Thermal Sealing of Nonwoven Geotextiles

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ABSTRACT: Geotextiles are utilized in civil engineering projects to perform one or a combination of six functions. These include: separation, filtration, drainage, reinforcement, cushion, and as waterproofing membrane when impregnated with a bitumen. Because continuity between manufactured panels is required to perform these functions, manufacturers have traditionally recommended either overlapping or sewing as a primary means of performing this task. This paper explores the use of heat seaming equipment as an alternate to overlapping or sewing. Mechanical tests are performed on heat seamed continuous filament needle-punched nonwoven geotextiles to determine the efficiency of thermally produced overlap and prayer seams.

For this study, all seams were made with hot wedge equipment. Since this equipment is commonly used in the seaming of geomembranes, the use of this seaming technique is economically advantageous within applications involving geomembrane fabrication. Results of mechanical testing are used to develop recommendations regarding temperature and seam speed settings.

1 INTRODUCTION

This paper explores the use of heat seaming equipment as an alternate to overlapping or sewing. Mechanical tests (namely, grab tensile tests) are performed on heat seamed polypropylene continuous filament needle-punched nonwoven geotextiles to determine the efficiency of thermally produced prayer and overlap seams. Such seams can be economically performed on those projects where similar equipment is used to fabricate geomembrane panels.

2 TEST PROGRAM

The test program involved selection of a geotextile weight range, wedge welder equipment, and seam geometry. The temperature and speed settings were then varied on the basis of the temperature setting selected for a particular trial run.

2.1 Geotextile Selection

Initially, thermal overlap seams were made on 540 and 120 g/m^2 polypropylene continuous filament needle-punched geotextiles. Subsequent prayer welds were performed only on the 540 g/m^2

continuous filament needle-punched nonwoven geotextile. The pertinent properties associated with the 540 g/m^2 geotextile are found in Table 1, while the properties for the 120 g/m^2 geotextile are included within Table 2.

Table 1. Manufacturer's Certifiable Minimum Average Roll Values (M.A.R.V.)

Property	*Test*	*M.A.R.V.*	*Units*
Weight	ASTM D5261	540	g/m^2
Thickness	ASTM D5199	3.8	mm
Grab Tensile	ASTM D4632	1510	N

Table 2. Manufacturer's Certifiable Minimum Average Roll Values (M.A.R.V.)

Property	*Test*	*M.A.R.V.*	*Units*
Weight	ASTM D5261	120	g/m^2
Thickness	ASTM D5199	1.0	mm
Grab Tensile	ASTM D4632	400	N

2.2 Thermal Welding Equipment

Two different pieces of thermal welding equipment were required to perform the overlap and prayer seams. The PFAFF 8362 wedge welder was used to manufacture the overlap seams tested within this study. The model 8362 weighs 125 N and can be used to manufacture either overlap or channel production welds on tents, tarps and geomembranes. This piece of equipment is illustrated in Figure 1. The PFAFF 8351 hand held wedge welder was used to manufacture the prayer seams tested within this study. The model 8351 weighs 67 N and is used to manufacture either overlap, prayer or channel production welds on tents, tarps and geomembranes. This piece of equipment is illustrated in Figure 2.

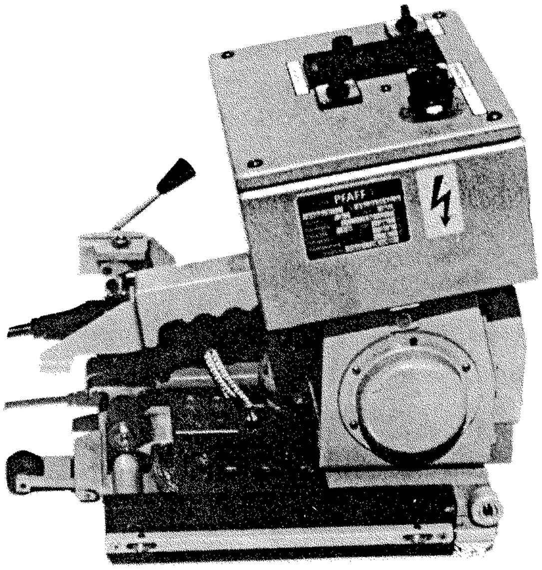


Figure 1. PFAFF Model 8362

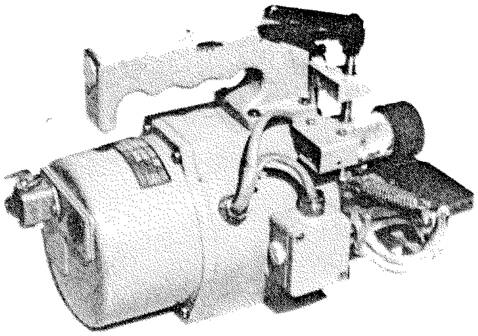
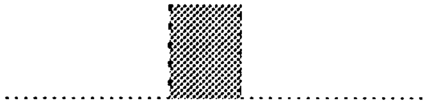


Figure 2. PFAFF Model 8351

2.3 Seam Geometry

The prayer and overlap seam configurations are the most commonly used seam geometry employed in geotextile panel fabrication. Both seam configurations are depicted within Figure 3. Test speeds and temperatures were varied for each configuration.

