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Validation of the Newly Developed Fabric Feel Tester for Its Accuracy and Reproducibility

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Abstract
The present paper deals with a comprehensive study of reproducibility of the newly developed instrument to study fabric handle characteristics using extraction principle. As reported earlier that a new nozzle extraction method for objective measurement of fabric handle characteristics has been developed. The force exerted by the fabric being drawn out of the nozzle is known as extraction force and the force exerted by the fabric at the side wall of the nozzle is known as radial force. A few fabric samples have been tested on this newly developed instrument and the effect of numbers of tests has been studied. It has been observed that minimum five samples of a fabric test in this instrument gives lower standard deviation of the test results. Also the overall deviations of results justified the reproducibility of the instrument and hence the said instrument if validated for its testing parameters.
Keywords: Nozzle extraction, fabric handle, instrument, reproducibility, validity

I. Introduction

Feel of Fabric or in other word hand value is one the most important fabric parameter related to the textiles intended to judge the apparel quality. Fabric hand value influences customer inclination towards the material and usefulness of the product and it has direct impact on the selling ability of the apparel. As reported earlier that an instrument has been developed to study fabric hand characteristics objectively using nozzle extraction method [1]. There are many researchers, working on this principle [2-9]. At this juncture I beg your pardon for mentioning very few references on the above; in fact list is very long. Due to various dimension of approach and complexity of the process the work on this area still goes on.

In the process of development of any test equipment or instrument, the feature of the instrument is very important, but more importantly the repeatability or reproducibility is the key issue apart from the type and nature of the instrument.

In the present study, the newly developed instrument was tested for its reproducibility. An effort has been made to study the variability of test results associated with this instrument. The natural variability of textile material is very high. Therefore, repeatability or reproducibility study of any instrument is very important under the checks and balances of the purview of the community. Applicability of the instrument is under the sole discretion of user the way they want to utilise the same.

II. Materials and Methods

2.1 Materials

Two suiting fabric samples were used for this purpose of the following particulars given in Table No. 1. In fact more number of fabric samples were studied for this purpose, but due to constraint of space only above mentioned two fabrics sample testing are being reported here.

2.2 Method Used

For each fabric samples 20 experiments were conducted. Experimental data were grouped from 2 to 10 and averages were calculated. Also variations of grouped data with different group number were calculated.

As mentioned earlier the said instrument records three types of forces generated during extracting through nozzle, namely one axial load and two radial – left and right loads. The above mentioned method followed for all the three forces and the data were analyzed for its accuracy level at different group number to determine the repeatability of the instrument and the optimum or minimum number of test required to perform in the instrument.

Table No. 1: Fabric Sample Particulars

Sample No.	EPI	PPI	Count (Ne)		Thickness (mm)	GSM	Bending Length			G, mg.cm	q, kg/sq cm
			Warp	Weft			Warp (cm)	Weft (cm)	Avg		
Su1	64	56	14.6	14.5	0.407	259.510	1.7	1.6	1.64	115.255	3.401
Su2	38	34	7.2	7.1	0.500	258.581	1.8	1.6	1.68	121.518	2.916

III. Results and Discussions

The axial load recorded by the instrument for sample number Su1 in kg is tabulated in table no. 2 and also calculations are done by grouping of data from 2 to 10. It can be seen from the table that the column correspond to Avg 2 i.e. the third column in the table gives the estimation of averages by taking two test data namely (1,2), (2,3), (3,4) and so on. Similarly in the next column three test data are grouped viz (1,2,3), (2,3,4), (3,4,5) and so on. The subsequent columns are also tabulated in the same manner. Similarly the experimental data of radial load – right and left load cells are tabulated and computed in the table number 3 and 4 respectively. At the bottom of the table standard deviations (SD) also computed for each corresponding columns. The data for SD for axial load, radial – right and radial – left loads are combined in the table number 5.

The data for the fabric sample number Su2 is tabulated and computed in the same manner for axial load, radial –right load, radial – left load and SD data in the table number 6, 7, 8 and 9 respectively.

From the table 2, 3 and 4 for sample Su1 and table 6, 7 and 8 for sample Su2, it can be seen that when number of test data grouping increased from 2 to 10 the variability of results gradually decreases. The said phenomenon is better visualised from the graphical representation of the same in fig 1, 2, 3, 5, 6 and 7.

