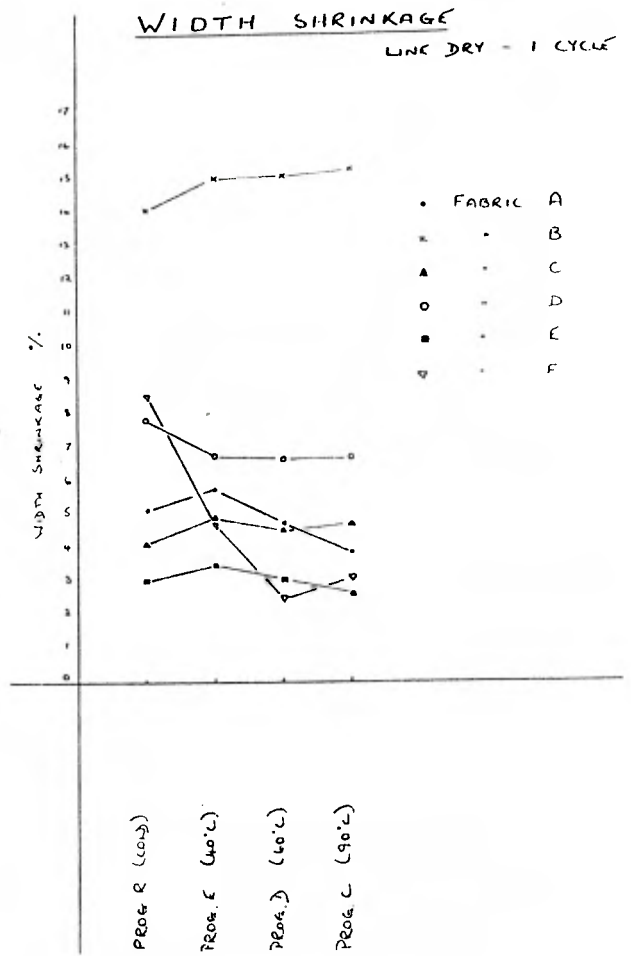
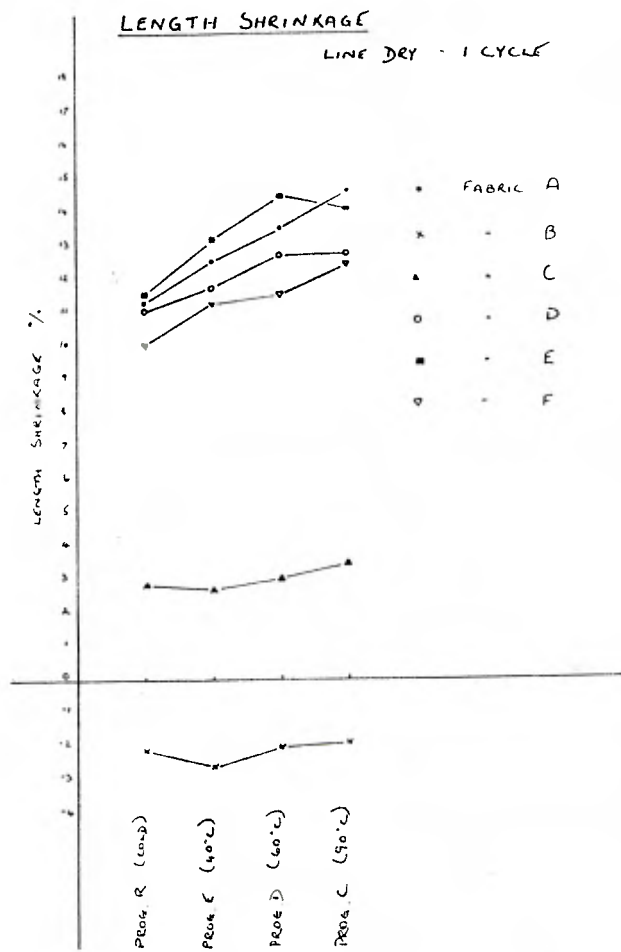
