EFFECT OF SOME CONSTRUCTION FACTORS ON FABRICS USED IN WALLS AND STEEP SIDED EMBANKMENTS

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Abstract
The concept of using geotextiles in walls and steep sided embankments construction is well accepted in the developed countries and practically today, the demand for them is ever increasing .In Egypt, of course, the utility of geotextiles is still very limited to this particular area of application.. This research aimed to produce nonwoven fabrics that can be used in walls and steep sided embankments . Two kinds of textiles materials were used ,polyester and polypropylene of denier 6 to produce fabrics of 350 ,600 and 850 g/m2 weights using three puncture depths 6,12 and 18 mm with two bonding techniques ,needle punching and Calendering . Some more results were reached concerns structures and materials .

Introduction

Among industrial textiles in general, geotextiles are the best established .they have been used on countless construction sites around the world for many years now .thanks to geotextiles ,roads ,railway ,lines ,drains ,embankments and dikes can be built more easily and at lower cost . [1]

Geotextiles serves five functions in environmental engineering:

Separation, filtration, drainage, reinforcement and protection. [2] In separation function ,geotextiles are used to separate two dissimilar materials ,such as two layers of soil with different properties maintain and improve the integrity and performance of both materials .In filtration function ,geotextiles act as filter by allowing free liquid flow through its plane and by retaining soil particles on the upstream side .The drainage function of geotextiles involves transmission of liquid in the plane of fabric without soil loss .In reinforcement function ,geotextiles are ideal materials to increase soil quality and also its structural ability .In protection function geotextiles can provide long-term protection for geomembranes against mechanical damage. [3] Although in many applications it is possible to identify one dominant function out of the five basic functions ,often other functions still perform essential roles even if they are secondary .[4]

Geotextiles in walls and steep sided embankments

Surface erosion due to rain and wind cause loss of huge amount of top soil walls , hill slopes , and embankment slopes .[5] Besides this there was problems with short –term instability in the form of deepseated rotational slippage or transverse spreading of the embankment. [6]

The main constituents of a reinforced soil wall and slopes are soil and reinforcement, as the name suggest. Since soil is weak in tension, the reinforcing elements are generally required to resist the tensile forces developed within the structure. [7]As geotextiles are high tensile strength materials , therefore they are ideal materials to increase soil quality and thus to increase soil structural stability.[3]

Unlike embankments on soft ground , walls (particularly if it is very high)and steep sided embankments need support from the geotextile or geogrid for their entire design life . Therefore, durability of the reinforcement is very important, [6] as geotextile improves the mechanical behavior of an earth structure leading to the improvement of the stability of the wall or embankment itself . [8]

The essence of construction is very simple , comprising the placing of selected fill incorporating horizontal layers of geotextile or geogrid reinforcement.(wrap – around method) .[7] As one lift of fill is completed , the reinforcement is rolled over the surface of the fill , ensuring that it runs far enough back from the face to ensure adequate bond length , as the free length of geotextile is left at the face sufficient to wrap around the next layer to extend back over it to ensure adequate anchorage.[6]

As the base to a wall or an embankment, the geotextile may be acting as a tensioned membrane (reinforcement.) , as a separator , and as a drain and filter facilitating the dewatering and consolidation of the soil or embankment. [9]

2.The experimental work

Nonwoven technique ,using cross-laid fiber orientation ,was used for producing all samples in the research .Two kinds of textile materials were used ,polyester and polypropylene of denier 6 and two kinds of bonding technique ,needle punching and calendering .Three fabric weights were produced 350,600,850 g/m^2 , 700 beats /min and three penetration depths were used 6 ,12 and 18 mm.

Table (1) specification of samples produced in this research

No	Property	Specifications
1	**Fiber type**	Waste (polyester and polypropylene)
2	**Weight (g/m2)**	350,600 and 850
3	**Web formation**	Cross-laid
4	**Number of beats /min**	700
5	**Puncture depth (mm)**	6,12 and 18
6	**Bonding technique**	Needle punching and Calendering

Tests applied to samples under study

In order to evaluate the performance properties of the produced samples ,the following tests were carried out :-

1- Water permittivity, this test was carried out according to the (ASTM-D 4716/87) [10]
2- Water permeability, this test was carried out according to the (ASTM-D 4491/92) [11]
3- Tensile strength & elongation at break, this test was carried out according to the (ASTM-D 1682) [12]
٤-Fabric thickness, this test was carried out according to the (ASTM-D1777) [13]

3. Results and Discussion

Results of experimental tests carried out on the produced samples are presented in the following tables and graphs . Results were also statistically analyzed for the data listed and relationships between variables were obtained.

Water permittivity and water permeability

It obvious from tables and figures that polyester fabrics had the highest rates of water permeability and permittivity compared to polypropylene fabrics .This is due to that moisture absorption of polyester fiber is 0.4 % which means it helps, a little bit, in the transport of water through the fabric, whereas moisture absorption of polypropylene is zero.

Also it can be noticed that there is an inverse relationship between fabric weight and its water permeability and permittivity .I can report that the increase in fabric weight increases the probability of number of fibers per unit area which delay the flow of water through the fabric, in both direction ,leading to the decrease in its permeability and permittivity .

It is clear from tables and figures that there is an inverse relationship between needles penetration depth and fabric water permeability and permittivity .I can report that the increase in penetration depth cause fabrics to be more compacted leading to a decrease in fabric permeability and permittivity.