Overlap Seam



Prayer or "Flat" Seam

Figure 3. Schematic Representation of Overlap and Prayer or "Flat" Seams

3 SEAM TESTING

3.1 Overlap Seam Tests

The overlap seams were manufactured at two different temperature and test speeds. Ten specimen were then prepared from each sample. All specimen were taken such that the tested direction was the geotextile cross machine direction. The specimen were tested in accordance with the American Society for Testing and Materials (ASTM) test method D4632. The seam was centered between the grips and tested at a speed of 300 mm/min. The results of this testing are found within Table 3.

As indicated within Table 3, optimum seaming efficiencies for both geotextile weights are achieved at 300 °C and a machine speed of 9.14 meters per minute. For both geotextile weights the seam efficiencies are in excess of 100%. This result is achieved because the seam efficiency is based on the manufacturer's certifiable minimum average roll value (M.A.R.V.).

Table 3. Overlap Seam Results

Weight g/m^2	540	540	120	120
Temp. °C	250	300	250	300
Speed m/min.	7.62	9.14	7.62	9.14
Seam Failed	10	2	2	1
Fabric Failed	0	8	8	9
Average Strength (N)	1156	1789	385	419
Standard Deviation	64	100	66	99
C.V. (%)	5.5	5.6	17	24
M.A.R.V.	1510	1510	400	400
Efficiency (%)	76	100+	96	100+

3.2 Prayer Seam Tests

The prayer seams were manufactured at four different temperature and test speeds. Ten specimen were then prepared from each sample. All specimen were taken such that the tested direction was the geotextile cross machine direction. The specimen were tested in accordance with the American Society for Testing and Materials (ASTM) test method D4632. The seam was centered between the grips and tested at a speed of 300 mm/min. The results of this testing are found within Table 4.

As indicated within Table 4, the optimum seaming efficiency for this piece of equipment is 80 percent. This is achieved at an equipment operating temperature of 400 °C and seam speed of 6.3 meters per minute. On the other hand, optimum coefficient of variation

(C.V.) is achieved at an equipment operating temperature of 400 °C and seam speed of 5.6 meters per minute.

Table 4. Prayer or "Flat" Seam Results

Weight g/m^2	540	540	540	540	540
Temp. °C	450	300	400	350	400
Speed m/min.	7.0	5.6	5.6	6.0	6.3
Seam Failed	1	10	4	10	7
Fabric Failed	9	0	6	0	3
Average Strength (N)	947	911	996	933	1207
Standard Deviation	106	104	94	127	200
C.V. (%)	11	11	9.4	14	17
M.A.R.V. (N)	1510	1510	1510	1510	1510
Efficiency (%)	63	60	66	62	80

4 FIELD USAGE

This test program validated the economic feasibility of thermally seaming both light weight (120 g/m^2) and heavy weight (540 g/m^2) polypropylene continuous filament needle-punched nonwoven geotextiles. The information obtained from this work should be used as a starting point for field installation. Naturally, the contractor will not necessarily be using the equipment that was used for this bench top study. As such, specifications must be properly written to insure that a satisfactory seam is performed in the field.

4.1 Thermal Seaming Specifications

Based on these laboratory findings, future project specifications could be modified as follows:

THERMAL SEAMS: Continuity of adjacent geotextile panels can be achieved through the use of wedge welders commonly employed to fabricate geomembrane panels. This same equipment has been found to satisfactorily seam polypropylene continuous filament needle-punched nonwoven geotextiles. Prior to seaming, the contractor shall demonstrate that this seaming technique produces at least an 80% efficiency. The efficiency is defined as the ratio of the seamed grab tensile strength to the manufacturer certified M.A.R.V. grab tensile strength value. Seams exhibiting the minimum requirement may only be used for cushion and filtration applications in noncritical areas. Should this method produce seams which exhibit an efficiency of 100%, this method may be used in lieu of other seaming methods in critical and noncritical areas.

5 CONCLUSIONS

Two pieces of thermal seaming equipment were evaluated for their ability to produce an efficient seam. Either piece of equipment can produce a seam having an efficiency of 80%. Testing has also indicated that the overlap seam resulted in the highest seam efficiency. Information from this work has been used to develop a statement regarding seaming which can be added within project specifications. Thermal seaming represents an economical means of fabricating polypropylene continuous filament needle-punched nonwoven geotextiles. The author's encourage engineers to permit thermal seaming of these materials.