U. S. DEPARTMENT OF COMMERCE NATIONAL BUREAU OF STANDARDS

RESEARCH PAPER RP861

Part of Journal of Research of the National Bureau of Standards, Volume 16, February 1936

EFFECT OF YARN TWIST ON THE PROPERTIES OF CLOTH [1]

By Herbert F. Schiefer and Daniel H. Taft

ABSTRACT

The effect of warp and filling yarn twist on the breaking strength, elongation at rupture, and fabric assistance of cotton cloth is discussed for the plain and 2/2 basket weaves. In both weaves the number of warp and filling yarns per inch of cloth was kept constant at 34. The cloths were woven from 10s cotton yarn in various combinations of warp and filling twist multipliers, which varied from 2.5 to 9. The breaking strength and elongation at rupture of the cloths vary approximately with the breaking strength and elongation at rupture of the yarns from which the cloths were woven. The fabric assistance varies inversely with the breaking strength of the yarn. The direction of twist in the yarn has no significant effect on the results. The breaking strength, elongation at rupture, and fabric assistance are greater in the plain weave than in the 2/2 basket weave. The cloths were tested by the grab and strip methods, and the effect of the method of test is shown.

CONTENTS

I. INTRODUCTION

In order to design a cotton cloth having the optimum combination of properties for a given use, it is desirable if not essential to know how each of the properties in question is affected by the changes that can be made in the construction of the cloth. The study reported in this paper is one of several undertaken for the purpose of providing this information.[2]

This paper is concerned with the effect of varying the twist in the warp and the filling yarns on the breaking strength and elongation at rupture of plain-weave and 2/2 basket-weave cloths made from 10s (8.4 typp) cotton yarns. The results are correlated with the breaking strength and elongation of the yarns and with the type of test, whether strip or grab.

A somewhat similar study has been made by Essam,[3] who used 50s yarn spun from fine Sakellaridis cotton in 4 different twists. The

[1] The authors wish to acknowledge the assistance of A. A. Mercier, who initiated this investigation before he left the National Bureau of Standards.

[2] Herbert F. Schiefer, Richard S. Cleveland, John W. Porter, and Joshua Miller, *Effect of weave on the properties of cloth*, BS J. Research **11**, 441 (1933) RP600; Herbert F. Schiefer and Daniel H. Taft, *Mechanical properties of cotton yarns*, J. Research NBS **15**, 237 (1935) RP826; Herbert F. Schiefer, Daniel H. Taft, and John W. Porter, *Effect of number of warp and filling yarns per inch and some other elements of construction on the properties of cloth*, NBS J. Research **16**, 139 (1936) RP862.

[3] John M. Essam, *The physical properties of fabrics: The effect of yarn and weaving structure*, J. Textile Inst. **19**, T37 (1928); **20**, T275 (1929).

yarns of the 4 twists were each woven into cloths of 4 different weaves, using the same twist in the warp and filling yarns, and the same number of yarns per inch in the warp and filling.

II. PREPARATION OF CLOTHS

The cloths were woven from the 10s (8.4 typp) cotton yarn whose properties are described in Research Paper RP826. The cloths were woven in a plain weave and in a 2/2 basket weave. In both weaves the number of warp and filling yarns per inch was kept constant at 34. The cloths were approximately of the same weight, namely 5.1 oz/yd^2 for the basket weave, and 5.3 oz/yd^2 for the plain weave.

Five different twist multipliers were used in the warp yarn for the basket weave, and four different warp twist multipliers were used for the plain weave. Eight different twist multipliers were used in the filling yarn with each warp twist multiplier of the two weaves. Right-hand (Z) and left-hand (S) twists were used for each twist multiplier of the warp and filling yarns.

The relative humidity was maintained at approximately 65 percent during the weaving of these cloths.

Some of the cloths are shown in figures 1 and 2. They show the effect of the twist of the warp and filling yarns on the appearance of the cloths.

III. TEST PROCEDURE

The cloths were tested for breaking strength and elongation at rupture by the standard grab and strip methods.[4] Five determinations were made in the warp and in the filling direction of each cloth for each method of testing. The tests were made on a machine of the pendulum type having a capacity of 150 pounds. The specimens tested were in equilibrium with an atmosphere having a relative humidity of 65 percent and a temperature of 70° F.