From tables and figures, it can be seen that needle punched samples had the highest rates of water permeability and permittivity than calendared samples. This is due to needle punching technique cause fibers to reorient making baths which permit the passage of water .

Table (2) results of water permeability test applied to samples under study

Fiber type	**Polyester**						**Polypropylene**					
Penetration depth	**٦**		**١٢**		**١٨**		**٦**		**١٢**		**١٨**	
bonding technique / Weight	**N.P***	**C****	**N.P**	**C**	**N.P**	**C**	**N.P**	**C**	**N.P**	**C**	**N.P**	**C**
٣٥٠	٠.٠٥١١	٠.٠٤١٨	٠.٠٤٩٣	٠.٠٤٠٤	٠.٠٤٠٣	٠.٠٣٧٣	0.0465	٠.٠٤٢٠	٠.٠٤٠٢	٠.٠٢١٨	٠.٠٣٨٨	٠.٠١٩٨
٦٠٠	٠.٠٣٩٦	٠.٠٢١٣	٠.٠٣٣٥	٠.٠١٥٠	٠.٠٣١١	٠.٠١٢٢	0.0359	٠.٠٢١٤	٠.٠٣٣٣	٠.٠١١٩	٠.٠٣٢٥	٠.٠١٠١
٨٥٠	٠.٠٢٢٢	٠.٠١٤٦	٠.٠٢١٠	٠.٠١٣٧	٠.٠١٨٥	٠.٠١٠١	0.0125	٠.٠١٤٥	٠.٠١١٣	٠.٠١١٢	٠.٠٣٠٢	٠.٠٠٩٤

*Needle punching

**Calendering punching

Table (3) results of water permittivity test applied to samples under study

Fiber type	**Polyester**						**Polypropylene**					
Penetration depth	**٦**		**١٢**		**١٨**		**٦**		**١٢**		**١٨**	
bonding technique / Weight	**N.P**	**C**	**N.P**	**C**	**N.P**	**C**	**N.P**	**C**	**N.P**	**C**	**N.P**	**C**
٣٥٠	٦.٩٦	٥.٤١	٦.٧٢	٥.١٤	٦.٤١	٤.٨٥	٦.٧٨	٥.١٨	٦.٦٩	٥.٦٩	٦.٣٤	٥.٢٣
٦٠٠	٥.٢٤	٤.٧٧	٥.٠٩	٤.٣٨	٤.٣٤	٤.١٢	٣.٦	٢.٤٠٧	٣.٠٣	٢.٠٣	٢.٩٢	١.٩٤
٨٥٠	٤.١١	٣.٠٣	٣.٧٢	٣.٧٢	٢.٨٩	٣.٥٥	٢.٨١	١.٥٠٤	٢.٢٥	١.٤٢	٢.٠٢	١.٢٣

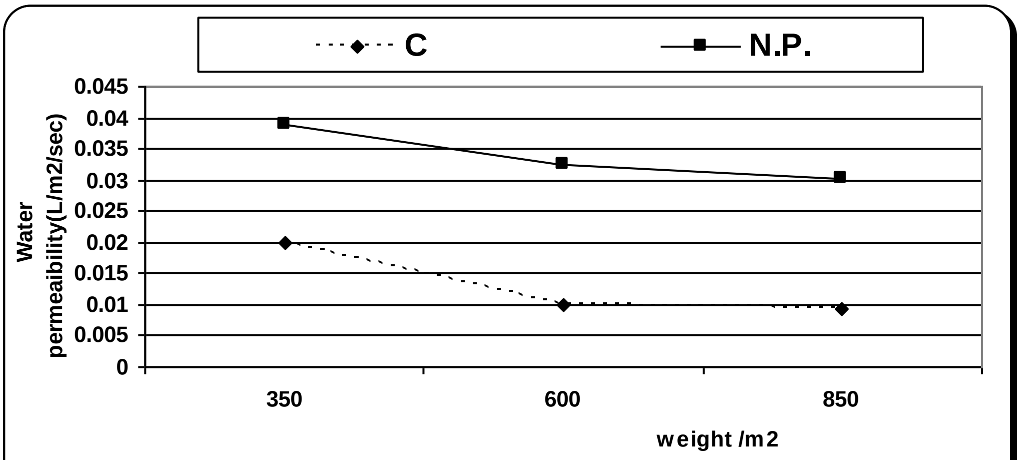

Fig.(1) effect of weight /m2 and bonding technique on water permeability ,at polyproplene and 18 penetration depth

Table (٤) regression equation and correlation coefficient for the effect of bonding technique and weight /m^2 on water permeability, using polypropylene and 18 penetration depth.