From the table 5 and 9, it can be seen that standard deviations of the test data are within acceptable limits considering the inherent variability of textile materials. The graphical representation of the same is given in fig 4 and 8 for Su1 and Su2 respectively. From the tables and the figs it is clear that the standard deviations decreases significantly when number of test data considered up to 5 and thereafter no significant reduction in SD.

Table 2: Sample No. Su1 - Effect of Number Test on Axial Load

Test No.	**Axial Load (kg)**	**Avg 2**	**Avg 3**	**Avg 4**	**Avg 5**	**Avg 6**	**Avg 7**	**Avg 8**	**Avg 9**	**Avg 10**
1	0.190									
2	0.210	0.2000								
3	0.215	0.2125	0.2050							
4	0.185	0.2000	0.2033	0.2000						
5	0.150	0.1675	0.1833	0.1900	0.1900					
6	0.230	0.1900	0.1883	0.1950	0.1980	0.1967				
7	0.245	0.2375	0.2083	0.2025	0.2050	0.2058	0.2036			
8	0.250	0.2475	0.2417	0.2188	0.2120	0.2125	0.2121	0.2094		
9	0.220	0.2350	0.2383	0.2363	0.2190	0.2133	0.2136	0.2131	0.2106	
10	0.241	0.2305	0.2370	0.2390	0.2372	0.2227	0.2173	0.2170	0.2162	0.2136
11	0.236	0.2385	0.2323	0.2368	0.2384	0.2370	0.2246	0.2196	0.2191	0.2182
12	0.195	0.2155	0.2240	0.2230	0.2284	0.2312	0.2310	0.2209	0.2169	0.2167
13	0.200	0.1975	0.2103	0.2180	0.2184	0.2237	0.2267	0.2271	0.2186	0.2152
14	0.235	0.2175	0.2100	0.2165	0.2214	0.2212	0.2253	0.2278	0.2280	0.2202
15	0.210	0.2225	0.2150	0.2100	0.2152	0.2195	0.2196	0.2234	0.2258	0.2262
16	0.195	0.2025	0.2133	0.2100	0.2070	0.2118	0.2160	0.2165	0.2202	0.2227
17	0.215	0.2050	0.2067	0.2138	0.2110	0.2083	0.2123	0.2159	0.2163	0.2197
18	0.180	0.1975	0.1967	0.2000	0.2070	0.2058	0.2043	0.2083	0.2119	0.2127
19	0.240	0.2100	0.2117	0.2075	0.2080	0.2125	0.2107	0.2088	0.2118	0.2147
20	0.245	0.2425	0.2217	0.2200	0.2150	0.2142	0.2171	0.2150	0.2128	0.2151
Avg	**0.2144**									
SD	**0.0266**	**0.0208**	**0.0164**	**0.0144**	**0.0129**	**0.0104**	**0.0081**	**0.0065**	**0.0055**	**0.0042**

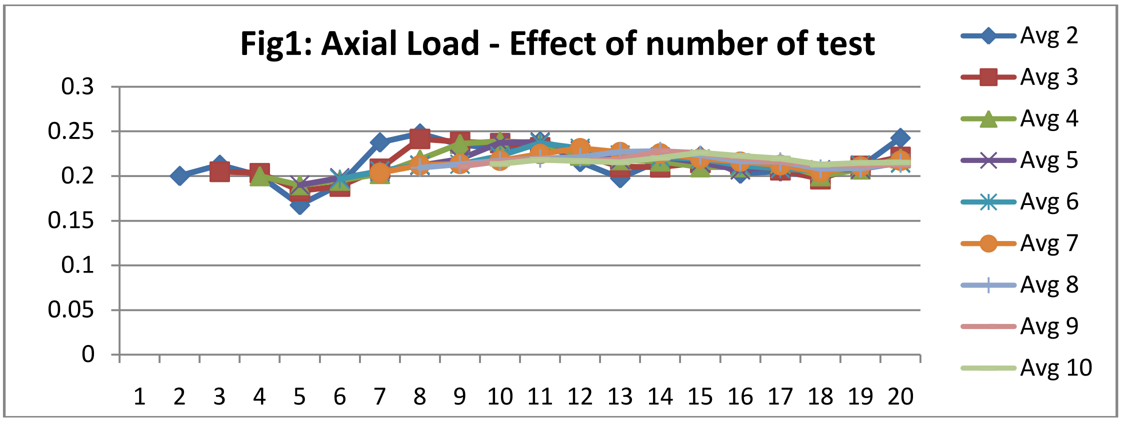


Table 3: Sample No. Su1 - Effect of Number Test on Radial Load (Right)