IV. RESULTS

There appeared to be no consistent differences in the data for the cloths woven from yarns with right-hand and left-hand twists for each of the various combinations of warp and filling twist multipliers used. These results confirm those noted in Research Paper RP826 for cotton yarns. No distinction with respect to direction of twist is therefore made in the results presented.

The effect of changing the warp twist multiplier on the warp breaking strength and elongation at rupture of the cloths for each of the various filling twist multipliers is shown by the curves of figure 3. The curves at the bottom are for cloths in which the twist multiplier of the filling yarn is 2.5. Each value plotted is the average of 20 determinations, 5 made on each of 4 cloths. The remaining curves are for other cloths in which the indicated filling twist multipliers are used.

Similar results are given in figure 4 for the filling breaking strength and elongation at rupture of the cloths. The curves at the bottom show the variation with filling twist multiplier for cloths in which the twist multiplier of the warp yarn is 3. The remaining curves are for other cloths in which the indicated warp twist multipliers are used.

[4] Federal Specification for Textiles; Test Methods, CCC-T-191.

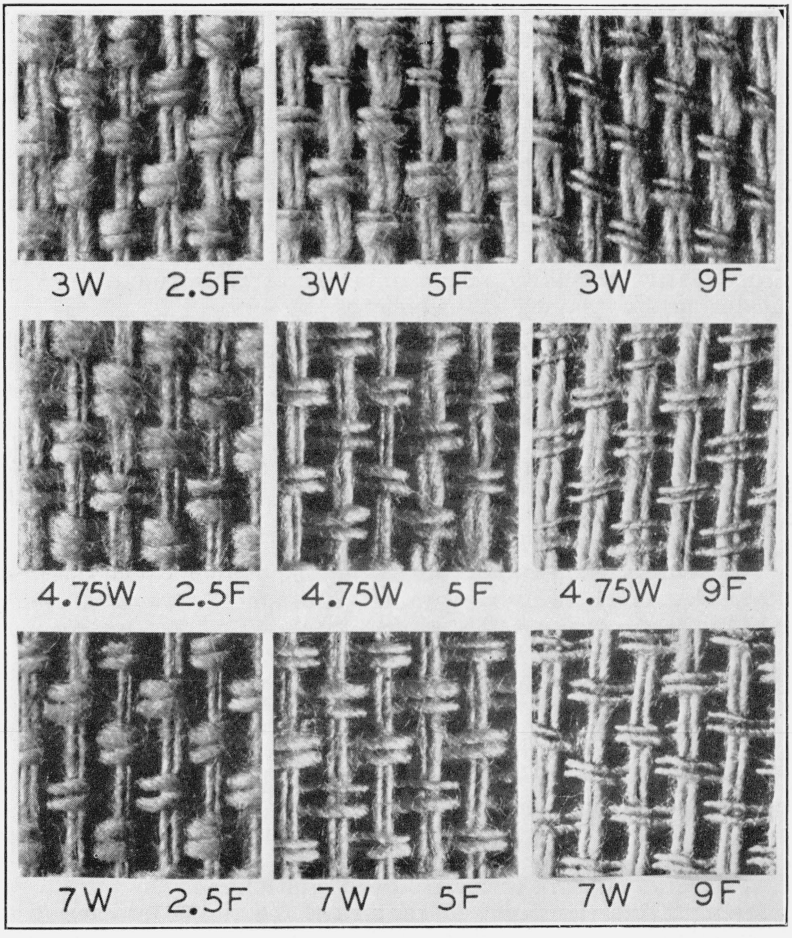

FIGURE 1.—*Effect of yarn twist on the appearance of 2/2 basket-weave cloth woven from 10s cotton yarn.*

The warp and filling twist multipliers are indicated by numbers. W and F refer to the warp (vertical) and filling (horizontal) yarns, respectively. Magnification about 4.