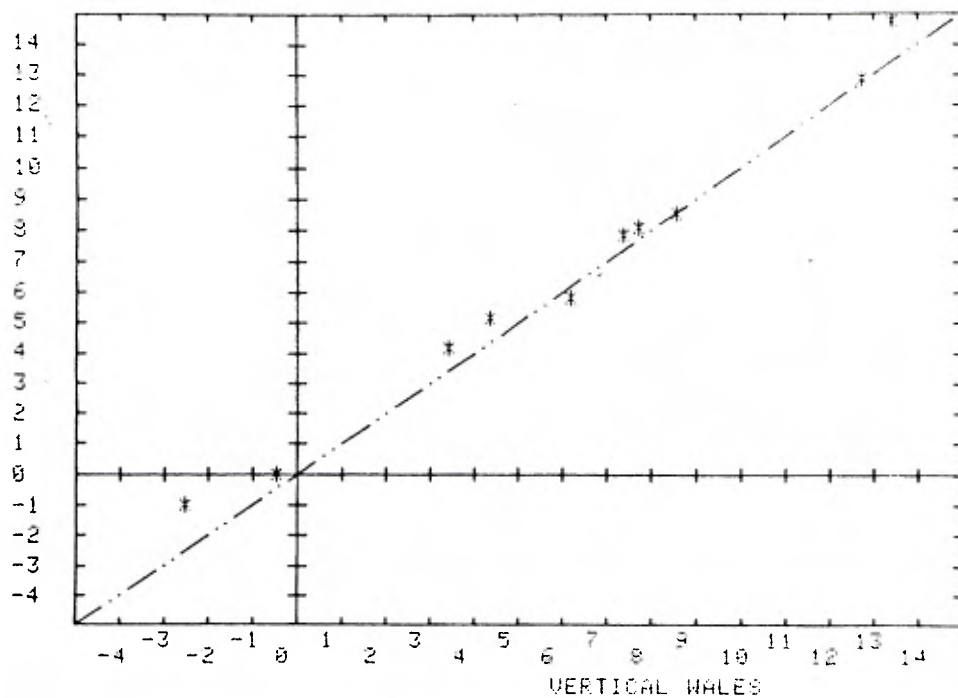


