

# Effects of wetting and compression/recovering time on the compressional behaviour of sanitary napkin layers

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## ABSTRACT – REZUMAT

### Effects of wetting and compression/recovering time on the compressional behaviour of sanitary napkin layers

Sanitary napkins are technical textile products which are used by women. They are designed as layered structures to fulfil several end-use properties at the same time. One of the most important properties of sanitary napkins is absorption property and this is widely studied in the literature. On the other hand, formability and sensorial comfort of sanitary napkins are of great importance but they are ignored during scientific researches. During daily life, women sit or sleep for certain time intervals and their sanitary napkins are exposed to compressional forces. If the sanitary napkin will squeeze and not recover, this can result with poor sensorial comfort and low formability. Also, wetting of sanitary napkins during usage can worsen the compressional properties. Therefore in this study, effect of wetting and compression/recovering time on the compressional behaviours of sanitary napkins was evaluated. Study was focused on separate sanitary napkin layers in order to detect the most problematic layers. Two compression times and four recovering times were applied to samples for compression tests. Also, sanitary napkin layers were characterised by scanning electron microscopy, unit mass, thickness and bending measurements. According to results, top sheet layer was the most compressible layer in dry and wet states. This is expected to give a soft and resilience sense to the sanitary napkin. Absorbent layer was responsible for low compressibility of sanitary napkins under different compression/recovering times. Bending rigidity of absorbent layer was the highest in dry state but it exhibited a dramatic decrement after wetting.

**Keywords:** sanitary napkin layers, dry compressibility, wet compressibility, thickness loss, compression-recovery time, bending behaviour

### Influența umectării și timpului de comprimare/revenire asupra comportamentului la compresie al straturilor tamponelor igienice

Tampoanele igienice sunt produse textile tehnice care sunt utilizate de către persoane de sex feminin. Acestea sunt concepute ca structuri stratificate pentru a îndeplini mai multe cerințe de utilizare finală în același timp. Una dintre cele mai importante proprietăți ale tamponelor igienice este proprietatea de absorbție și aceasta este studiată pe larg în literatura de specialitate. Pe de altă parte, formabilitatea și confortul senzorial al tamponelor igienice sunt de o mare importanță, dar sunt ignorate în timpul cercetărilor științifice. În viața de zi cu zi, femeile stau în poziție șezând sau dorm în anumite intervale de timp, iar tampoanele igienice pe care le poartă sunt expuse forțelor de compresie. Dacă tamponul igienic se va stoarce și nu își va reveni, acest lucru poate avea ca rezultat un confort senzorial scăzut și o formabilitate redusă. De asemenea, umezirea tamponelor igienice în timpul utilizării poate agrava proprietățile de compresie. Prin urmare, în acest studiu, a fost evaluat efectul umectării și al timpului de comprimare/revenire asupra comportamentului la compresie al tamponelor igienice. Studiul s-a axat pe straturi de tampoane igienice separate pentru a detecta cele mai problematice zone. Doi timpi de comprimare și patru timpi de revenire au fost aplicați probelor pentru testele de compresie. De asemenea, straturile tamponelor igienice au fost caracterizate prin microscopie electronică de scanare, determinarea masei, grosimii și capacității de îndoire. Conform rezultatelor, stratul superior a fost cel mai compresibil strat în stare uscată și umedă. Se așteaptă ca acest lucru să ofere un tușeu moale și rezistență tamponului igienic. Stratul absorbant a fost responsabil pentru compresibilitatea scăzută a tamponelor igienice în diferite perioade de comprimare/revenire. Rigiditatea la îndoire a stratului absorbant a fost cea mai ridicată în stare uscată, dar a prezentat o scădere dramatică după umectare.

**Cuvinte-cheie:** straturi ale tamponului igienic, compresibilitate uscată, compresibilitate umedă, pierderi de grosime, timp de revenire din compresie, comportament la îndoire

## INTRODUCTION

Sanitary napkins are a member of absorbent/disposable hygiene products and they are used by women to collect the menstrual fluids hygienically. Sanitary napkins are layered materials to fulfil different end-use properties at the same time. In an ordinary sanitary napkin, there are 4 distinct layers. These layers

include textile and film structures. The first layer is the porous top sheet film that is in contact with the body. Top sheet layer is designed to transfer the menstrual flow to the inner parts of the sanitary napkin, faster. Under the top sheet, acquisition-distribution layer (ADL) exists. ADL is responsible of taking the menstrual fluid from the top sheet and transfer it to the absorbent layer. Absorption layer takes the fluid

and usually stores it in the gel form. The composition and structure of the absorbent layer may change. The last layer is the back sheet film. Back sheet has additional adhesive tapes for preventing shifting [1–3]. For ADL and absorbent layers, nonwoven structures are used as they are faster to produce, they can absorb high amounts of liquid and they are comfortable [4].