Bonding technique	**Regression equation**	**Correlation coefficient**
Needle punching	Y =-٠.0000172X +0.٤4153	-0.96578
Calendering	Y =-٠.0000208X +0.2558	-0.٨9456

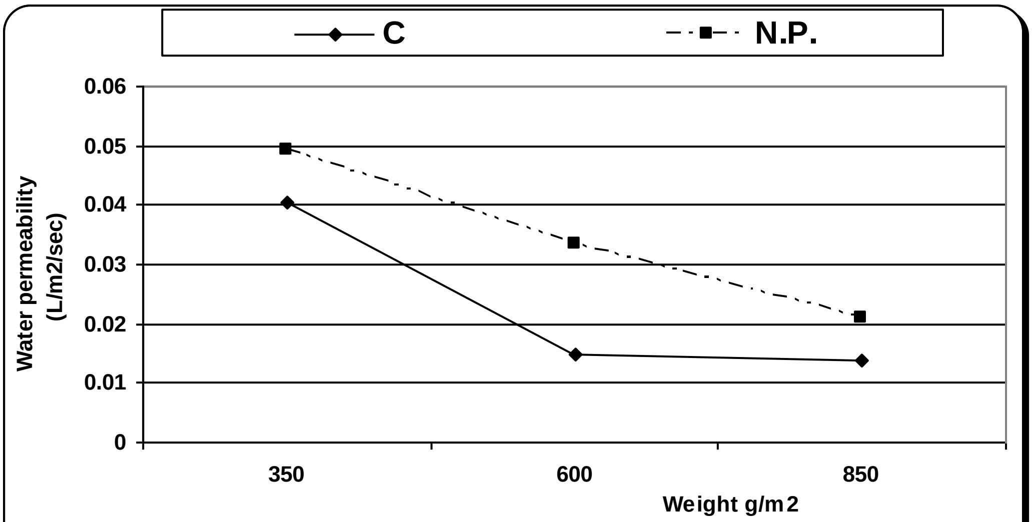

Fig.(2) effect of weight /m2 and bonding technique on water permeability ,at polyester and 18 penetration depth

Table (٥) regression equation and correlation coefficient for the effect of bonding technique and weight /m^2 on water permeability, using polyester and 18 penetration depth.

Bonding technique	**Regression equation**	**Correlation coefficient**
Needle punching	Y =-٠.0000٥٦٦X +0.٠٦٨٥٦	-0.٩٩٧٧٤١
Calendering	Y =-٠.0000٥٣٤X +0.٥٥٠٧٣٣	-0.8888066

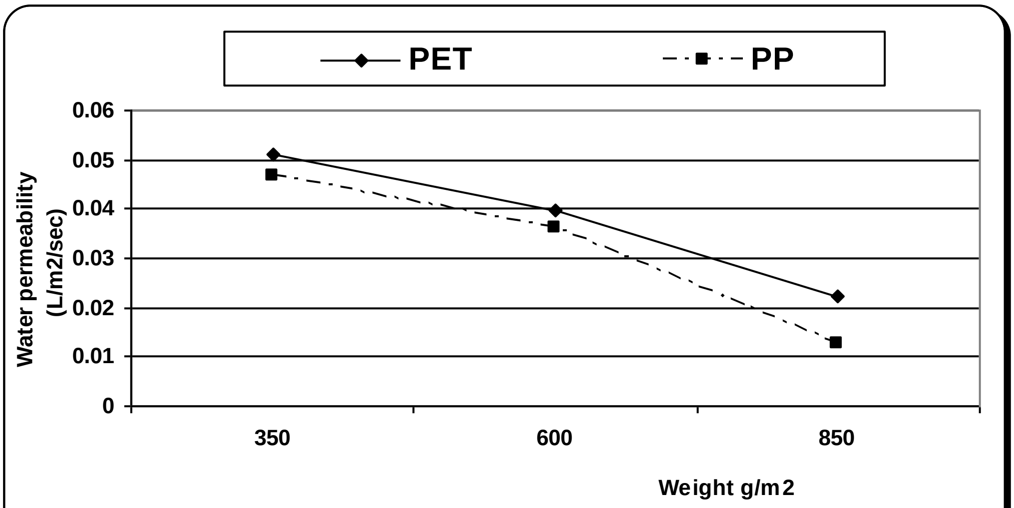

Fig.(3) effect of weight /m2 and fiber type on water permeability ,using neddle punching technique and 6 penetration depth

Table (٦) regression equation and correlation coefficient for the effect of fiber type and weight /m^2 on water permeability, using needle punching and 6 penetration depth.

Fiber type	**Regression equation**	**Correlation coefficient**
Polyester	Y =-٠.0000٥٧٨X +0.٠٧٢٣١٣	-0.٩٩١٣٢٥١
Polypropylene	Y =-٠.000068X +0.0724333	-0.9771836

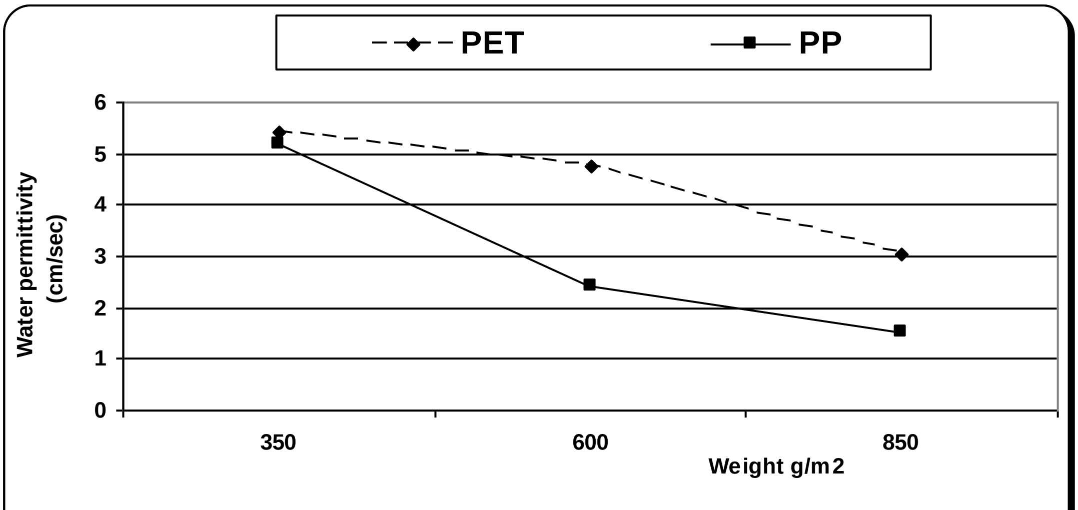

Fig.(4) effect of weight /m2 and fiber type on water permittivity ,at penetration depth 6 and calendaring technique