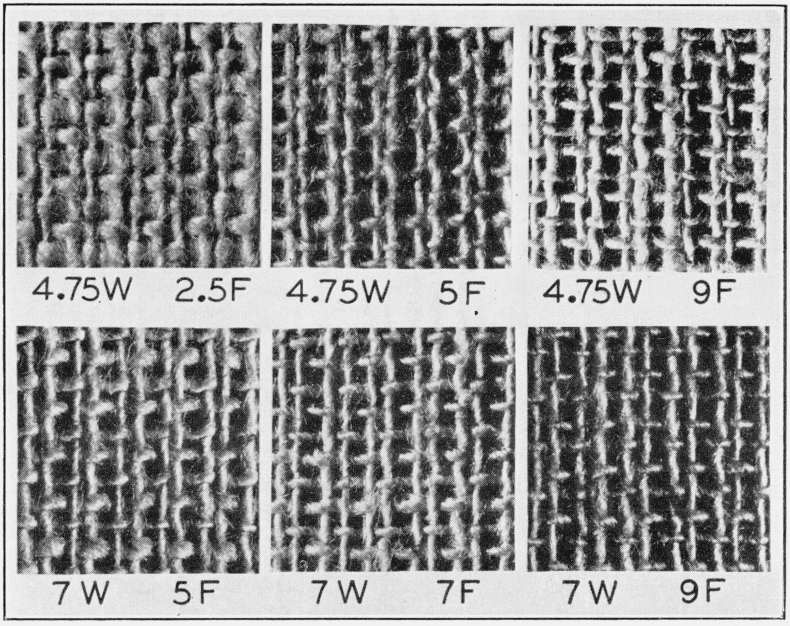

FIGURE 2.—*Effect of yarn twist on the appearance of plain-weave cloth woven from 10s cotton yarn.*

The warp and filling twist multipliers are indicated by numbers. W and F refer to the warp (vertical) and filling (horizontal) yarns, respectively. Magnification about 4.

