PARAMETRIC STUDY OF STUD BLANK PARAMETERS FOR MAXIMUM OUTER DIAMETER OF THREAD BY ANOVA ANALYSIS

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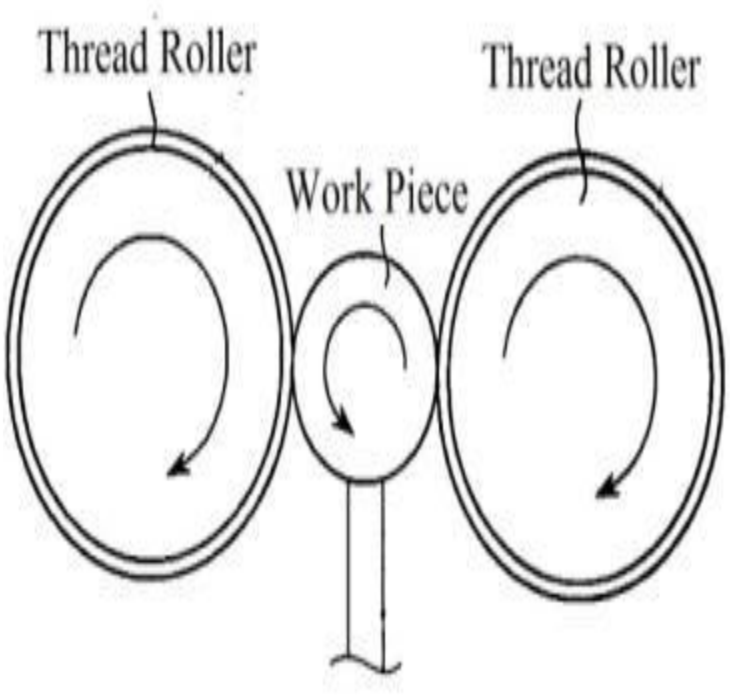
INTRODUCTION

- Thread rolling is a cold forming process operation in which the threads are formed by rolling a thread blank between hardened dies that cause the metal to flow radially into the desired shape.

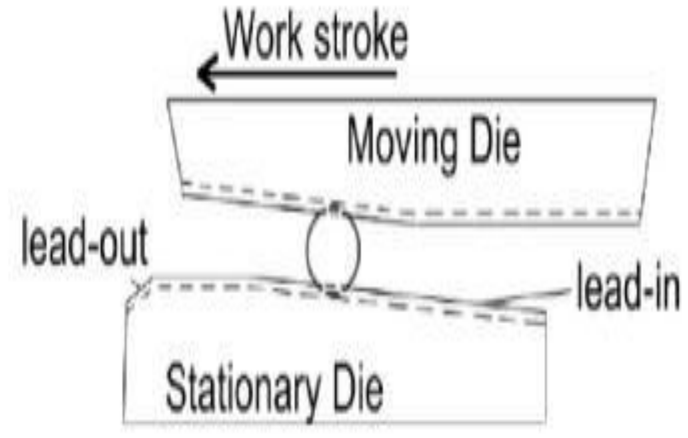
- Thread rolling requires a tooling investment to be made in the heads and rollers, which is higher than a single-point threading insert. However, for applications that involve hardened material, high surface finish and surface integrity as well as production volumes, thread rolling technology may be more cost effective over the long haul.

- For optimizing the outer diameter of a thread, process parameters like surface roughness, material properties like tensile strength and out of roundness are considered as mentioned in research paper. We use Taguchi approach for designing the experiment to determine the optimal diameter of stud thread.

PRINCIPLE OF THREAD ROLLING



Rotary Die



Reciprocationg Die

OBJECTIVES

- Threaded components like stud and bolt are most widely used in automobile components and many industrial applications like submersible pump.

- For the industry which produces the thread is a key skill to adopt the accurate and precise machining of threads because there are so many parameters which affect the dimensions of thread.

- For optimizing the outer diameter of a thread, process parameters surface roughness, material properties like tensile strength and out of roundness are considered.