Table (٧) regression equation and correlation coefficient for the effect of fiber type and weight /m^2 on water permittivity, using Calendering technique and 6 penetration depth.

Fiber type	**Regression equation**	**Correlation coefficient**
Polyester	Y =-٠.00٤٧٦X +٧.٢٥٩٣٣	-0.٩٦٦١٩٢٦
Polypropylene	Y =-٠.00٧٣٥٢X +٧.441533	-0.9771836

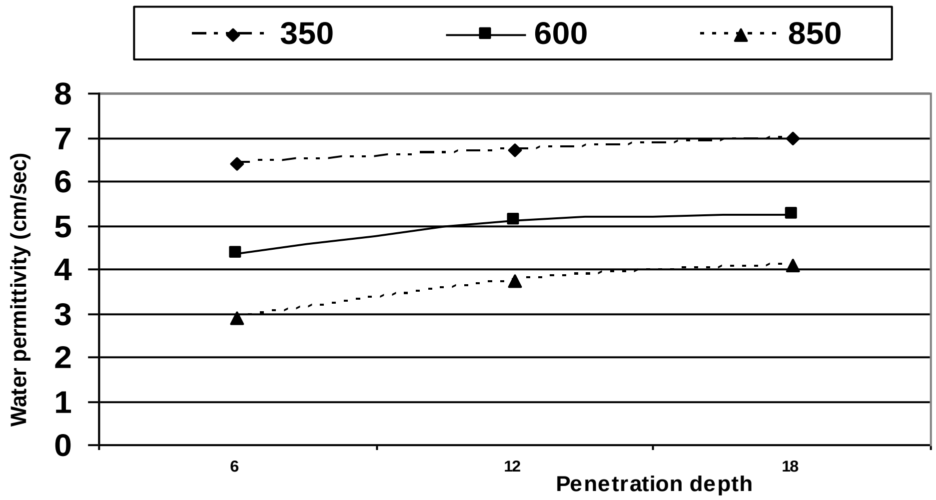

Fig.(5) effect of weight /m2 and penetration depth on water permittivity ,at polyester and needle punching technique

Table (٨) regression equation and correlation coefficient for the effect of penetration depth and weight /m^2 on water permittivity, using Calendering technique and 6 penetration depth.

Penetration depth	**Regression equation**	**Correlation coefficient**
6	Y =-٠.00٧٠٤X +٨.٧٧٠٦٦٦	-0.٩٩٩٨٦٩
12	Y =-٠.00٦X +٨.٧٧٦٦٦	-0.٩٩٩٨٧٥٠٤
18	Y =-٠.٠٠٠٥٧X +٨.٨٥٦٦٦	-0.9٩٢٩٣٢٩

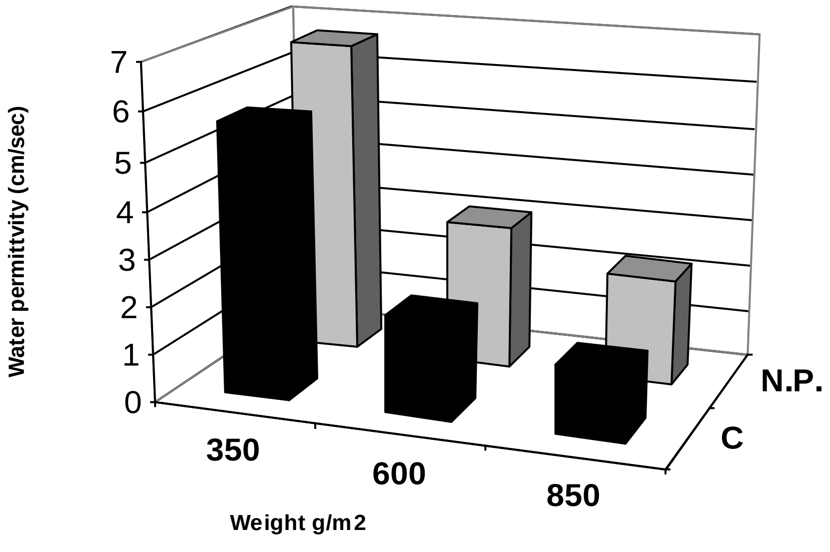

Fig.(6) effect of weight /m2 and bonding technique on water permittivity ,at polypropylene fiber and 12 penetration depth

Table (٩) regression equation and correlation coefficient for the effect of bonding technique and weight /m^2 on water permittivity, using polypropylene and 12 penetration depth.