Test No.	Radial Load (Right) (kg)	Avg 2	Avg 3	Avg 4	Avg 5	Avg 6	Avg 7	Avg 8	Avg 9	Avg 10
1	0.025									
2	0.030	0.0275								
3	0.022	0.0260	0.0257							
4	0.027	0.0245	0.0263	0.0260						
5	0.026	0.0265	0.0250	0.0263	0.0260					
6	0.031	0.0285	0.0280	0.0265	0.0272	0.0268				
7	0.036	0.0335	0.0310	0.0300	0.0284	0.0287	0.0281			
8	0.040	0.0380	0.0357	0.0333	0.0320	0.0303	0.0303	0.0296		
9	0.015	0.0275	0.0303	0.0305	0.0296	0.0292	0.0281	0.0284	0.0280	
10	0.028	0.0215	0.0277	0.0298	0.0300	0.0293	0.0290	0.0281	0.0283	0.0280
11	0.032	0.0300	0.0250	0.0288	0.0302	0.0303	0.0297	0.0294	0.0286	0.0287
12	0.035	0.0335	0.0317	0.0275	0.0300	0.0310	0.0310	0.0304	0.0300	0.0292
13	0.045	0.0400	0.0373	0.0350	0.0310	0.0325	0.0330	0.0328	0.0320	0.0315
14	0.037	0.0410	0.0390	0.0373	0.0354	0.0320	0.0331	0.0335	0.0332	0.0325
15	0.041	0.0390	0.0410	0.0395	0.0380	0.0363	0.0333	0.0341	0.0343	0.0340
16	0.039	0.0400	0.0390	0.0405	0.0394	0.0382	0.0367	0.0340	0.0347	0.0348
17	0.033	0.0360	0.0377	0.0375	0.0390	0.0383	0.0374	0.0363	0.0339	0.0345
18	0.028	0.0305	0.0333	0.0353	0.0356	0.0372	0.0369	0.0363	0.0353	0.0333
19	0.024	0.0260	0.0283	0.0310	0.0330	0.0337	0.0353	0.0353	0.0349	0.0342
20	0.038	0.0310	0.0300	0.0308	0.0324	0.0338	0.0343	0.0356	0.0356	0.0352
Avg	0.0316									
SD	0.0074	0.0060	0.0053	0.0047	0.0041	0.0036	0.0033	0.0030	0.0029	0.0026

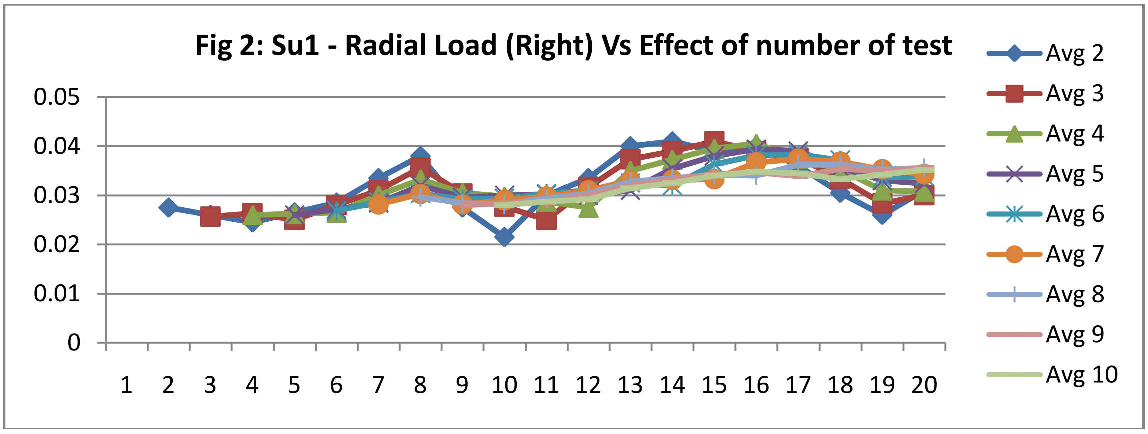


Table 4: Sample No. Su1 - Effect of Number Test on Radial Load (Left)