A sanitary napkin should exhibit many properties such as absorbability, leakage prevention, odour prevention, comfort, mobility, fit to the body contour and etc. In the literature, researches are usually focused on the absorption and moisture management properties of absorbent layer. For example; Karakurd Elma et al. investigated the effect of absorbent layer thickness and the ratio of superabsorbent polymer particles on the acquisition time and liquid acquisition capacities [5]. Wijesingha and Perera examined the usability of corn-husk fibres as the absorbent layer [6]. Das et al. produced absorbent layers with different concentrations of superabsorbent viscose fibres and tested their properties [7]. Similar research works can be found in the literature on sanitary napkins, incontinence pads or baby diapers [4, 8–14]. In addition, there are some survey and field studies in the literature, which question the sanitary napkin usage, perception, accessibility etc. in local places such as African countries and India [15–22]. As seen from the literature search, the studies on sanitary napkins are frequent on absorption properties. But in fact, some other properties such as bending rigidity and compressional behaviour of sanitary napkins are of great importance but they have been ignored during scientific researches.

During usage, sanitary napkins are subjected to compressive forces as a result of moving, sitting, sleeping and other daily actions. The compression and subsequent thickness recoveries of sanitary napkins are repeated during the day. This can lead to fragmentations in nonwoven content and cause shape changes during usage. As a result, the wearer can feel discomfort and experience leakage. Also, compression can change the porosity, hydraulic and absorption properties of nonwoven layers. This can also adversely affect the absorptive performance of sanitary napkins [23–26]. In addition, compressibility is related to softness and fullness of the textile structures [27]. So the compressional behaviour like compressibility and thickness recovery should be provided

in order to maintain the hand and sensorial comfort properties of sanitary napkins.

Another ignored research field for sanitary napkins is flexibility, in other terms, bending behaviour. Sanitary napkins are fixed to underwear by means of adhesive layer and wings. Because of the layered and voluminous structure of the sanitary napkin, it can resist getting the shape and it can give discomfort to the user. A sanitary napkin serves with partially dry and partially wet parts during menstruation. It is known that textile structures may exhibit different properties in dry and wet conditions [28]. So the properties of dry and wet sanitary napkins should be tested, separately. In the context of this study, by considering the literature search, compressional properties and bending behaviour of sanitary napkin layers were investigated both in dry and wet states. To determine the time dependency, compressional behaviours were evaluated for 2 compression times and 4 recovering times. The research especially targeted the sanitary napkin layers to make comparisons between them and decide the main layer which affects the aforementioned mechanical properties of the end-product. It was aimed to close the lack about this subject in the literature.

## MATERIALS AND METHODS

### Materials

Materials of this study consisted of a commercial sanitary napkin and its separate 4 layers. The samples were supplied from a Turkish company (Kocaeli, Turkey). Properties of the layers and the sanitary napkin are given in table 1. Top sheet and back sheet layers were both polyethylene (PE) films but they were differed by the production technology. Other two layers, namely ADL and absorbent layers were nonwoven fabrics. They were composed of wood pulp and superabsorbent polymer (SAP).

### Methods

#### *Microscopic evaluation*

Surface topographies of sanitary napkin layers were evaluated by using scanning electron microscope (SEM) (Jeol 6060). Energy of 5 kV was applied during operation. Both front sides and back sides of sanitary napkin layers were observed with 30 times magnification. Also 75 and 200 magnification levels were used for measurements.

Table 1

MATERIALS OF THE STUDY				
Material	Layer name	Sample code	Raw materials	Production technology
1st layer	Top sheet	TS	PE	Perforated film
2nd layer	ADL	ADL	Pulp	Airlaid nonwoven
3rd layer	Absorbent layer	ABL	Pulp+SAP	Airlaid nonwoven
4th layer	Back sheet	BS	PE	Film
Sanitary napkin	Gathered	SN	-	-

### Determination of unit mass and thickness

Unit mass of samples were determined according to TS EN 29073-1 standard by using an electronic balance [29]. Thickness of samples were determined according to TS 7128 EN ISO 5084 standard by using James Heal RxB Cloth Thickness Tester under 5 g/cm<sup>2</sup> thickness test pressure [30]. Thickness and unit mass measurements were repeated 5 times for each sample type.

All the tests were performed under standard atmosphere conditions (65±4% relative humidity and 20 ± 2°C) after being conditioned for 24 hours.

### Determination of thickness loss and compressibility

Sanitary napkins are exposed to compression loads while sitting, sleeping, walking and working for different time intervals during the day. In this study, an experimental setup was built in order to simulate the compressional forces on the sanitary napkin. According to a study [31], where the pressure maps of 68 people (36 of them were women) were obtained while sitting on a wood seat model, the maximum pressure was detected as 0.1059 kgf/cm<sup>2</sup> (105.9 gf/cm<sup>2</sup>) and it dropped to 0.053 kgf/cm<sup>2</sup> (53 gf/cm<sup>2</sup>) when sat to a pressure absorbing seat material. As the sanitary napkin partially faces the compression load during sitting, 50 gf/cm<sup>2</sup> load was selected for simulating real life conditions.