Bonding technique	Regression equation	Correlation coefficient
Needle punching	Y =-٠.00٨٨٨X +٩.٣١٨	-0.٩٣٦٤٨٣
Calendering	Y =-٠.00٨٥٤X +٨.١٧٠٦٦٦٧	-0.9771836

Tensile strength and elongation

It can be seen from tables and figures that polyester samples have recorded the highest rates of tensile strength and the lowest rates of elongation, but the differences were insignificant .This is due to that polyester fibers a have high breaking tenacity compared to polypropylene fibers .

It is clear from figures that there is a direct relationship between fabric weight and tensile strength, and an inverse relationship between fabric weight and its elongation properties .This is mainly because of that the increase of fabric weight means an increase in the number of fibers per unit area and so the contact areas between fibers will be increased and its resistance to slippage will also be increased leading to the increase in fabric strength and the decrease in its elongation

Also from the results obtained in tables and figures, it was found that the tensile strength values in machine direction are higher than values of cross direction, and the opposite for elongation values, for all cases but the differences are insignificant

From the results in tables it can be seen that, with the increase of puncture depth, the tensile strength increases, but its elongation at break decreases .This is mainly because of that, the increase in puncture depths increases the contact points between fibers and decreasing its ability to slippage which increases fabric strength and decreases its elongation.

It is also clear from figures that needle punched samples had a highest tensile strength and lower elongation compared to calendared samples .this is mainly due to that punching effect cause fibers to follow a curved path in the thickness from the top to the bottom surface of the fabric leading to the increase of contact points between horizontal and vertical levels of structure and decrease the ability of fibers slippage leading to the increases of fabric strength and the decrease in its elongation .

Table (10) results of tensile strength test applied to samples under study

Fiber type	**Polyester**											
Penetration dept	٦				١٢				١٨			
bonding technique	**N.P**		**C**		**N.P**		**C**		**N.P**		**C**	
Weight	**MD**	**CD**	**MD**	**CD**	**MD**		**MD**	**CD**	**MD**	**CD**	**MD**	**CD**
٣٥٠	٢٢٣	٢٢٠	٢١٤	٢١٧	٢٤٣	٢٣١	٢٧٩	٢٣٤	٢٥١	٢٤٣	٢٩١	٢٤٢
٦٠٠	٢٦٣	٢٥٩	٢٥٢	٢٥٤	٢٧٩	٢٦٦	٢٧٠	٢٦٢	٢٩٣	٢٧٥	٢٨٣	٢٧٦
٨٥٠	٣٦٤	٣٥٧	٣٠٥	٢٩٦	٣٧٠	٣٦٢	٣١١	٣٠١	٣٧٨	٣٧١	٣٣١	٣١٩

Table (11) results of tensile strength test applied to samples under study

Fiber type	**Polypropylene**											
Penetration dept	٦				١٢				١٨			
bonding technique / **Weight**	**N.P**		**C**		**N.P**		**C**		**N.P**		**C**	
	MD	**CD**	**MD**	**CD**	**MD**	**CD**	**MD**	**CD**	**MD**	**CD**	**MD**	**CD**
٣٥٠	٢١٩	٢١٦	١٧٩	١٦٤	٢٣٦	٢٣٤	١٨٨	١٦٨	٢٤٥	٢٤٨	٢٠١	١٨٩
٦٠٠	٢٥١	٢٤٧	٢٦٥	٢٤٥	٢٧٨	٢٦٤	٢٧٠	٢٧٨	٢٩٣	٢٧٦	٢٨٨	٢٦٤
٨٥٠	٣٤١	٣٣١	٢٩١	٢٨٠	٣٥٣	٣٤٠	٢٩٢	٢٨٦	٣٧١	٣٥٢	٣٠٤	٢٨٥

Table (12) results of elongation test applied to samples under study

Fiber type	**Polyester**											
Penetration dept	٦				١٢				١٨			
bonding technique / **Weight**	**N.P**		**C**		**N.P**		**C**		**N.P**		**C**	
	MD	**CD**	**MD**	**CD**	**MD**	**CD**	**MD**	**CD**	**MD**	**CD**	**MD**	**CD**
٣٥٠	٨٤	٨٩	١٢١	١٤٠	٨٢	٨٦	٧٥	98	٨٠	٨٣	٧٧	٧٨
٦٠٠	٧٥	٨١	١١٠	١٢٠	٧٤	٧٨	٧٨	٨٨	٧١	٧٦	٦٩	٧٤
٨٥٠	٧٠	٨٦	١٠٠	١٠٥	٧١	٧٥	٩٠	٨٠	٦٨	٧٢	٦٥	٦٧

Table (13) results of elongation test applied to samples under study

Fiber type	**Polypropylene**											
Penetration dept	٦				١٢				١٨			
bonding technique / **Weight**	**N.P**		**C**		**N.P**		**C**		**N.P**		**C**	
	MD	**CD**	**MD**	**CD**	**MD**	**CD**	**MD**	**CD**	**MD**	**CD**	**MD**	**CD**
٣٥٠	٩٧	١١٩	١٢١	١٤٠	٨٩	٩٢	٩١	١٠١	٧٦	٨٨	٨٧	٩٧
٦٠٠	٨٩	٩٥	٧٨	٨٩	٧١	٨٠	٨٥	٩٨	٦٨	٧٨	٨١	٩٤
٨٥٠	٧٩	٩٠	٧٧	٨٨	٦٤	٧٧	٧٨	٨٥	٦١	٧٤	٧٥	٨١