FIG. 1

LENGTH SHRINKAGE-----1 CYCLE

HORIZ. WALES



LENGTH SHRINKAGE-----FIVE CYCLES

HORIZ. WALES

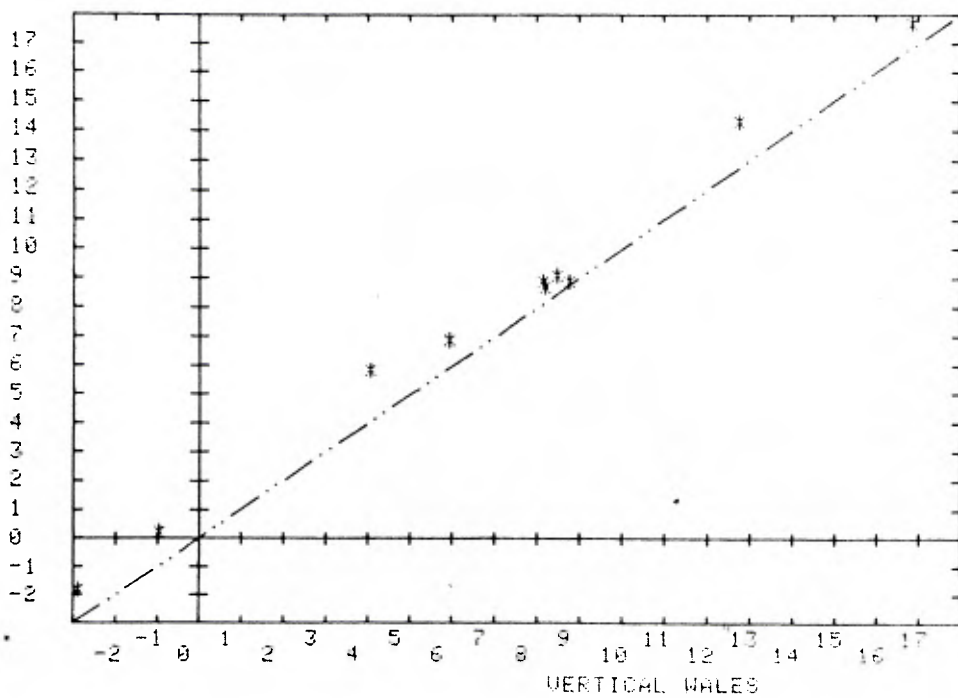
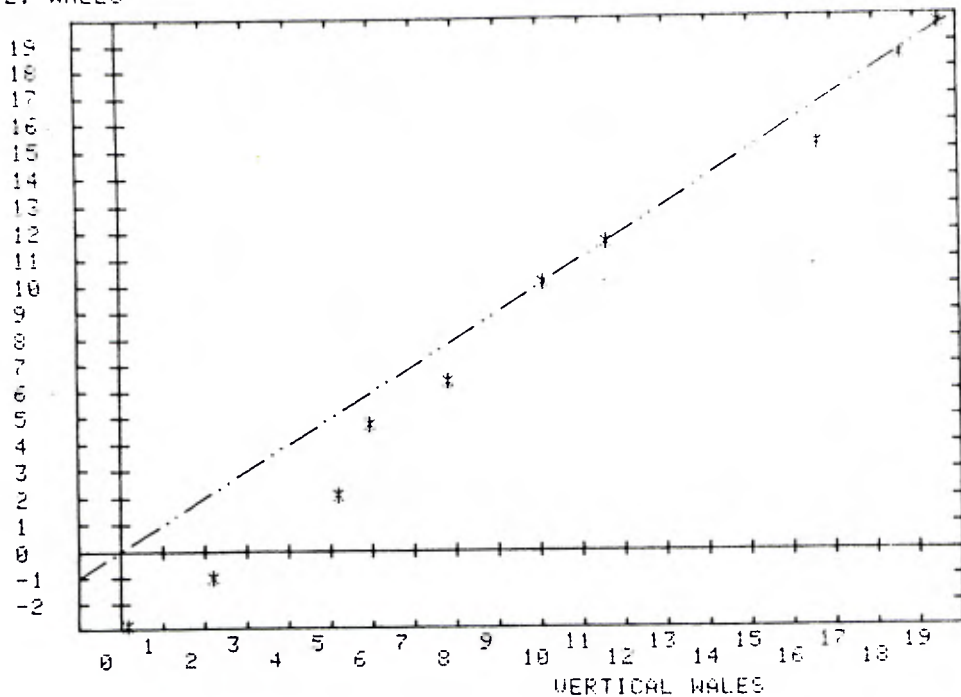


FIG 2.