Test No.	Radial Load (Left) (kg)	Avg 2	Avg 3	Avg 4	Avg 5	Avg 6	Avg 7	Avg 8	Avg 9	Avg 10
1	0.025									
2	0.023	0.0240								
3	0.028	0.0255	0.0253							
4	0.031	0.0295	0.0273	0.0268						
5	0.033	0.0320	0.0307	0.0288	0.0280					
6	0.026	0.0295	0.0300	0.0295	0.0282	0.0277				
7	0.024	0.0250	0.0277	0.0285	0.0284	0.0275	0.0271			
8	0.038	0.0310	0.0293	0.0303	0.0304	0.0300	0.0290	0.0285		
9	0.026	0.0320	0.0293	0.0285	0.0294	0.0297	0.0294	0.0286	0.0282	
10	0.027	0.0265	0.0303	0.0288	0.0282	0.0290	0.0293	0.0291	0.0284	0.0281
11	0.032	0.0295	0.0283	0.0308	0.0294	0.0288	0.0294	0.0296	0.0294	0.0288
12	0.033	0.0325	0.0307	0.0295	0.0312	0.0300	0.0294	0.0299	0.0300	0.0298
13	0.035	0.0340	0.0333	0.0318	0.0306	0.0318	0.0307	0.0301	0.0304	0.0305
14	0.024	0.0295	0.0307	0.0310	0.0302	0.0295	0.0307	0.0299	0.0294	0.0298
15	0.028	0.0260	0.0290	0.0300	0.0304	0.0298	0.0293	0.0304	0.0297	0.0293
16	0.036	0.0320	0.0293	0.0308	0.0312	0.0313	0.0307	0.0301	0.0310	0.0303
17	0.035	0.0355	0.0330	0.0308	0.0316	0.0318	0.0319	0.0313	0.0307	0.0314
18	0.032	0.0335	0.0343	0.0328	0.0310	0.0317	0.0319	0.0319	0.0313	0.0308
19	0.024	0.0280	0.0303	0.0318	0.0310	0.0298	0.0306	0.0309	0.0310	0.0306
20	0.022	0.0230	0.0260	0.0283	0.0298	0.0295	0.0287	0.0295	0.0299	0.0301
Avg	0.0291									
SD	0.0049	0.0036	0.0024	0.0015	0.0012	0.0014	0.0013	0.0010	0.0010	0.0009