Samples were placed on a wood platform and a static load of 50 gf/cm<sup>2</sup> was applied on them. The duration of load application was selected as 2 h and 4 h. After the stated time intervals, the load was removed and thickness of samples were measured under 5 and 50 g/cm<sup>2</sup> thickness test pressures after predetermined time intervals (immediately after load removal (0 min.) and 2, 5 and 10 min. after load removal). Also thickness of samples was measured before loading. By using the measured thickness results, compressibility and thickness loss values of samples were calculated according to equations 1 and 2 [32, 33]:

$$\text{Compressibility} = C = \frac{t_5 - t_{50}}{t_5} \times 100 \quad (\%) \quad (1)$$

where  $t_5$  is thickness measured under 5 g/cm<sup>2</sup> thickness test pressure,  $t_{50}$  – thickness measured under 50 g/cm<sup>2</sup> thickness test pressure.

$$\text{Thickness loss} = t_l = \frac{t_i - t_r}{t_i} \times 100 \quad (\%) \quad (2)$$

where  $t_i$  is initial thickness (thickness before loading),  $t_r$  – recovered thickness (thickness after 0, 2, 5 and 10 min. after load removal).

Compressibility values were calculated for all time intervals (before loading and 0, 2, 5 and 10 min. after load removal). Also, thickness loss values were calculated for all time intervals and for 5 g/cm<sup>2</sup> and 50 g/cm<sup>2</sup> thickness test pressures.  $t_i$  and  $t_r$  values are schematized in figure 1.

### Determination of bending behaviour

Bending rigidity of sanitary napkin and sanitary napkin layers were determined according to ASTM D

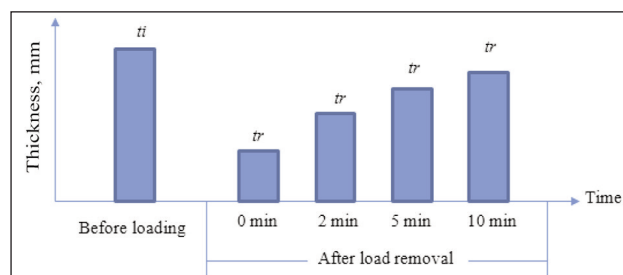


Fig. 1. Schematics of initial and recovered thickness values

1388-B standard (Heart Loop Method) [34]. Sample dimensions were 2.5 cm × 25 cm and test dimensions were 2.5 cm × 20 cm. Bending rigidity of samples was determined in the machine direction by considering the shape of the sanitary napkin.

Measurements were performed for two sides of each sample and the average was taken. For each sample type, tests were repeated for 4 times according to the standard. The measured loop lengths were used to calculate the bending rigidity values, according to equation 3. Bending length ( $c$ ),  $f_2(\theta)$  and  $\theta$  were calculated according to equations 4, 5 and 6, respectively [35]:

$$\text{Bending rigidity} = G = 1.421 \cdot 10^{-5} \cdot w \cdot c^3 \quad (\mu\text{joule/m}) \quad (3)$$

$$c = 0.1337L \cdot f_2(\theta) \quad (\text{cm}) \quad (4)$$

$$f_2(\theta) = (\cos\theta / \tan\theta)^{1/3} \quad (5)$$

$$\theta = 32.85 \cdot ((l - 0.1337L) / (0.1337L)) \quad (^\circ) \quad (6)$$

where  $L$  is strip length in cm,  $w$  – unit mass in g/m<sup>2</sup> and  $l$  – loop length in cm. Measurement of loop length in heart loop method is schematised in figure 2.

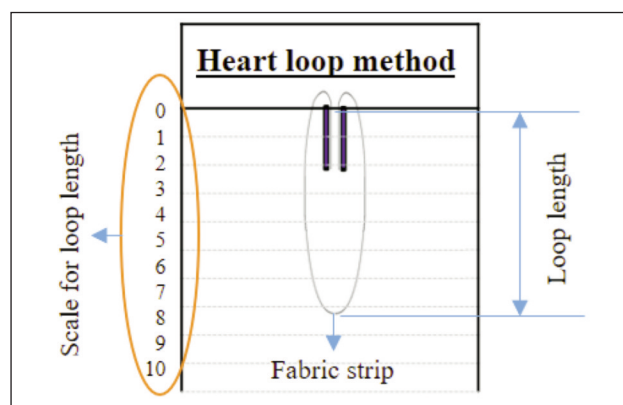


Fig. 2. Schematics of heart loop bending rigidity measurement

### Wetting of samples for wet bending test and wet compression test

For the wet bending and wet compressibility tests, samples were wetted with synthetic urine (0.9% NaCl solution) [5, 10, 36] which was kept at standard atmosphere conditions for 48 h before the tests.

For the wet bending test, samples with 2.5×25 cm sizes were wetted with 10 ml of synthetic urine with



the help of pipette. To wet the samples equally along the long side, 1 ml of synthetic urine was applied to every 2.5 cm length. The samples were kept in this situation for 5 min and then excessive solution was removed by putting the samples between two drying papers for 10–15 seconds. Before and after wetting, samples were weighed to calculate the average amount of absorbed solution.

Similarly, for wet compression test, 5×5 cm samples were wetted with 4 ml synthetic urine to keep the same ratio of wetting (0.16 ml/cm<sup>2</sup>) with the wet bending test. After removing the excessive solution, weighing and thickness measurements were performed as in aforementioned tests.

**RESULTS AND DISCUSSIONS**

**Microscopic evaluation**

SEM image of the sanitary napkin cross section is given in figure 3. Front and back side views of sanitary napkin layers are given in figure 4. As seen from the figures, all the layers have different surface topographies and different structures. They are composed together to fulfil the requirements of a sanitary napkin.