WIDTH SHRINKAGE-----ONE CYCLE

HORIZ. WALES



WIDTH SHRINKAGE-----FIVE CYCLES

HORIZ. WALES

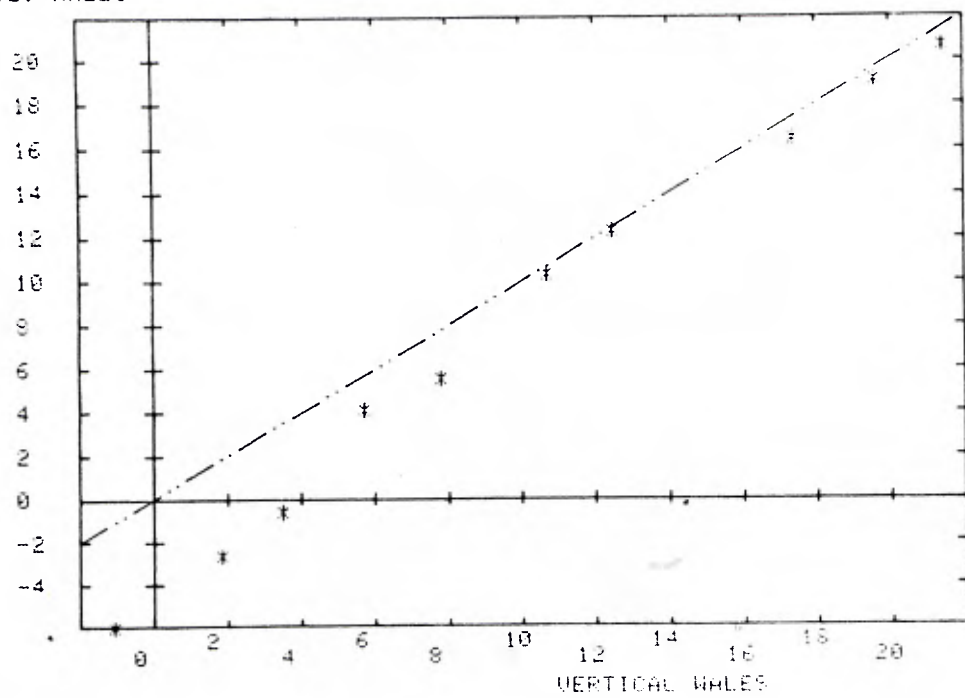
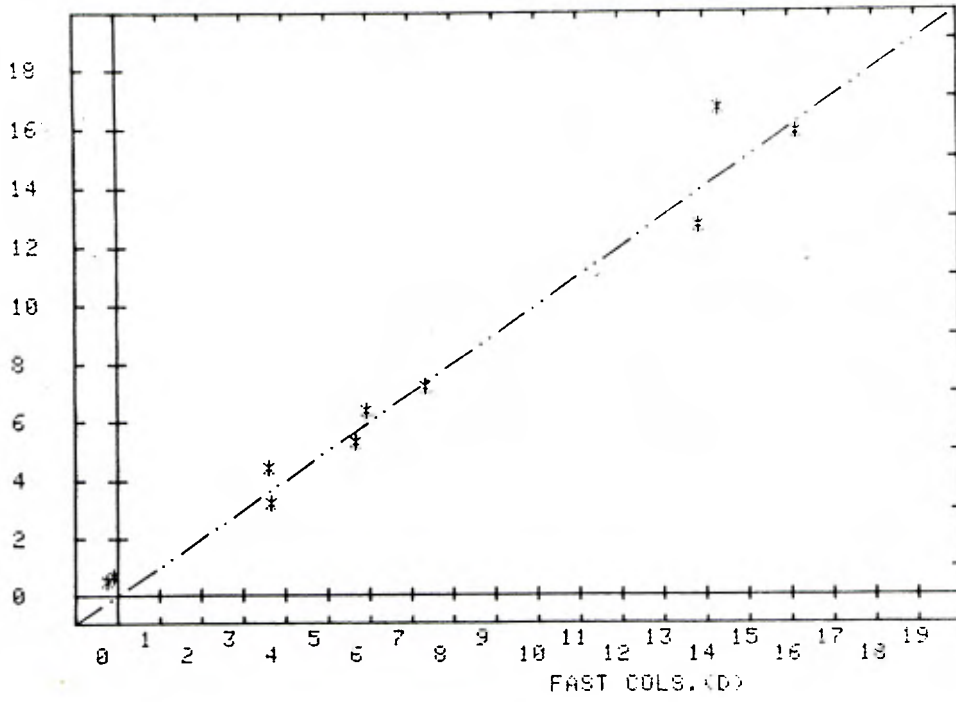


FIG. 3

LENGTH SHRINKAGE-----LINE DRY TEST--ONE CYCLE

MIN. IRON(J)



LENGTH SHRINKAGE-----LINE DRY TEST--FIVE CYCLES

MIN. IRON(J)