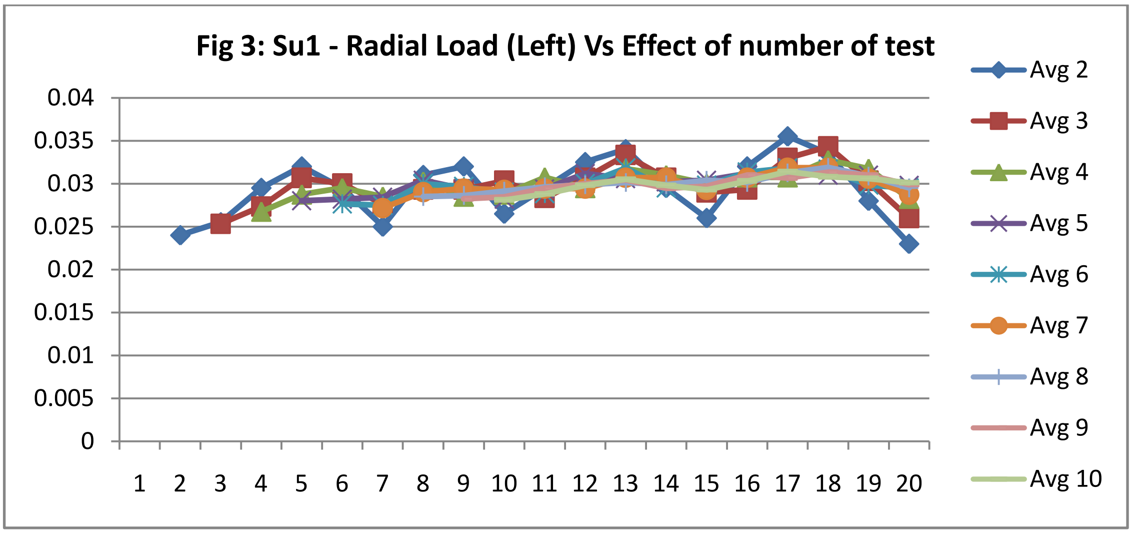


Fig 3: Su1 - Radial Load (Left) Vs Effect of number of test

Table 5: Su1 - Number of test data grouped Vs Standard Deviations

	2	3	4	5	6	7	8	9	10
Axial	0.02080679	0.0164437	0.0144372	0.0129085	0.0103642	0.0081432	0.0064789	0.0054582	0.0041541
Radial - Right	0.0059642	0.0053149	0.0046861	0.004113	0.0036409	0.0032614	0.0030278	0.0029096	0.0026212
Radial - Left	0.00360778	0.0023577	0.0015413	0.0012082	0.0013558	0.0012808	0.0009721	0.0009874	0.0009438

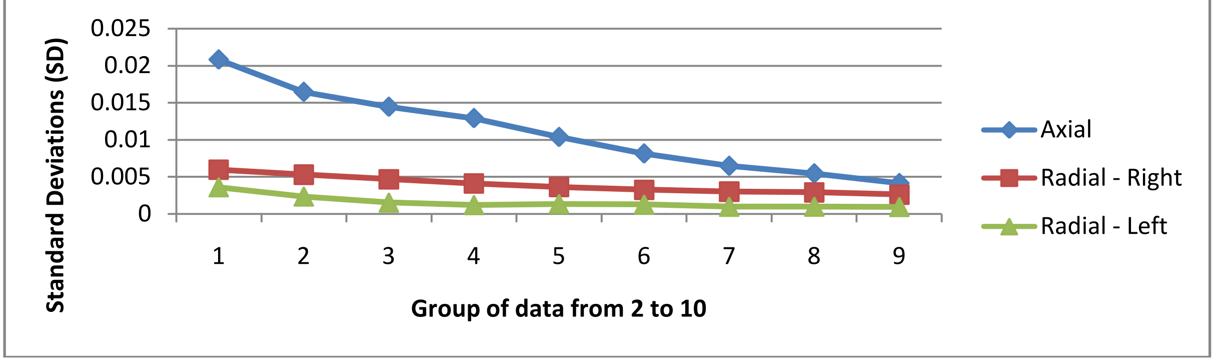


Fig4: Su1 - Number of test Vs Standard deviations

Table 6: Sample No. Su2 - Effect of Number Test on Axial Load

Test No.	Axial Load (kg)	Avg 2	Avg 3	Avg 4	Avg 5	Avg 6	Avg 7	Avg 8	Avg 9	Avg 10
1	0.320									
2	0.335	0.3275								
3	0.350	0.3425	0.3350							
4	0.290	0.3200	0.3250	0.3238						
5	0.285	0.2875	0.3083	0.3150	0.3160					
6	0.310	0.2975	0.2950	0.3088	0.3140	0.3150				
7	0.325	0.3175	0.3067	0.3025	0.3120	0.3158	0.3164			
8	0.340	0.3325	0.3250	0.3150	0.3100	0.3167	0.3193	0.3194		
9	0.345	0.3425	0.3367	0.3300	0.3210	0.3158	0.3207	0.3225	0.3222	
10	0.320	0.3325	0.3350	0.3325	0.3280	0.3208	0.3164	0.3206	0.3222	0.3220
11	0.355	0.3375	0.3400	0.3400	0.3370	0.3325	0.3257	0.3213	0.3244	0.3255
12	0.360	0.3575	0.3450	0.3450	0.3440	0.3408	0.3364	0.3300	0.3256	0.3280
13	0.345	0.3525	0.3533	0.3450	0.3450	0.3442	0.3414	0.3375	0.3317	0.3275
14	0.330	0.3375	0.3450	0.3475	0.3420	0.3425	0.3421	0.3400	0.3367	0.3315
15	0.290	0.3100	0.3217	0.3313	0.3360	0.3333	0.3350	0.3356	0.3344	0.3320
16	0.285	0.2875	0.3017	0.3125	0.3220	0.3275	0.3264	0.3288	0.3300	0.3295
17	0.315	0.3000	0.2967	0.3050	0.3130	0.3208	0.3257	0.3250	0.3272	0.3285
18	0.340	0.3275	0.3133	0.3075	0.3120	0.3175	0.3236	0.3275	0.3267	0.3285
19	0.350	0.3450	0.3350	0.3225	0.3160	0.3183	0.3221	0.3269	0.3300	0.3290
20	0.315	0.3325	0.3350	0.3300	0.3210	0.3158	0.3179	0.3213	0.3256	0.3285
Avg	**0.3253**									
SD	**0.0239**	**0.0208**	**0.0178**	**0.0148**	**0.0125**	**0.0107**	**0.0089**	**0.0068**	**0.0046**	**0.0027**