According to SEM figures, top sheet had a voluminous perforated film structure. There were pores with 336.7 μ diameter (10 measurements) and they formed protruding holes from back side to front side. This mesh structure both provides the fast liquid transfer to inner layers and soft surface. The ADL and SAP layers were in the form of nonwoven structures but they differed in the surface morphology. Face side of ADL was covered with fibrous structure with 38 μ fibre thickness (10 measurements) and the backside had adhesive points with approximately 846 μ width and 536 μ height (4 measurements). Although having wood pulp again, surface topography of absorbent layer was

different than ADL layer. The superabsorbent polymer particles could be seen in absorbent layer. The average fibre thickness was calculated as 35 μ by using 10 measurements. The back sheet was in the form of a solid film. This makes this layer waterproof. Some roughness of the back sheet surface could be

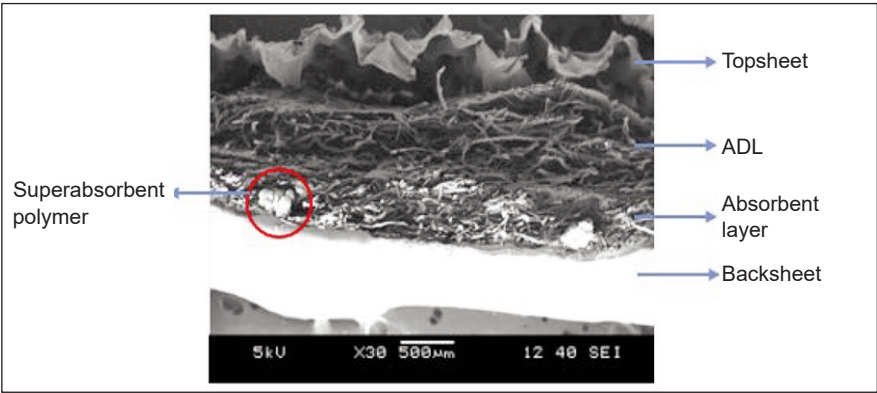


Fig. 3. Cross sectional view of the sanitary napkin

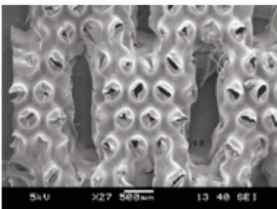
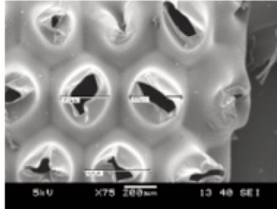
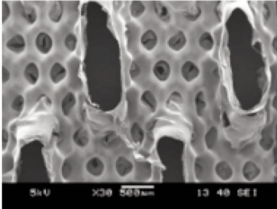
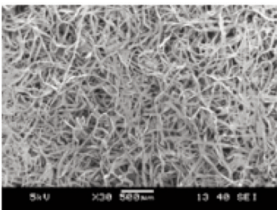
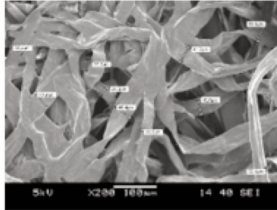
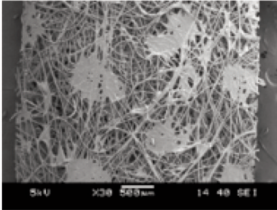
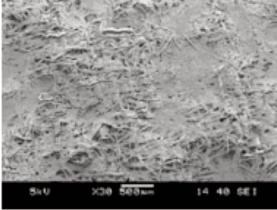
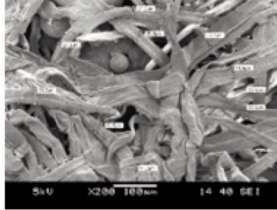
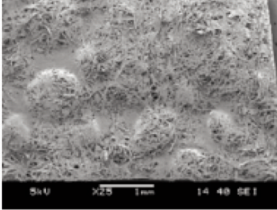
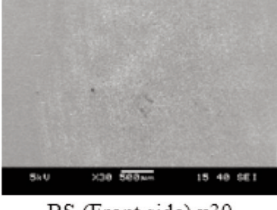
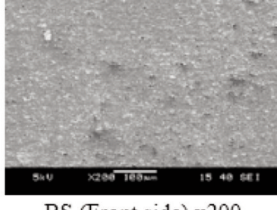
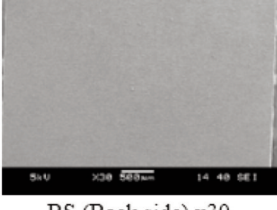
Front views of the layers		Back views of the layers
		