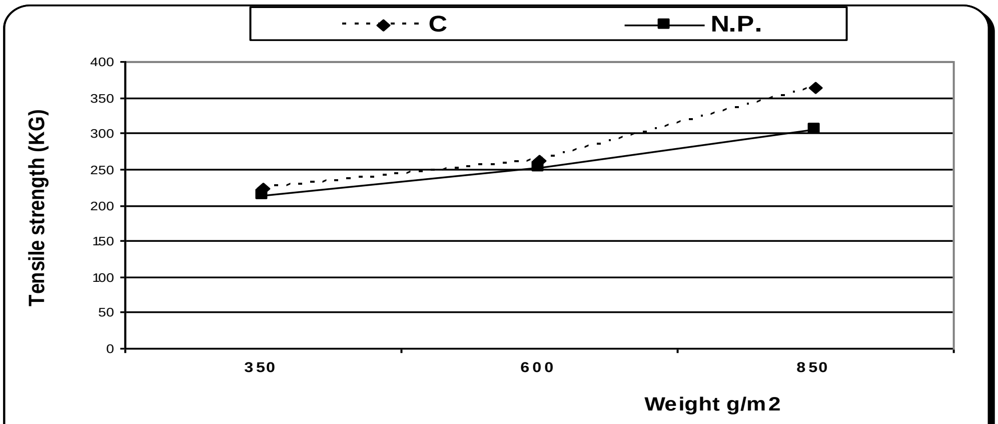

Fig.(7) effect of weight /m2 and bonding technique on tensile strength ,at polyester and 6 penetration depth (MD)

Table (14) regression equation and correlation coefficient for the effect of bonding technique and weight /m^2 on tensile strength, using polyester and 6 penetration depth.(MD)

Bonding technique	**Regression equation**	**Correlation coefficient**
Needle punching	Y =-٠.182X +147.٨	0.٩٩٥٥٠٢
Calendering	Y =-٠.٢٨٢X +١١٤.١٣٣٣	0.97٠١٩٣٦

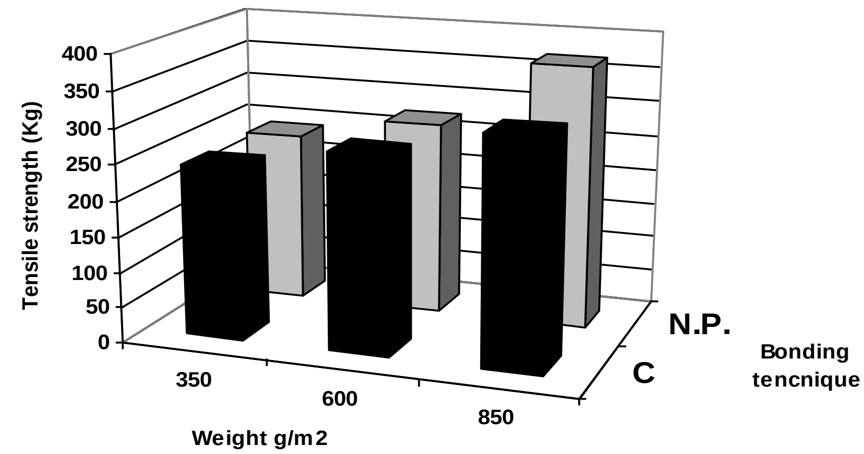

Fig.(8) effect of weight /m2 and bonding technique on tensile strength ,at polyester and 18 penetration depth ,(CD)

Table (15) regression equation and correlation coefficient for the effect of bonding technique and weight /m^2 on tensile strength, using polyester and ١٨ penetration depth.(CD)

Bonding technique	Regression equation	Correlation coefficient
Needle punching	Y =-٠.256X +142. 73	0.٩60796
Calendering	Y =-٠.1٥٤X +186. 6	0.٩٩٧٧٣1

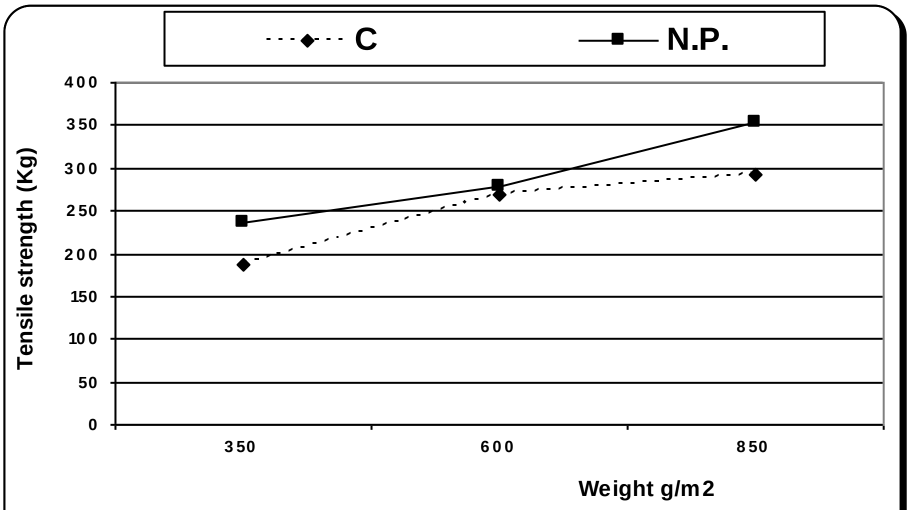

Fig.(9) effect of weight /m2 and bonding technique on tensile strength ,at polypropylene and 12 penetration depth ,(MD)