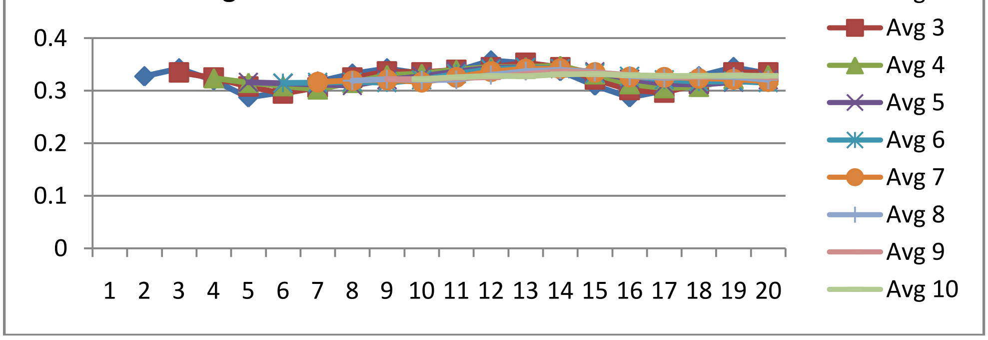


Fig 5: Su2 -Axial Load vs Effect of number of test

Table 7: Sample No. Su2 - Effect of Number Test on Radial Load (Right)

Test No.	Radial Load (Right) (kg)	Avg 2	Avg 3	Avg 4	Avg 5	Avg 6	Avg 7	Avg 8	Avg 9	Avg 10
1	0.050									
2	0.045	0.0475								
3	0.039	0.0420	0.0447							
4	0.055	0.0470	0.0463	0.0473						
5	0.060	0.0575	0.0513	0.0498	0.0498					
6	0.035	0.0475	0.0500	0.0473	0.0468	0.0473				
7	0.040	0.0375	0.0450	0.0475	0.0458	0.0457	0.0463			
8	0.052	0.0460	0.0423	0.0468	0.0484	0.0468	0.0466	0.0470		
9	0.063	0.0575	0.0517	0.0475	0.0500	0.0508	0.0491	0.0486	0.0488	
10	0.037	0.0500	0.0507	0.0480	0.0454	0.0478	0.0489	0.0476	0.0473	0.0476
11	0.048	0.0425	0.0493	0.0500	0.0480	0.0458	0.0479	0.0488	0.0477	0.0474
12	0.046	0.0470	0.0437	0.0485	0.0492	0.0477	0.0459	0.0476	0.0484	0.0475
13	0.051	0.0485	0.0483	0.0455	0.0490	0.0495	0.0481	0.0465	0.0480	0.0487
14	0.063	0.0570	0.0533	0.0520	0.0490	0.0513	0.0514	0.0500	0.0483	0.0495
15	0.058	0.0605	0.0573	0.0545	0.0532	0.0505	0.0523	0.0523	0.0509	0.0493
16	0.036	0.0470	0.0523	0.0520	0.0508	0.0503	0.0484	0.0503	0.0504	0.0494
17	0.062	0.0490	0.0520	0.0548	0.0540	0.0527	0.0520	0.0501	0.0516	0.0516
18	0.052	0.0570	0.0500	0.0520	0.0542	0.0537	0.0526	0.0520	0.0503	0.0516
19	0.054	0.0530	0.0560	0.0510	0.0524	0.0542	0.0537	0.0528	0.0522	0.0507
20	0.060	0.0570	0.0553	0.0570	0.0528	0.0537	0.0550	0.0545	0.0536	0.0530
Avg	0.0503									
SD	0.0093	0.0063	0.0043	0.0033	0.0028	0.0029	0.0029	0.0025	0.0020	0.0019