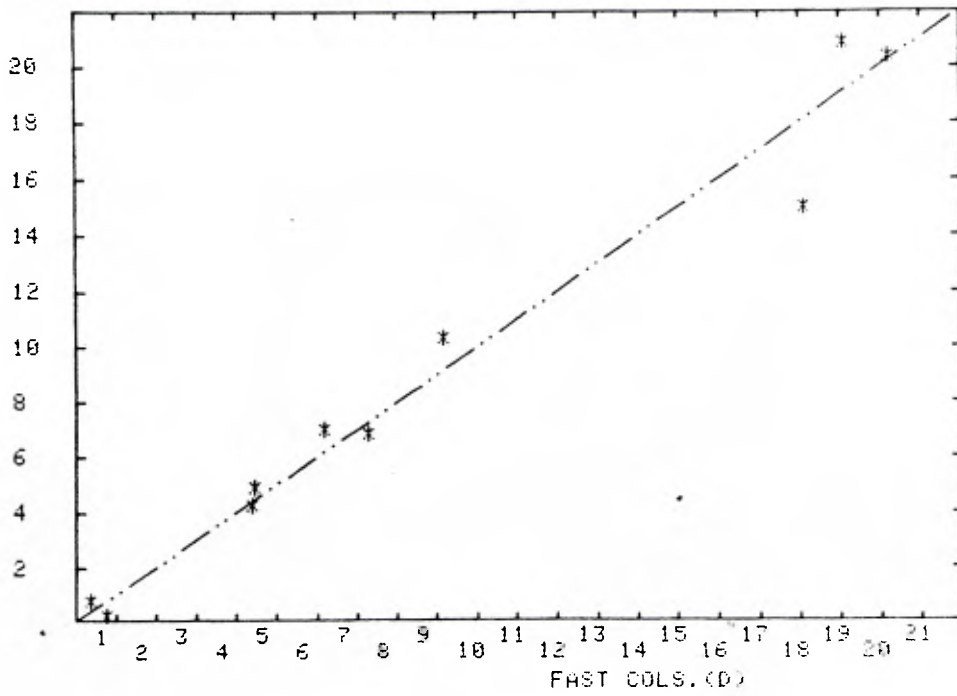
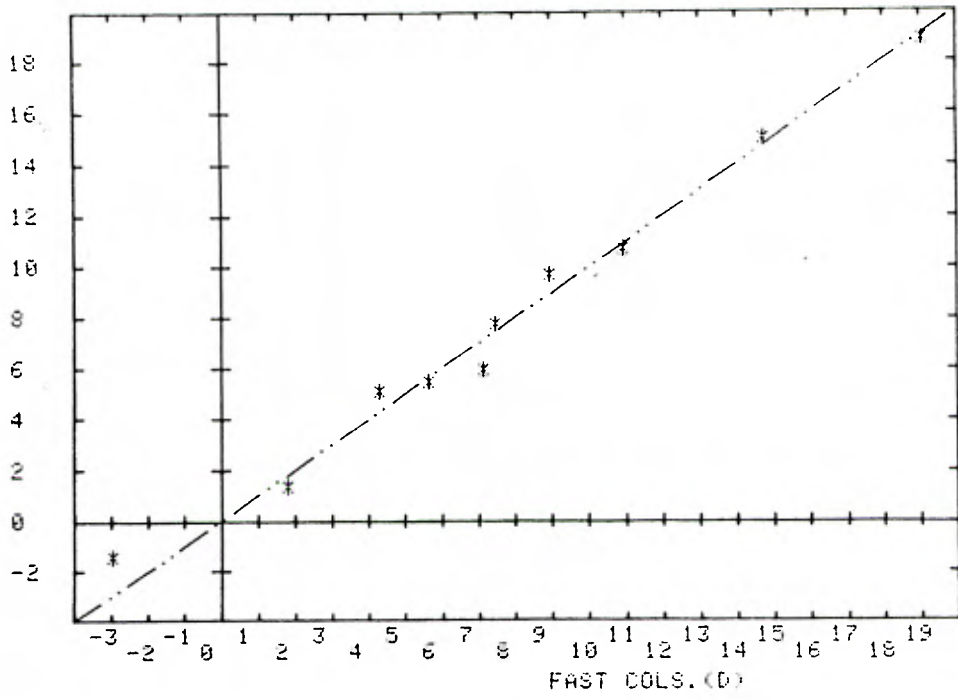


Fig 4.

WIDTH SHRINKAGE-----LINE DRY TEST--ONE CYCLE

MIN. IRON(J)



WIDTH SHRINKAGE-----LINE DRY TEST--FIVE CYCLES

MIN. IRON(J)