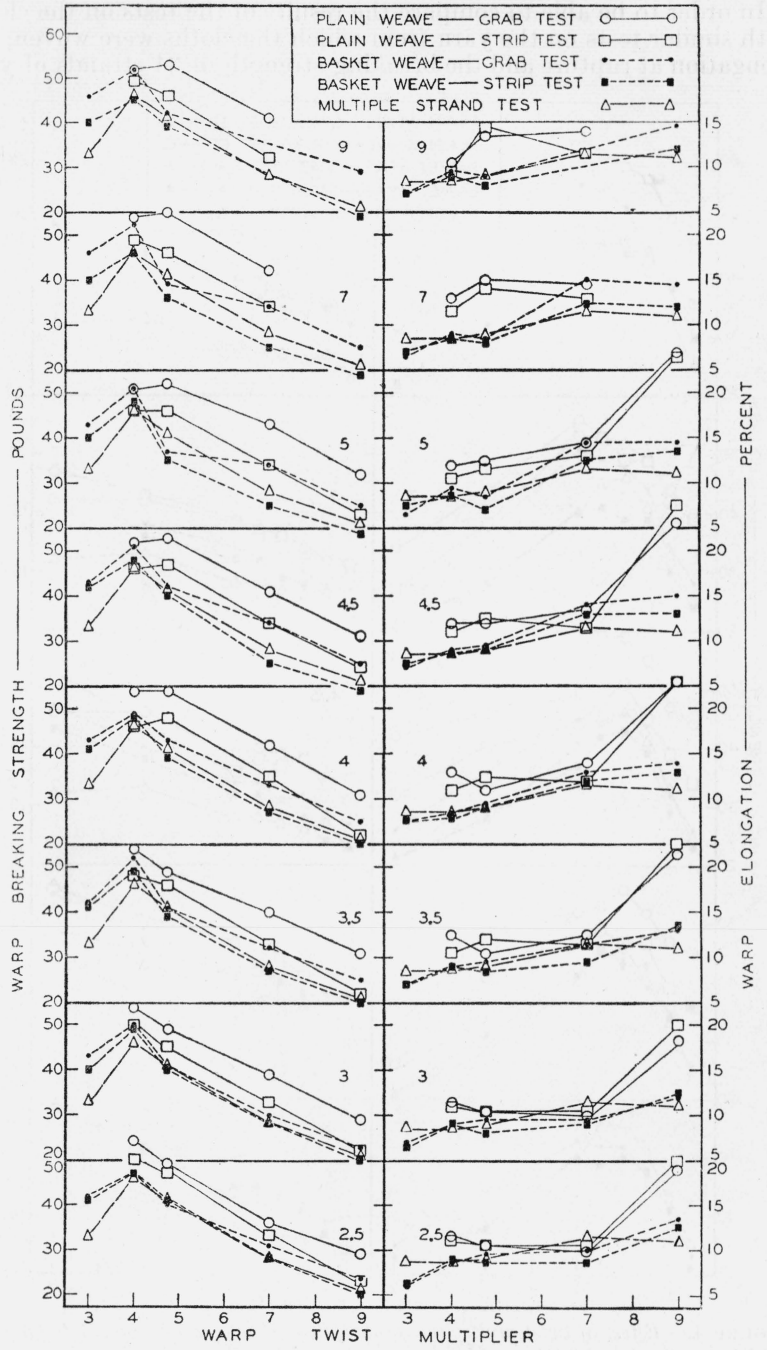

FIGURE 3.—*Effect of twist multiplier on the warp breaking strength and elongation at rupture of cloth woven from 10s cotton yarn.*

The number associated with each group of curves represents the filling twist multiplier.

In order to be able to compare the results of the tests on the cloths with similar tests on the yarn from which the cloths were woven, the elongation at rupture and the breaking strength of 34 strands of yarn

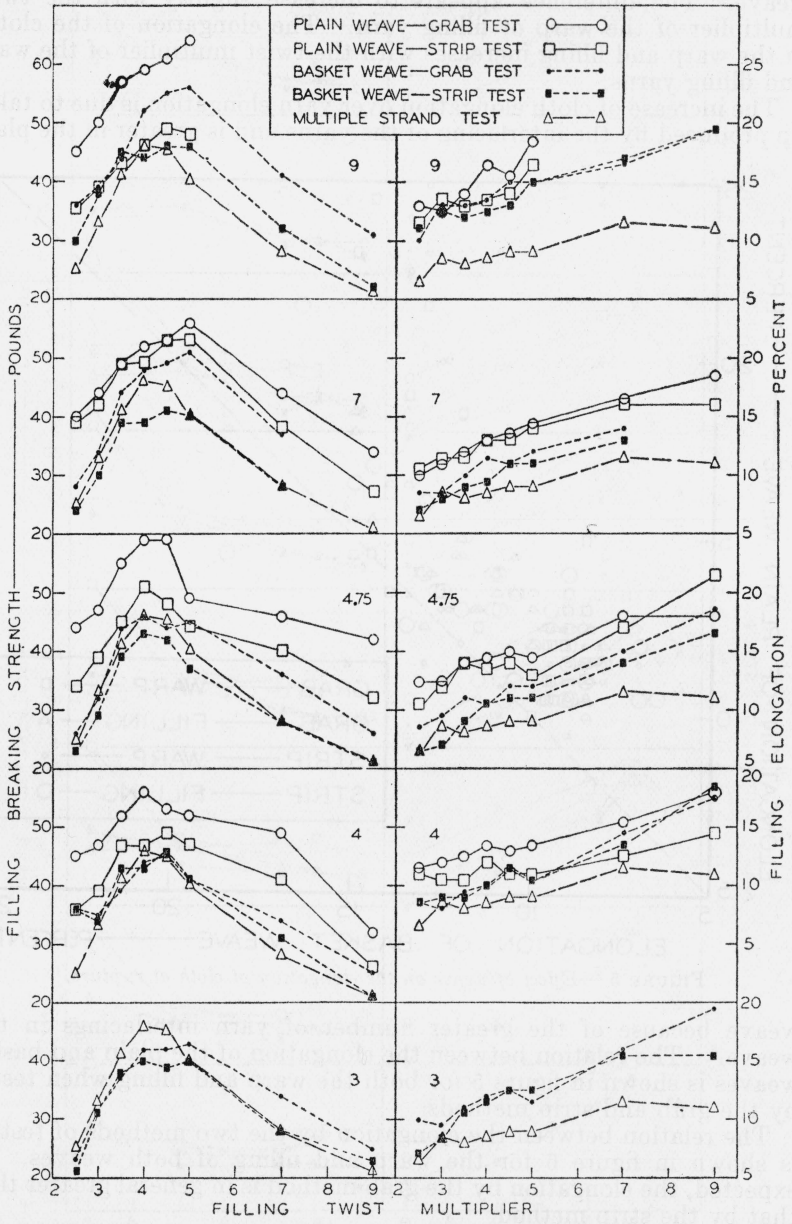

FIGURE 4.—*Effect of twist multiplier on the filling breaking strength and elongation at rupture of cloth woven from 10s cotton yarn.*

The number associated with each group of curves represents the warp twist multiplier.

on the basis of the multiple-strand test are also plotted in figures 3 and 4.