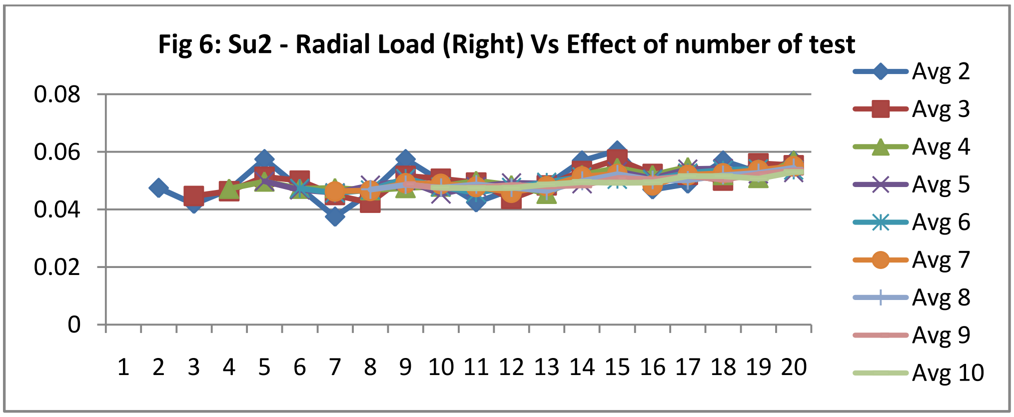


Table 8: Sample No. Su2 - Effect of Number Test on Radial Load (Left)

Test No.	Radial Load (Left) (kg)	Avg 2	Avg 3	Avg 4	Avg 5	Avg 6	Avg 7	Avg 8	Avg 9	Avg 10
1	0.049									
2	0.068	0.0585								
3	0.065	0.0665	0.0607							
4	0.072	0.0685	0.0683	0.0635						
5	0.060	0.0660	0.0657	0.0663	0.0628					
6	0.045	0.0525	0.0590	0.0605	0.0620	0.0598				
7	0.070	0.0575	0.0583	0.0618	0.0624	0.0633	0.0613			
8	0.063	0.0665	0.0593	0.0595	0.0620	0.0625	0.0633	0.0615		
9	0.066	0.0645	0.0663	0.0610	0.0608	0.0627	0.0630	0.0636	0.0620	
10	0.068	0.0670	0.0657	0.0668	0.0624	0.0620	0.0634	0.0636	0.0641	0.0626
11	0.071	0.0695	0.0683	0.0670	0.0676	0.0638	0.0633	0.0644	0.0644	0.0648
12	0.055	0.0630	0.0647	0.0650	0.0646	0.0655	0.0626	0.0623	0.0633	0.0635
13	0.065	0.0600	0.0637	0.0648	0.0650	0.0647	0.0654	0.0629	0.0626	0.0635
14	0.077	0.0710	0.0657	0.0670	0.0672	0.0670	0.0664	0.0669	0.0644	0.0640
15	0.074	0.0755	0.0720	0.0678	0.0684	0.0683	0.0680	0.0674	0.0677	0.0654
16	0.068	0.0710	0.0730	0.0710	0.0678	0.0683	0.0683	0.0680	0.0674	0.0677
17	0.065	0.0665	0.0690	0.0710	0.0698	0.0673	0.0679	0.0679	0.0677	0.0672
18	0.054	0.0595	0.0623	0.0653	0.0676	0.0672	0.0654	0.0661	0.0663	0.0663
19	0.057	0.0555	0.0587	0.0610	0.0636	0.0658	0.0657	0.0644	0.0651	0.0654
20	0.063	0.0600	0.0580	0.0598	0.0614	0.0635	0.0654	0.0654	0.0642	0.0649
Avg	0.0638									
SD	0.0083	0.0060	0.0047	0.0036	0.0029	0.0025	0.0022	0.0022	0.0019	0.0016