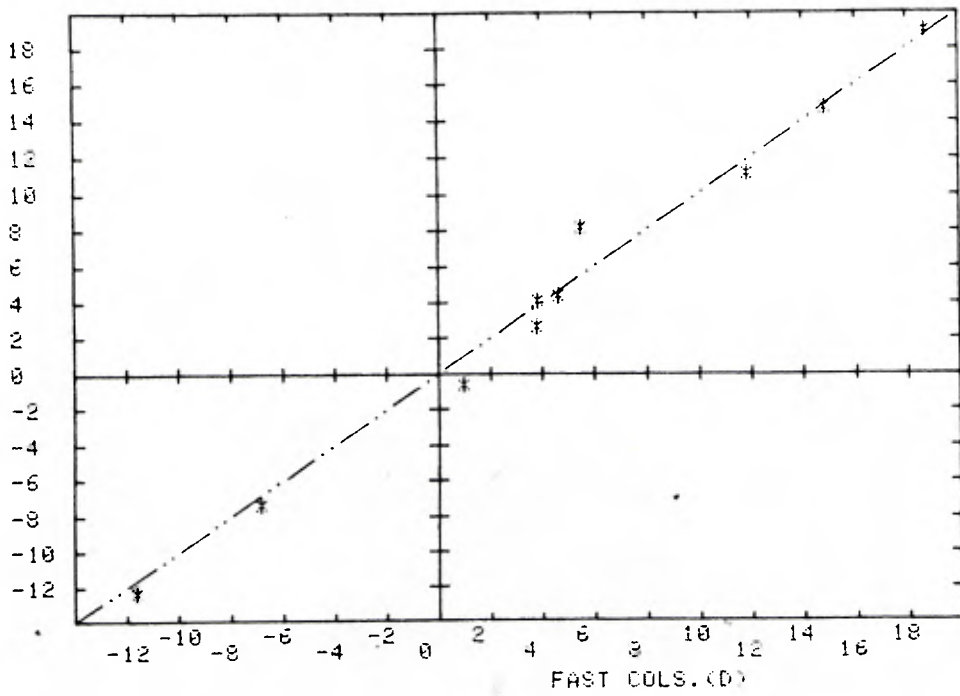
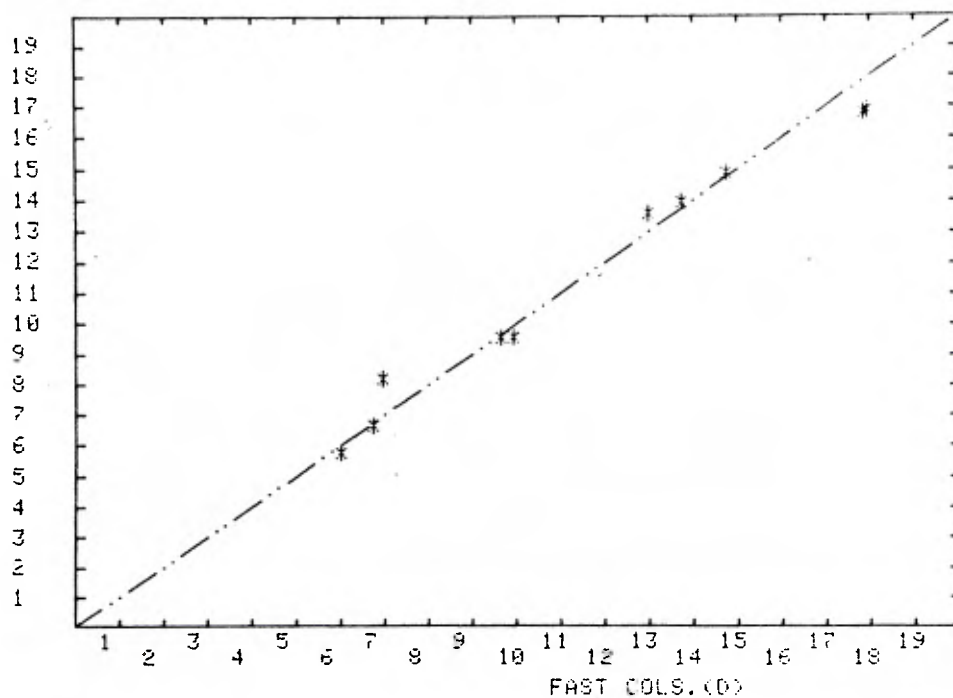


Fig. 5.

LENGTH SHRINKAGE-----TUMBLE DRY TEST--ONE CYCLE

MIN. IRON(J)



LENGTH SHRINKAGE-----TUMBLE DRY TEST--FIVE CYCLES

MIN. IRON(J)