TS (Front side) x27	TS (Front side) x75	TS (Back side) x30
		
ADL (Front side) x30	ADL (Front side) x200	ADL (Back side) x30
		
ABL (Front side) x30	ABL (Front side) x200	ABL (Back side) x30
		
BS (Front side) x30	BS (Front side) x200	BS (Back side) x30

Fig. 4. SEM images of samples

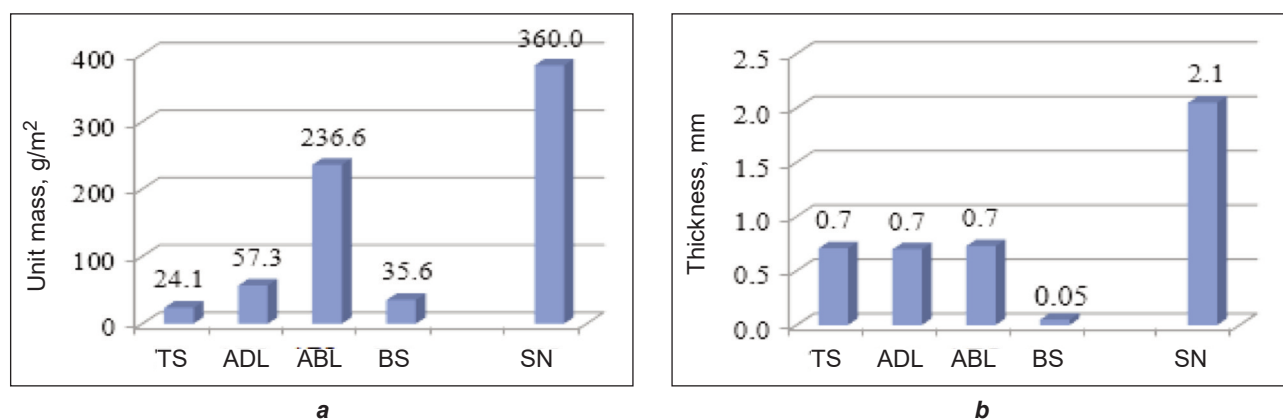


Fig. 5. Graphical representations of: *a* – unit mass of samples; *b* – thickness of samples

observed from front side view with 200 magnifications.

### Unit mass and thickness results of samples

Unit mass and thickness results of samples are given in figure 5, *a* and *b*, respectively. As seen in figure 5, *a*, unit mass of sanitary napkin layers varied in a wide range, from 24 to 236 g/m<sup>2</sup>. The lightest layer of the sanitary napkin was top sheet. ADL and absorbent layer had heavier weights. But according to figure 5, *b*, the thickness of top sheet, ADL and absorbent layer was the same as 0.7 mm. This indicated compact structures for ADL and absorbent layer. Especially absorbent layer which included wood pulp and super-absorbent polymer had a very dense structure. Absorbent layer was 10 times heavier than top sheet. The back sheet layer was the thinnest layer and it was only 0.05 mm thick. But as back sheet was not in a perforated structure, it possessed a higher weight when compared to top sheet.

Sanitary napkin unit mass and thickness values were very high when compared to its separate layers. Sanitary napkin unit weight was about 360 g/m<sup>2</sup> which corresponded to total weight of layers. Sanitary napkin was a heavy weight textile structure and most of its weight was caused by absorbent layer. The thickness of sanitary napkin was 2.1 mm and again the total thickness of layers reflected to end-product thickness. With 2.1 mm thickness value, the sanitary napkin sample belonged to ultra-thin sanitary napkin class [1]. Unlike weight distribution of sanitary napkin layers; top sheet, ADL and absorbent layer had equal effects on the thickness of sanitary napkin.

### Amount of wetting

For wet bending and wet compression tests, the samples were wetted according to aforementioned procedure. The mass increments of wet samples are given in figure 6.

According to the figure, average mass increments of wet samples were similar for bending test and compression test. For top sheet and ADL layers, mass increments after wetting were around 200–240 %. Back sheet nearly did not absorb any amount of synthetic urine that is most probably about the dense



Fig. 6. Mass changes of samples:  
■ wet bending samples; ■ wet compressed samples

and hydrophobic structure of the film. Absorbent layer had the highest weight increments after wetting about 670–680%. This is caused by the superabsorbent polymer content of this layer. For the sanitary napkin, weight changes were obtained around 400 %. The mass changes after wetting is related to absorption characteristics of sanitary napkin layers [37] which are the most for absorbent layer and least for back sheet.

### Compressibility behaviour of samples

As compressional properties, thickness loss (%) and compressibility (%) of samples were determined after 2 h and 4 h static load application (compression). It was aimed to mimic the sitting action in the experimental design. Tests were repeated for dry and wet samples. Back sheet layer was not included in this test as it was very thin and the changes in thickness could not be detected by the measurement device. Compressibility values after 2 h and 4 h compression times are given in figure 7. According to figure, compressibility of top sheet was the highest for both dry and wet samples after 2 h and 4 h compression (40–50%). This is related to voluminous structure of top sheet which was observed in SEM images in figure 4. Top sheet includes high amount of free air which makes it more porous and compressible. This porosity of top sheet makes fluids able to flow through the fabric [38]. Compressibility of top sheet was followed by ADL and absorbent layer, respectively. For all samples, compressibility was higher