LITERATURE REVIEW

- **Darshith. S, Ramesh Babu and Manjunath S S Comprehensive Study of Cut and Roll Threads.**

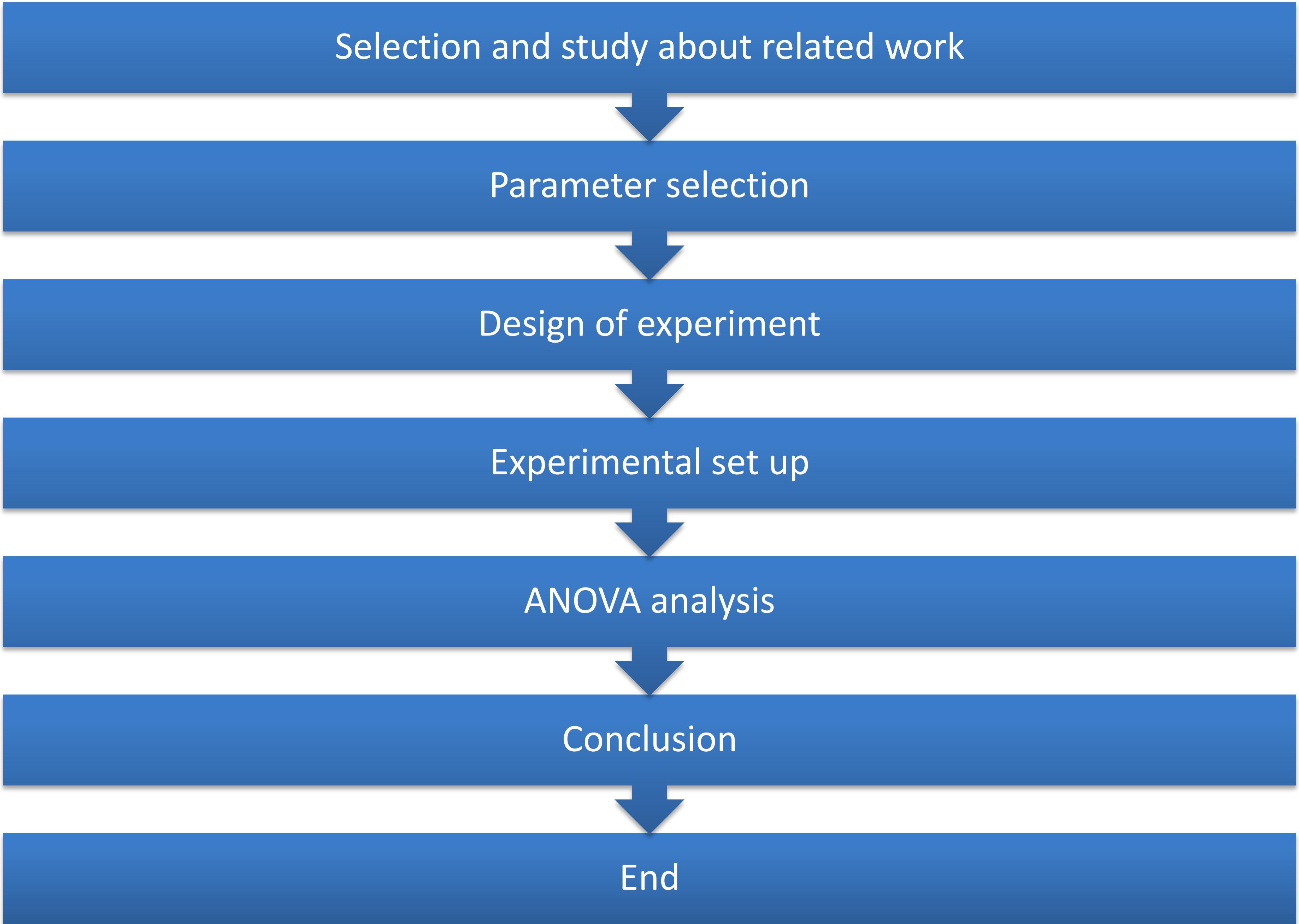
This paper deals with the thread cutting and thread rolling process for specil threads. They find that the rolled threads are having more strength when compare to cut thread. In general the rolled thread will be as much as 20% stronger than the cut thread. The rolled threads are having more toughness.