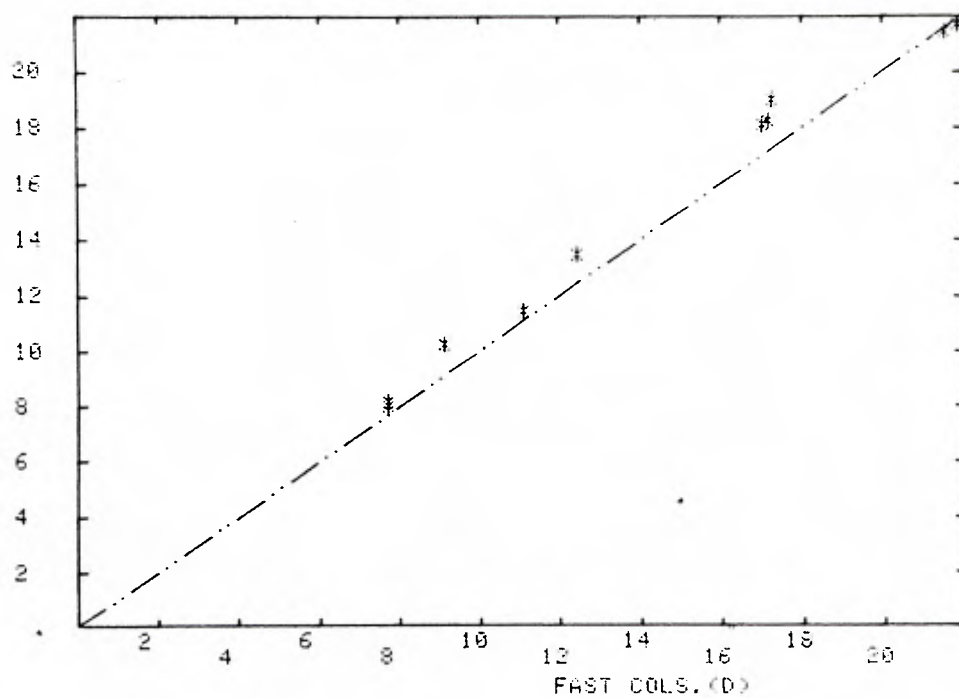
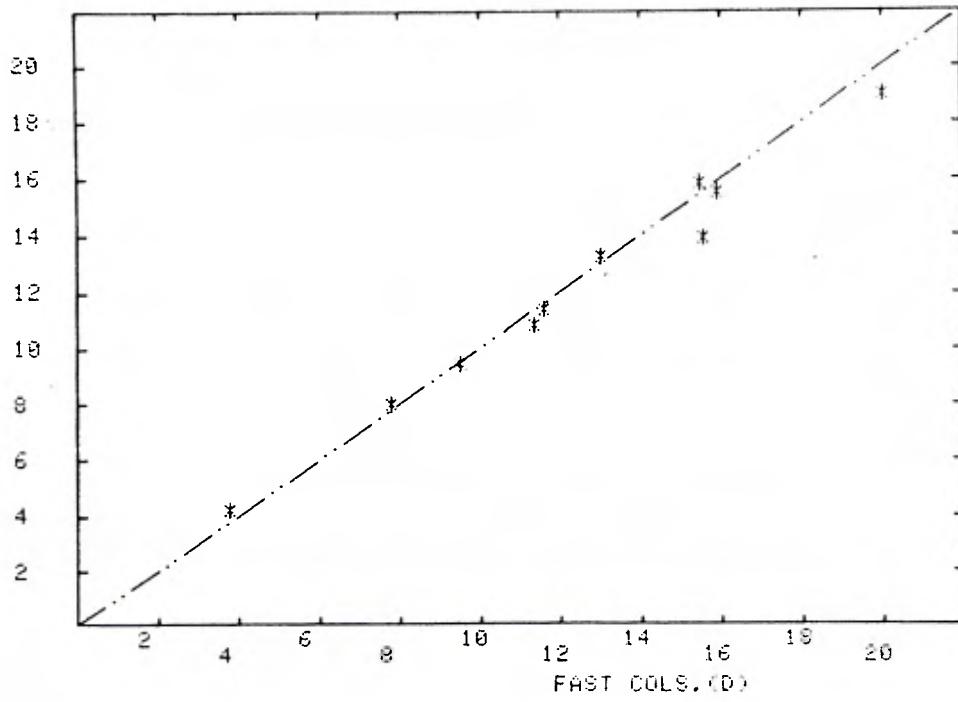


FIG 6

WIDTH SHRINKAGE-----TUMBLE DRY TEST--ONE CYCLE

MIN. IRON(O)



WIDTH SHRINKAGE-----TUMBLE DRY TEST--FIVE CYCLES

MIN. IRON(O)