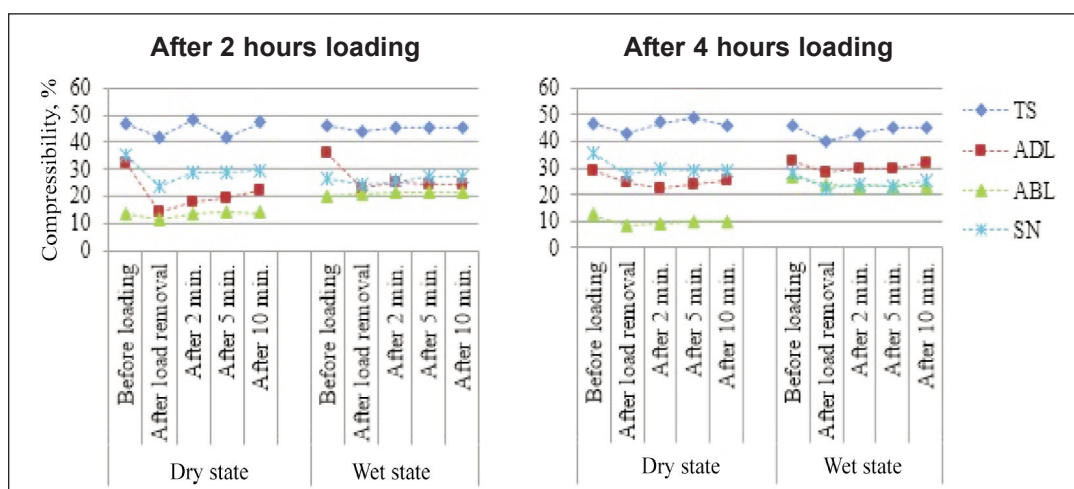


Fig. 7. Compressibility values after 2 h and 4 h compression

before static load application. After load removal, compressibility of samples started to increase by time and recovered mostly within 2 minutes.

Compressibility recoveries were more time dependent for dry samples. This is valid for both 2 h and 4 h compression times. For dry sanitary napkin, compressibility values were between top sheet and ADL layers for both 2 h and 4 h compression. After wetting, compressibility of sanitary napkin became closer to ADL or absorbent layer.

Thickness losses of samples after 2 h and 4 h compression times are given in figures 8 and 9. Thickness losses of samples in dry state are similar for 2 h and 4 h loading for 5 g/cm<sup>2</sup> and 50 g/cm<sup>2</sup> test pressures. In dry states, maximum thickness losses were obtained generally from ADL layer whereas absorbent layer exhibited the least thickness losses. Thickness losses of top sheet and sanitary napkin were similar for dry and wet states. Thickness losses of absorbent layer increased after wetting.

Interestingly, ADL layer started to swell after 5 min of load removal for 4 h compression. It is a good property as ADL layer will stay open under load, maintain void volume, resist wet collapse, enhance the desorption properties of the fabric, preserve void volume capacity and maintain rapid fluid uptake after applications of fluid [28]. The thickness loss results measured at 5 g/cm<sup>2</sup> thickness test pressure were in accordance with thickness loss results measured at 50 g/cm<sup>2</sup> thickness test pressure.

In general, for all layers, thickness loss values decreased after 10 min of load removal for both dry and wet states (after 2 h and 4 h compression). This indicates that, after load removal, thickness of sanitary napkin will recover and sanitary napkin will continue to serve with a more voluminous structure. In a study, Debnath and Madhusoothanan found out that initial thickness and compressibility of the polyester needle-punched fabrics decreased but thickness loss increased under wet condition when compared to the dry condition [28]. It can be understood that these