Table (16) regression equation and correlation coefficient for the effect of bonding technique and weight /m^2 on tensile strength, using polypropylene and ١٢ penetration depth.(MD)

Bonding technique	Regression equation	Correlation coefficient
Needle punching	Y =-٠.234X +148. 6	0.٩86999
Calendering	Y =-٠.208X +125. 2	0.٩٩87534

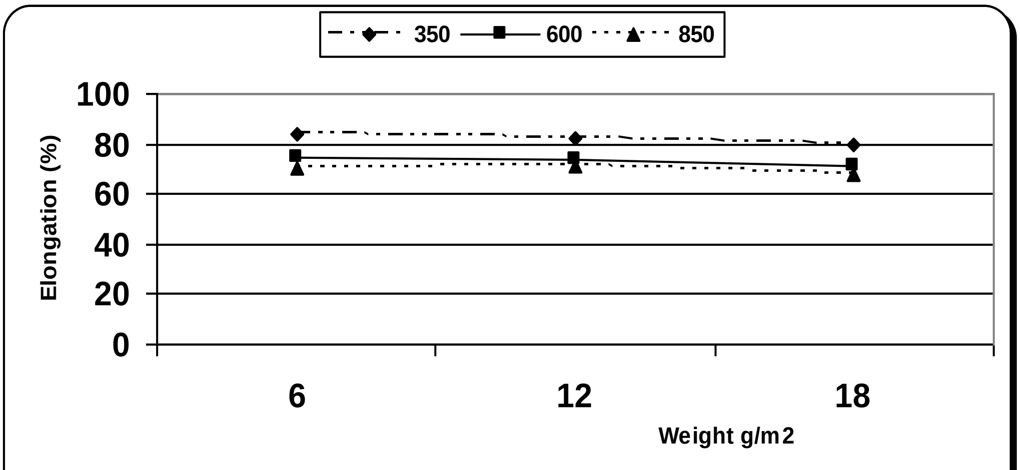

Fig.(10) effect of weight /m2 and Penetration depth on elongation ,at polypropylene and needle punching technique(MD)

Table (17) regression equation and correlation coefficient for the effect of penetration depth and weight /m^2 on elongation, using polypropylene and needle punching. technique (MD)

Penetration depth	Regression equation	Correlation coefficient
6	Y =-٠.028X +93.17333	-0.٩٨٦٦٦
12	Y =-٠.022X +٨٨.٨٦٦٦	-0.٩٩٩٨٧٥٠٤
18	Y =-٠.٠٢٤X +٨٧.٤	-0.9٦٠٧٨٩٢٣

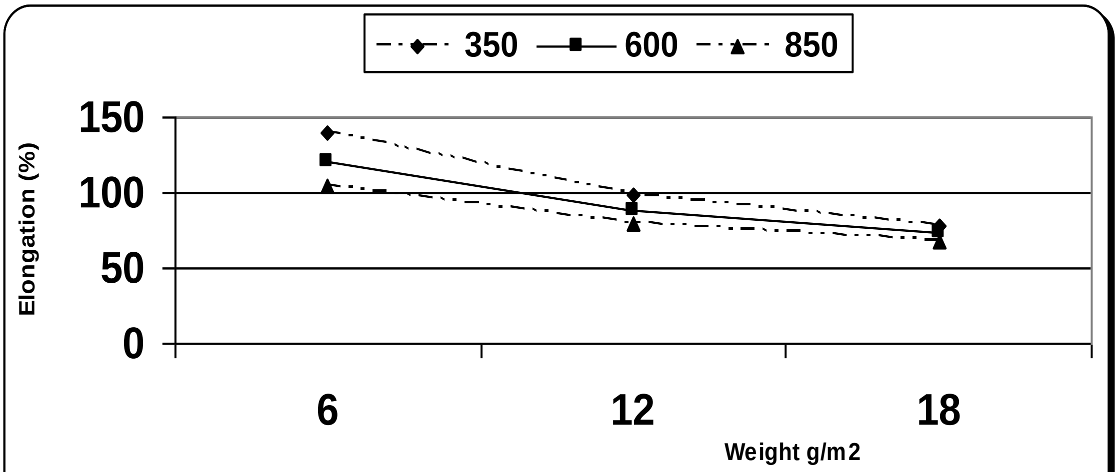

Fig.(11) effect of weight /m2 and Penetration depth on elongation ,at polyester and calendaring technique(CD)

Table (18) regression equation and correlation coefficient for the effect of penetration depth and weight /m^2 on elongation, using polyester and Calendering. technique (CD)

Penetration depth	Regression equation	Correlation coefficient
6	Y =-٠.07X +163.66667	-0.٩966158
12	Y =-٠.036X +110.2٦٦٦	-0.٩٩7948
18	Y =-٠.٠22X +٨6.2	-0.987829

Thickness

It can be seen from figures that polyester samples had a higher thickness than polypropylene samples .This might be due to that polyester fibers have a high density (1.38 g/m^3) compared to polypropylene which have a lower fibers have a low density (0.91 g/m^3)

It is also obvious from tables and figures that there is a direct relationship between fabric thickness and its weight .This is because of fact that an increase in fabric weight means an increase in number of fibers per unit area which leads to the increase in fabric bulkiness and so its thickness.