It is to be noted that the elongations of the cloths are in general greater than the elongations of the yarns. The difference is greatest in the filling of the plain weave and least in the warp of the basket weave. The difference appears to increase slightly with the twist multiplier of the warp or filling yarn. The elongation of the cloths in the warp and filling increases with the twist multiplier of the warp and filling yarns.

The increase of cloth elongation over yarn elongation is due to take-up produced by the interlacing of the yarns and is greater in the plain

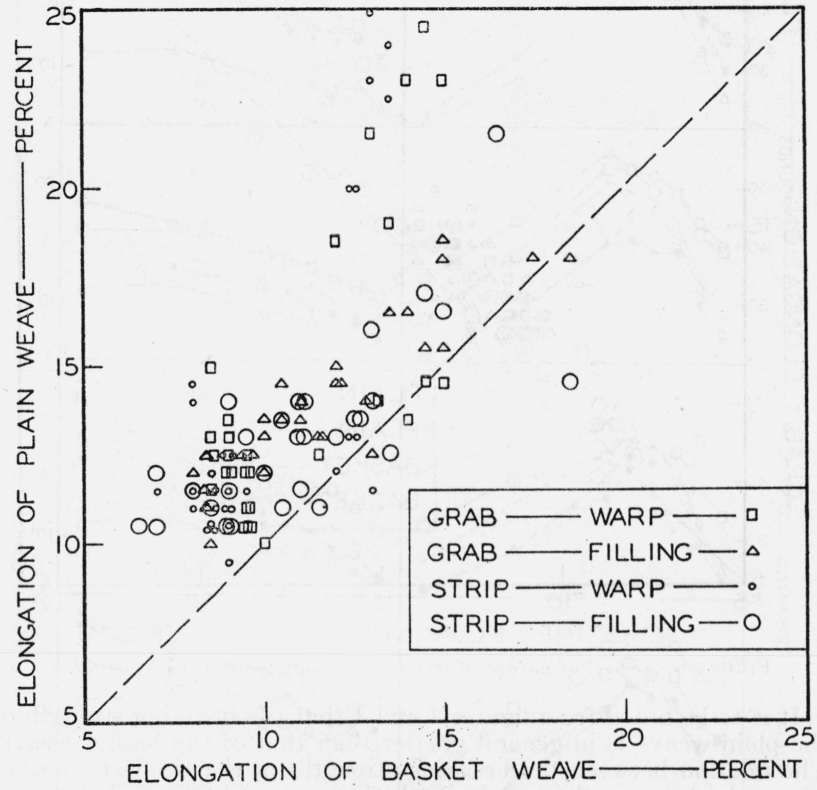

FIGURE 5.—*Effect of weave on the elongation of cloth at rupture.*

weave because of the greater number of yarn interlacings in this weave.[5] The relation between the elongation of the plain and basket weaves is shown in figure 5 for both the warp and filling when tested by the grab and strip methods.

The relation between the elongation by the two methods of testing is shown in figure 6 for the warp and filling of both weaves. As expected, the elongation by the grab method is in general greater than that by the strip method.

The breaking strength of the cloths in the warp and filling increases with the twist multiplier of the warp and filling yarns to a maximum

[5] Herbert F. Schiefer, Richard S. Cleveland, John W. Porter, and Joshua Miller, *Effect of weave on the properties of cloth.* BS J. Research **11,** 441 (1934) RP600.

and then decreases for high twist multipliers in the same manner in which the breaking strengths of the yarns vary with twist multiplier.[6] In general these cloths reach a maximum breaking strength in either the warp or filling at a twist multiplier between 4 and 4.75.