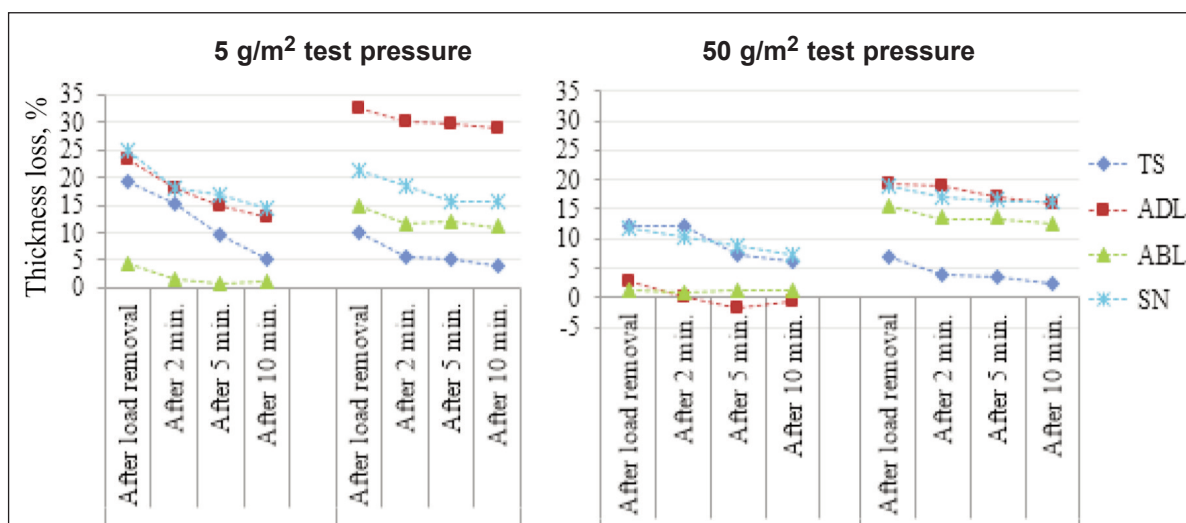


Fig. 8. Thickness loss values after 2 h compression



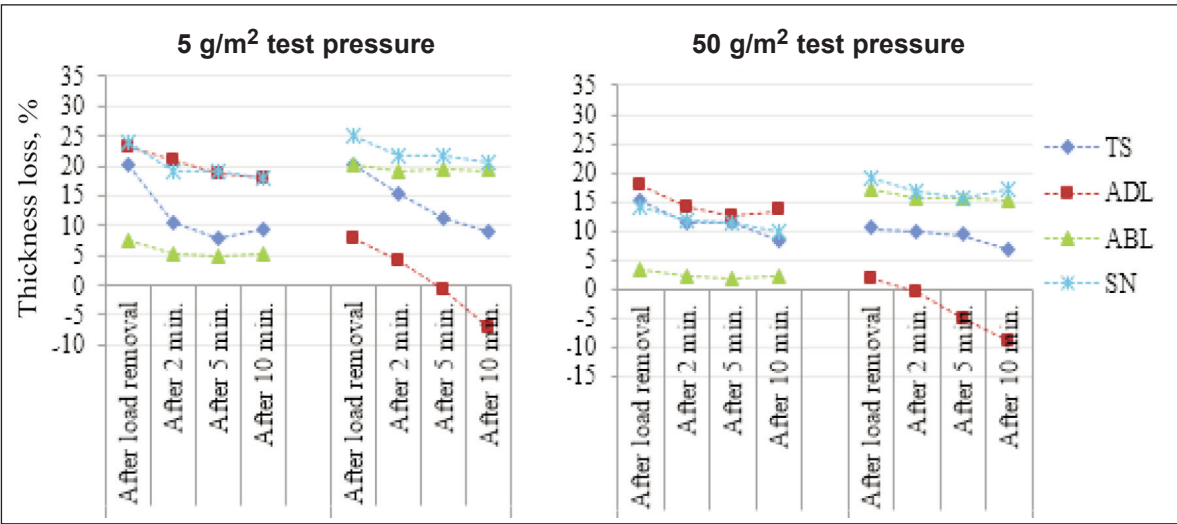


Fig. 9. Thickness loss values after 4 h compression

results do not fit with compressional behaviours of all sanitary napkin layers. Although compressibility recoveries were mostly obtained after 2 min of load removal, samples exhibited some amounts of thickness losses even after 10 min of load removal.

#### Bending behaviour of samples

Bending results of samples are given in table 2. Also, average loop lengths measured during tests are

schematized in figure 10. Bending lengths were calculated by using measured loop lengths. Bending length results were between 1.46 cm and 3.41 cm before wetting and 1.02–2.04 cm after wetting. In general, bending lengths of sanitary napkin layers and sanitary napkin decreased after wetting and the loop lengths of samples increased after wetting.

Bending rigidity results are visualised in figure 11. Before wetting, absorbent layer owned the highest

Table 2

BENDING RIGIDITY RESULTS				
Code	Dry bending properties		Wet bending properties	
	Bending length (cm)	Bending rigidity ( $\mu\text{J}/\text{m}$ )	Bending length (cm)	Bending rigidity ( $\mu\text{J}/\text{m}$ )
TS	2.15	3.4	1.52	3.5
ADL	2.80	17.5	1.30	5.7
ABL	3.41	128.6	1.02	27.4
BS	1.46	1.6	1.53	1.8
SN	3.19	177.3	2.04	235.9

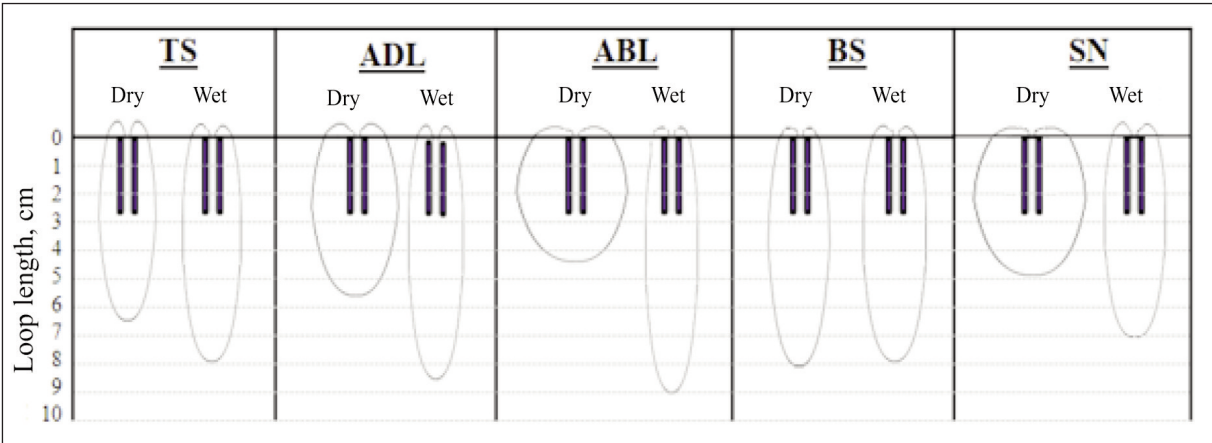


Fig. 10. Schematizing l (loop lengths) of samples in dry and wet states

bending rigidity among the sanitary napkin layers. Also, the loop length was the lowest for this layer. The lightweight top sheet, ADL and back sheet layers possessed ignorable bending rigidity results (1.6–17.5  $\mu\text{J/m}$ ) when compared to superabsorbent layer (128.6  $\mu\text{J/m}$ ) and sanitary napkin (177.3  $\mu\text{J/m}$ ), before wetting.