The secondary process is may not required for rolled threads. The rolled threads are having more smoothness.

- **P.S.Chauhan and K.C.Arora study effect of surface roughness of blank diameter on external threads**.

This paper presents the effect of surface roughness of blank diameter on external threading when it is manufactured by thread rolling process on sup 9A material. Sup 9 A is stainless steel which is used manufacturing of stabiliser bar of automobile. The work has been carried out at M/S NHK Spring India Pvt. Ltd. Malanpur on Hydraulic circular dies rolling machine using HSS die and sup9A workpiece. The effect of Surface roughness of blank diameter has been studied on dimension of threads. The results indicate that the surface roughness affect significantly the dimension of thread, pitch circle diameter decrease when surface roughness increase and vice versa.

METHODOLOGY



Work Preparation

❑ Input Parameters

- Surface Roughness (µRa)
- Tensile Strength(N/mm²)
- Out of roundness (µ)

❑ Output Parameters

- Outer Diameter of thread

Material specification

Material: MS, SS316, SS410

Blank Diameter: 10mm [M10 × 1.50]

Length: 100mm

Machine Specification

Name: Reciprocating Die Thread Rolling Machine

Job Diameter: 3 to 14 mm

Length: Up to 100 mm

Motor: 6KW

Industry Name:

Weltech Industry, Naroda GIDC,

Ahmedabad

Tensile Strength test

- MS- 380 N/mm2
- SS316- 520 N/mm2
- SS410- 450 N/mm2

Surface roughness Test

- MS- 1.0 µm
- SS316- 1.7 µm
- SS410- 1.1µm

Out of roundness

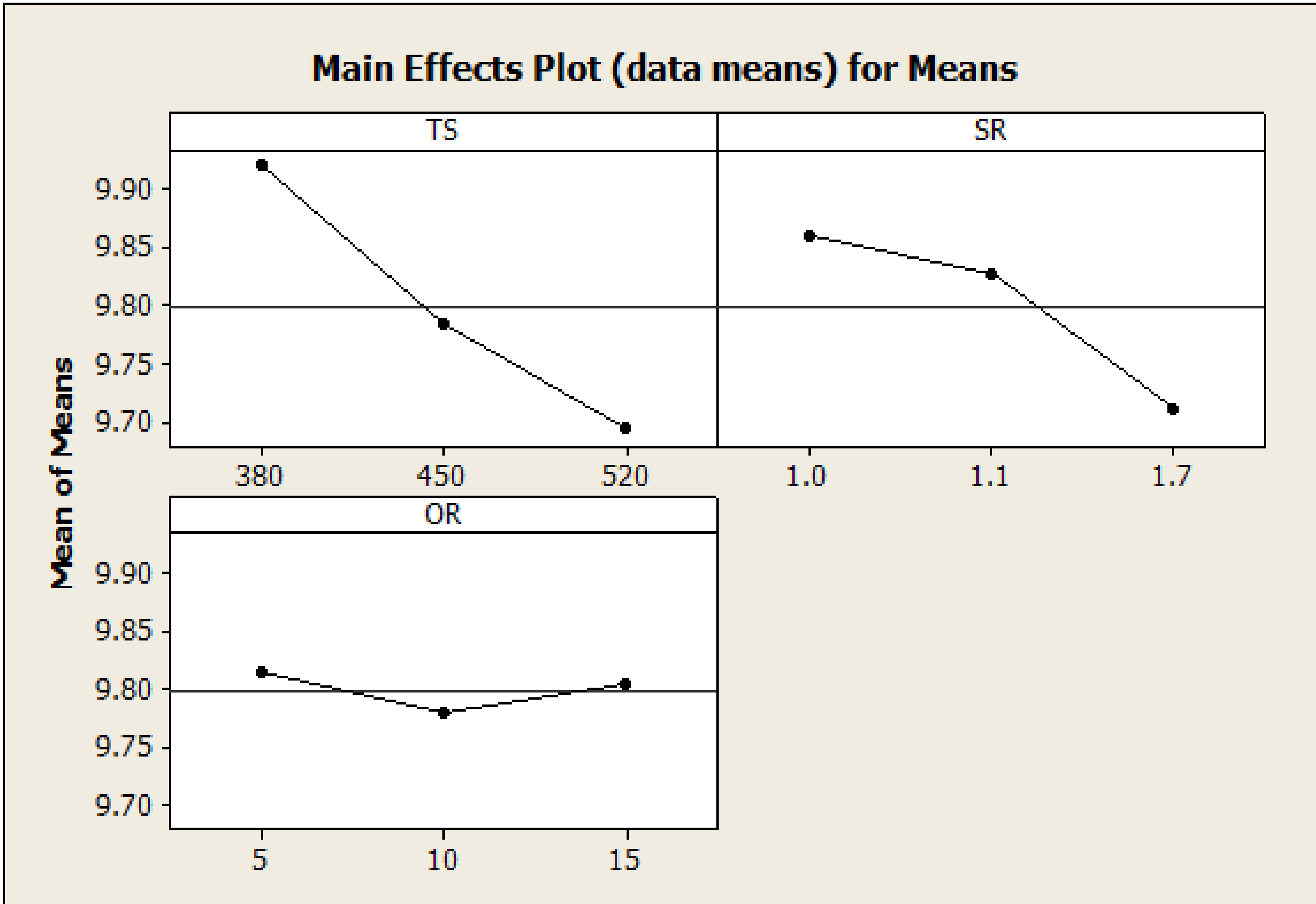
- MS:- 5μ
- SS 316:- 15μ
- SS 410:- 10μ