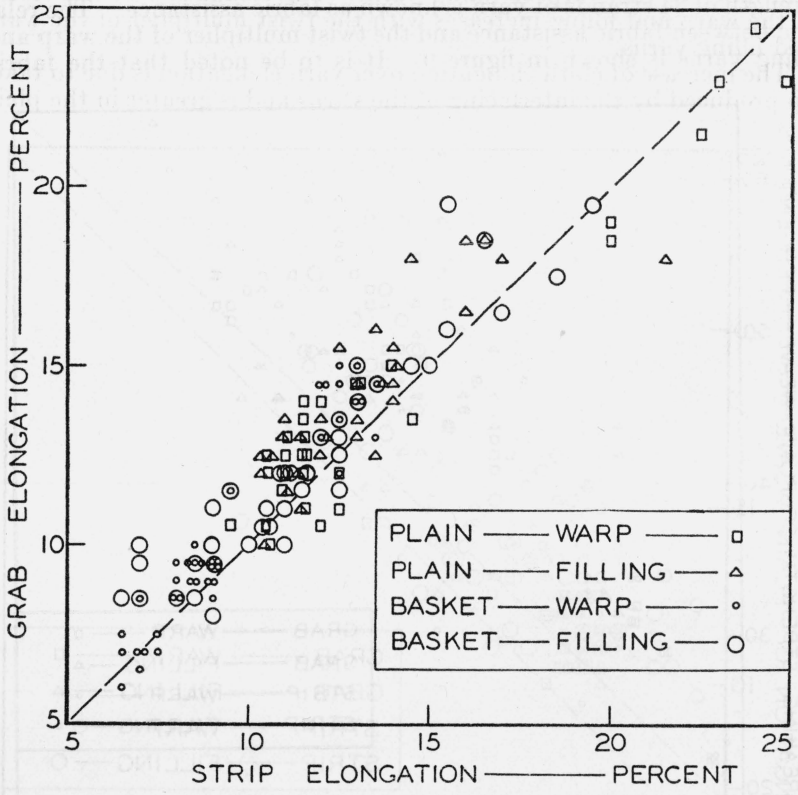

FIGURE 6.—*Effect of method of test on the elongation of cloth at rupture.*

It is to be noted from figures 3 and 4 that the breaking strength of the plain weave is in general greater than that of the basket weave. The relation between the breaking strengths of the plain and basket weaves is shown in figure 7 for both the warp and filling when tested by the grab and strip methods.

The relation between the breaking strength by the two methods of testing is shown in figure 8 for the warp and filling of both weaves.

[6] Herbert F. Schiefer and Daniel H. Taft, *Mechanical properties of cotton yarns.* J. Research, NBS **15**, 237 (1935) RP826.

As expected, the breaking strength by the grab method is in general greater than that by the strip method.

The difference between the breaking strength of the cloth and the breaking strength of 34 strands of yarn on the basis of the multiple strand test of the yarn, expressed as a percentage of the breaking strength of 34 strands of yarn is known as fabric assistance. The relation between fabric assistance and the twist multiplier of the warp and filling yarns is shown in figure 9. It is to be noted that the fabric

