

**STUDIES ON CHANGES IN TENSILE PROPERTIES  
OF SEWING THREAD DURING HIGH SPEED  
INDUSTRIAL SEWING**

by

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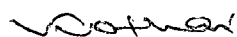
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## CERTIFICATE

This is to certify that the thesis entitled “*Studies on changes in Tensile Properties of Sewing Thread during High Speed Industrial Sewing*” being submitted by Mr. Vinay Kumar Midha to the Indian Institute of Technology, Delhi, for the award of degree Doctor of Philosophy, is a record of bonafide research work carried out by him. He has worked under our guidance and supervision and fulfilled the requirements for the submission of thesis, which has attained the standard required for a Ph.D degree of this Institute.

The results contained in this thesis have not been submitted, in part or in full, to any other University or Institute for the award of any degree or diploma.



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## ABSTRACT

During high speed sewing, needle thread is subjected to repeated tensile stresses, heat, bending, pressure, torsion and wearing. These stresses act on the thread repeatedly and the thread passes 50-80 times through the fabric, the needle eye and the bobbin case mechanism, before getting incorporated into the seam. As a result both the sewing thread and the yarns in the fabric get abraded/severed during the seaming process. A number of researchers observed 30% to 40% loss in needle thread strength after sewing. A number of studies have been carried out on thread strength loss after sewing, but the influence of various stresses acting on the thread and the effect of various technological, process and machine parameters on the loss in tensile properties is yet to be investigated thoroughly. In order to design the sewing machine and threads for maximum strength retention, it is important to understand how the mechanical properties of threads change as the thread progresses through the machine and gets incorporated into the seam.

In this work, the tensile properties of the needle thread are measured at four different sewing stages viz. before sewing, after dynamic loading due to the action of take up lever, after passage through the needle and fabric, and after bobbin thread interaction. The contribution of dynamic loading, passage through the needle and fabric and bobbin thread interaction has been analyzed. It is observed that the loss in tensile properties is dominated by the displacement of plies and loosening of the structure during thread's interaction with the bobbin thread. More than 50% of the total loss in tenacity is observed during this stage. Dynamic loading, which was expected to contribute significantly to the loss in thread tensile properties, was found to affect tenacity, breaking elongation and breaking energy of cotton threads only. Polyester threads are not influenced much by the dynamic loading. Initial modulus of cotton threads was found to increase during dynamic loading, due to the realignment of fibres. Passage through needle and fabric assembly has

relatively small contribution in damaging the thread tensile properties. The effect of fabric weight and composition on the loss in tensile properties is also studied and it is observed that the loss in tensile properties does not change significantly as the fabric weight changes. However, composition of the fabric being sewn has significant influence on the tensile properties of polyester staple spun and poly-poly core spun threads only.

Subsequently, the effect of process and machine parameters (number of fabric layers, stitch density and needle size) on changes in tensile properties of threads is studied following experimental design procedure. It is found that as the number of fabric layers increase, the loss in tensile properties remains unchanged for polyester staple spun and core spun threads, whereas it decreases initially in case of cotton thread. This is in contrary to the normal expectation. Thread consumption/stitch increased as number of fabric layers increase. Therefore the number of dynamic loading and abrasive cycles experienced by a segment of thread before getting incorporated into seam decrease, which is responsible for the insignificant change or decrease in tensile properties as the number of fabric layers increase. Loss in tensile properties of polyester staple spun and core spun threads increase substantially as the needle size increases. Stitch density does not show any significant effect on tenacity, breaking elongation and breaking energy of polyester threads.

From the empirical models it is possible to predict the loss in tensile properties from these parameters, with reasonable accuracy. In the end, artificial neural network model is developed to predict the loss in tenacity and it is possible to predict the loss in tenacity with good accuracy. In the sensitivity analysis, the thread type has been found to be most important parameter influencing tenacity loss, followed by thread linear density, number of fabric layers, fabric area density, stitch density and needle size.

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