Bending rigidity values of top sheet and back sheet layers almost did not change after wetting. For ADL and absorbent layer, bending rigidity values decreased importantly after wetting. The increased weight of sanitary napkin layers resulted with longer loop lengths and smaller bending lengths (figure 10 and table 2). In contrary, sanitary napkin bending rigidity increased after wetting. The multilayer structure of the sanitary napkin restricted the loop length of the sanitary napkin. Its loop length only increased to 7.03 cm in spite of getting 4 times heavier after wetting. This situation resulted with higher bending rigidity for sanitary napkin after wetting procedure.

## CONCLUSIONS

In this study, bending and compressional behaviours of sanitary napkin layers were determined in order to make comparisons between them and make inferences about the formability and sensorial comfort of sanitary napkins.

According to SEM evaluations, it was clearly observed that all 4 layers of the sanitary napkin were specially structured for their individual mission in the sanitary napkin. The layers differed in raw material, construction and surface morphologies. According to unit mass and thickness results, although top sheet, ADL and absorbent layer were equal in their thickness, their densities and compactness were very different. Top sheet was very light and porous and it made this layer more compressible even in dry and wet states. In contrary, absorbent layer was 10 times heavier than top sheet in spite of being in the same thickness. Altogether, the layers' unit mass and thickness results determined the overall weight and thickness of the sanitary napkin.

The bending and compressional behaviours of samples were determined both in dry and wet states as wet textiles can exhibit different properties under wet conditions. Same amount of synthetic urine was applied to sanitary napkin layers but they hold the amount according to their absorptive capacities [37]. According to bending test results, wetting did not importantly affect the bending rigidities of top sheet and back sheet layers. But especially, bending rigidity of absorbent layer decreased dramatically after wetting. This indicates to a more formable absorbent

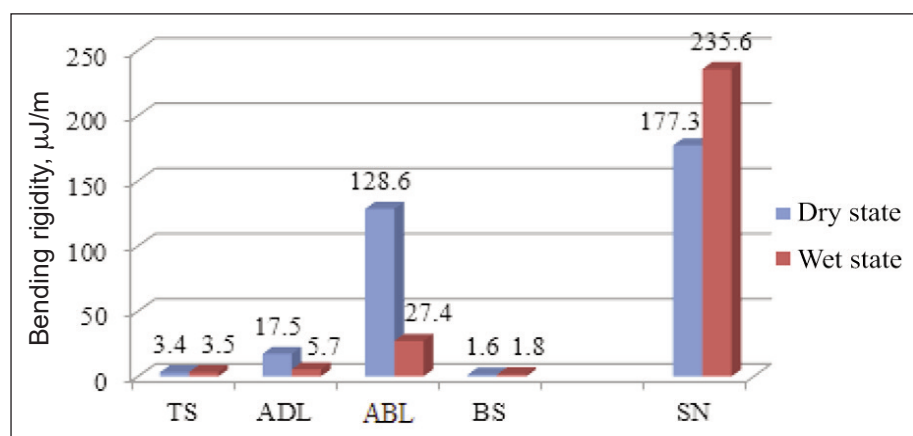


Fig. 11. Bending rigidity values of samples

layer when it got wet because of menstrual flow. But as the unit mass of sanitary napkin increased too much and the layered structure restricted the loop length of sanitary napkin, bending rigidity of sanitary napkin did not decrease after wetting. This can lead to low formability and make the user feel discomfort. The compressional behaviour results showed that top sheet was the most compressible layer before and after being compressed with static load. So it can make the user feel a soft and dry surface. The compressibility of sanitary napkin was in somewhere around ADL and absorbent layer. The least compressible layer of the sanitary napkin was absorbent layer.

The thickness loss values after load application can be imagined as a sanitary napkins' compressional behaviour after a woman sits on it for 2 h and 4 h. After the load removal, the thickness of sanitary napkin starts to recover. In this study, compressibility and thickness changes of the sanitary napkin layers were determined within 10 min after load removal. The thickness loss values determined at 5  $\text{g/cm}^2$  represented the free recovering of sanitary napkin after load removal. The thickness loss values determined at 50  $\text{g/cm}^2$  may be considered as the woman sit on the sanitary napkin again after load removal within 10 min. So in this case, effect of repetitive sits on the sanitary napkin was tried to mimic. This setup of experiment was designed according to experiences and literature search but different setups may be made using different compression times or using dynamic loading cycles, in further studies.

As the back sheet material was only a few microns thick, the changes of back sheet could not be measured accurately by using the current test device. So the compressional behaviour results of back sheet were not added to the paper. In further studies, specially constructed gauges may be used to detect the thickness changes of back sheet. For this study, as the thickness changes of back sheet layer were very small when compared to other layers, back sheet layers compressional behaviours are omitted.



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mechanical properties of sanitary napkin layers" at November, 2019/Bursa/Turkey.

This current study was focused on compressional properties of sanitary napkin layers and the study is improved and differed by adding new parameters and measurements to the experimental design.

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