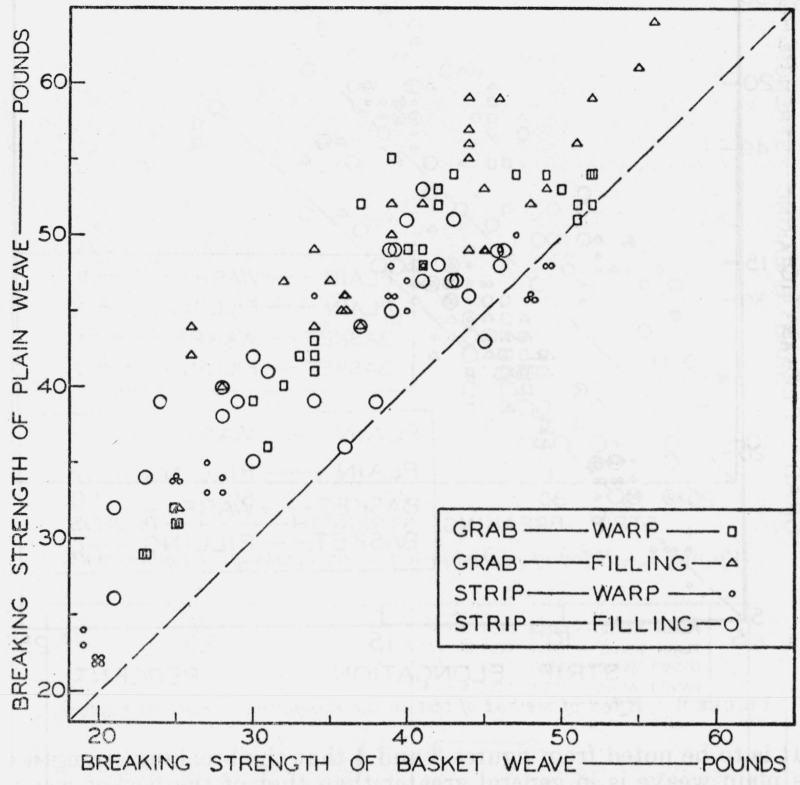

FIGURE 7.—*Effect of weave on the breaking strength of cloth.*

assistance decreases in general with an increase in twist multiplier to a minimum and then increases for high twist multipliers. Minimum fabric assistance is obtained at the twist multiplier which yields, in general, a maximum strength in the yarn and also in the cloth. The fabric assistance is greater in the plain weave than in the basket weave. This difference may be attributed to the greater number of yarn interlacings in the plain weave.[7] The effect of the method of

[7] See footnote 5.

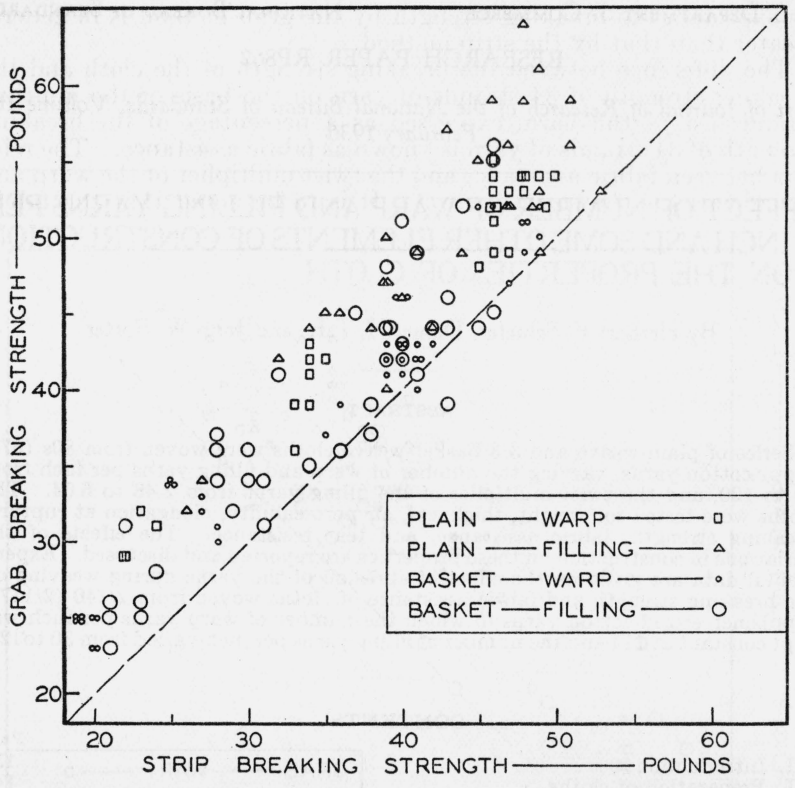

FIGURE 8.—*Effect of method of test on the breaking strength of cloth.*

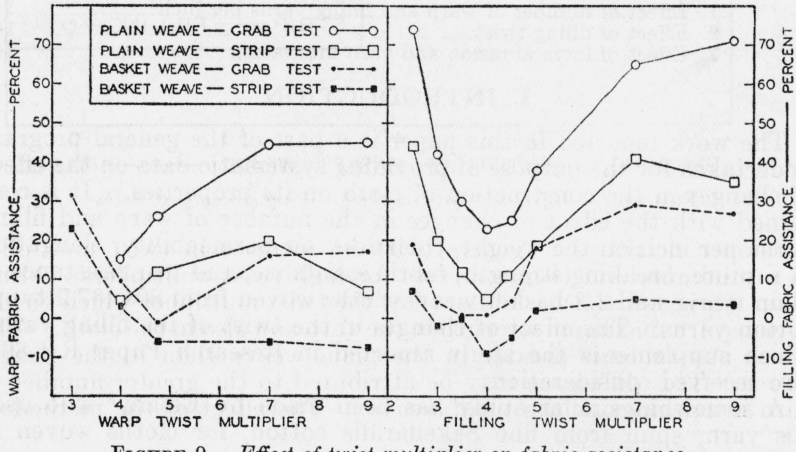

FIGURE 9.—*Effect of twist multiplier on fabric assistance.*

testing on the fabric assistance is also indicated by the curves of figure 9.

WASHINGTON, December 30, 1935.