It is clear from the figures that there is an inverse relationship between penetration depth and fabric thickness. This is due to that high puncture depth lead to a high fiber entanglement and a decrease in spaces between fibers leading to a decrease in fabric thickness.

From tables and figures, it can be seen that needle punched samples had lower thickness than calendared samples. This is due to needle punching technique cause fibers to reorient and spaces between them are decreased, leading to a decrease in fabric thickness.

Table (19) results of thickness test applied to samples under study

Fiber type	Polyester						Polypropylene					
Penetration depth	٦		١٢		١٨		٦		١٢		١٨	
bonding technique / Weight	N.P	C	N.P	C	N.P	C	N.P	C	N.P	C	N.P	C
٣٥٠	٢.٨٧	٢.٨٨	٢.٨٢	٣.١	٢.٧٤	٢.٨٩	٢.٩	٣.٤	٢.٧١	٤.٣	٢.٦٨	٤.١
٦٠٠	٤.٥٥	٤.٨	٤.٣٨	٤.٢٥	٤.٢٥	٤.٠٢	٤.٤٨	٥.٥٥	٤.٣٧	٤.٧٦	٤.٢٢	٤.١
٨٥٠	٥.٥١	٥.٨	٥.١٢	٥.٣	٤.٩٩	٤.٩٥	٥.٤١	٥.٦	٥.٠٣	٥.١٣	٤.٩٣	٤.٧٢

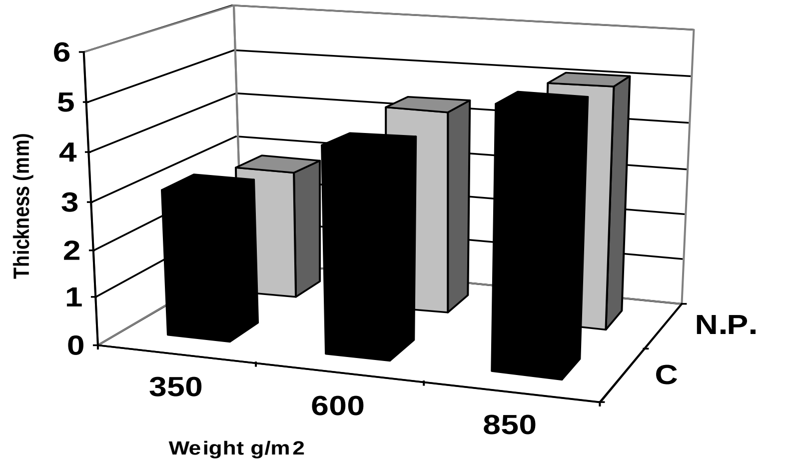

Fig.(12) effect of weight /m2 and bonding technique on thickness ,at polyester and 12 penetration depth

Table (20) regression equation and correlation coefficient for the effect of bonding technique and weight /m^2 on thickness, using polyester and 12 penetration depth.(MD)

Bonding technique	Regression equation	Correlation coefficient
Needle punching	Y =-٠.0046X +1. 34666	0.٩79965
Calendering	Y =-٠.0044X +1.57666	0.٩99655

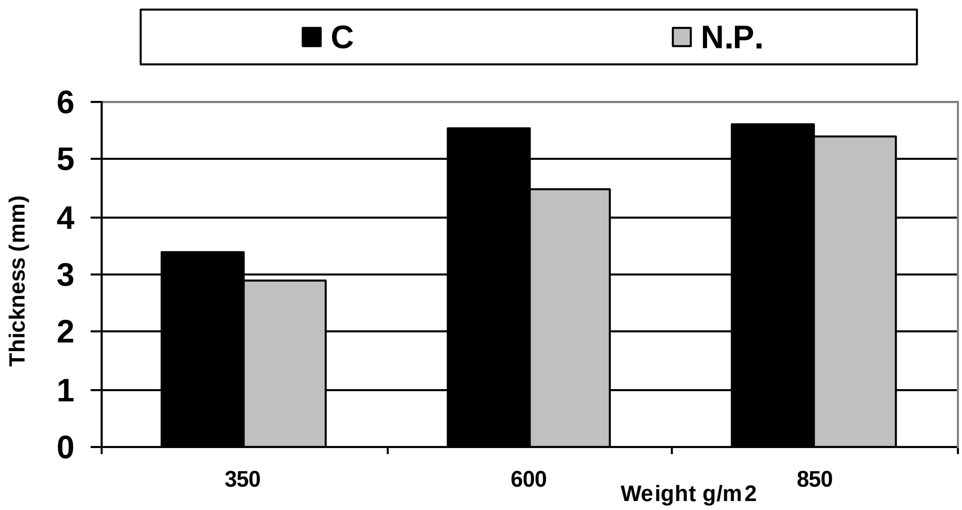

Fig.(13) effect of weight /m2 and bonding technique on thickness ,at polypropylene and 6 penetration depth

Table (21) regression equation and correlation coefficient for the effect of bonding technique and weight /m^2 on thickness, using polyester and 6 penetration depth.(MD)

Bonding technique	Regression equation	Correlation coefficient
Needle punching	Y =-٠.٠٠٠٥٠٢X +1.٢٥١٣٣	0.٩٨٩٠٠٦
Calendering	Y =-٠.٠٠٠٤٤X +٢.٢١	0.٨٧٥٨٠٦

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