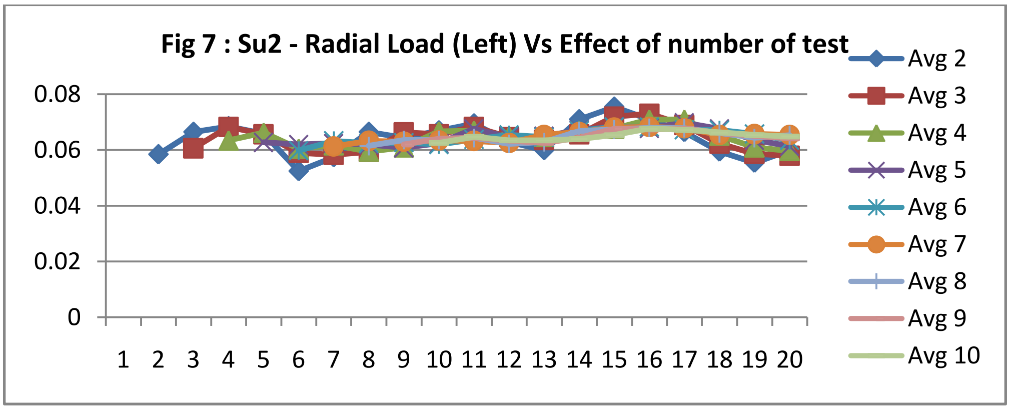
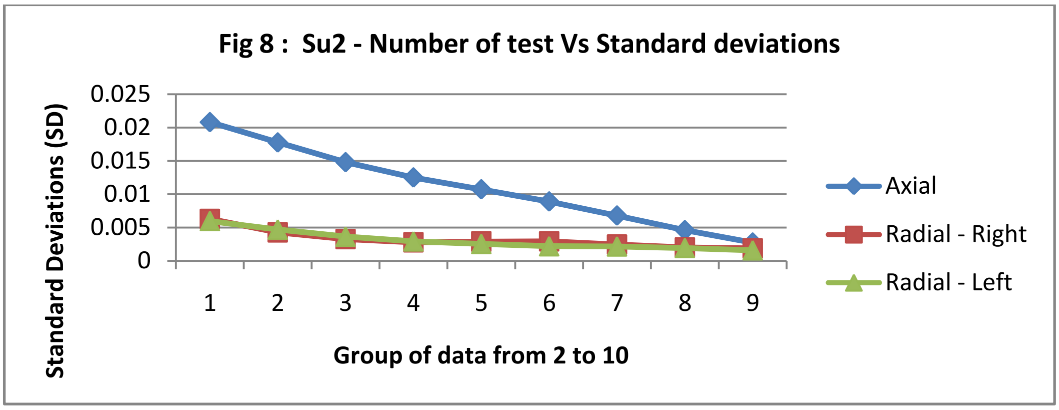


Fig 7 : Su2 - Radial Load (Left) Vs Effect of number of test

Table 9: Su2 - Number of test data grouped Vs Standard Deviations

	2	3	4	5	6	7	8	9	10
Axial	0.02083	0.01778	0.01481	0.01251	0.01073	0.0089	0.00679	0.00459	0.00272
Radial - Right	0.0063	0.00429	0.00325	0.00278	0.0029	0.00293	0.00246	0.002	0.00187
Radial - Left	0.00597	0.00471	0.00365	0.00293	0.00254	0.0022	0.00217	0.00195	0.0016



IV. CONCLUSION

From the abovementioned study it is hereby concluded that the newly developed fabric feel tester accurate enough to conduct study on handle characteristics of textile fabrics. To increase the accuracy of results, the number of test per samples should be minimum five. Hence, it is hereby claimed that the said instrument is validated for its use to study the handle characteristics in various format depending upon the researchers or application areas as applicable. As mentioned earlier that the newly developed instrument is having many features that may be useful to study and derive a fabric feel factor that will be reported in due course of time.

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