Levels Of Parameters

Parameters	Symbols	Levels		
		Level 1	Level 2	Level 3
Tensile Strength(N/mm^2)	A	380	450	520
Surface Roughness(µm)	B	1.0	1.1	1.7
Out Of Roundness(µ)	C	5	10	15

Experimental Set –up (L9 Array)

Experiment no	Tensile Strength	Surface Roughness	Out Of Roundness	Outer Diameter
1	380	1.0	5	9.95
2	380	1.1	10	9.92
3	380	1.7	15	9.89
4	450	1.0	10	9.88
5	450	1.1	15	9.77
6	450	1.7	5	9.70
7	520	1.0	15	9.75
8	520	1.1	5	9.79
9	520	1.7	10	9.54


Main Effects Plot (data means) for Means
TS
SR
OR
Mean of Means
9.90
9.85
9.80
9.75
9.70
380
450
520
1.0
1.1
1.7
5
10
15

Analysis of Variance (ANOVA)

Correction Factor = T^2/N

Where, T= Sum of total outer diameter

N=Number of runs

So,

$$C.F.=(88.19)^2/9$$

$$=864.1640$$

Total Sum of Squared deviations SSt:-

$$SS_T = \sum_{i=0}^{n} Y_i^2 - C.F.$$

Where,
n=number of experiment in orthogonal array
Y=outer diameter
C.F.=Correction Factor

So, $SS_T = 864.2965 – 864.1640$

$=0.1325$

❑Total Contribution of each Level:-

➢For Tensile Strength:-

At level 1,

Total sum of Outer Diameter

A1=9.95+9.92+9.89

=29.76

At level 2,

A2=9.88+9.77+9.70

=29.35

At level 3,

A3=9.75+9.79+9.54

=29.08

So,

Factor Sum of Square for Tensile Strength,

$$S_A = [(A_1^2+A_2^2+A_3^2) \div 3] - C.F.$$

$$=0.0782$$

➢ **For Surface Roughness:-**

At level 1,

Total sum of Outer Diameter

$B1=9.95+9.88+9.75$

$=29.58$

At level 2,

$B2=9.92+9.77+9.79$

$=29.48$

At level 3,

$B3=9.89+9.70+9.54$

$=29.13$

So,

Factor Sum of Square for Surface Roughness,

$$S_B = [(B_1^2+B_2^2+B_3^2) \div 3] - C.F.$$

$$=0.0372$$

- **For Out Of Roundness:-**

At level 1,

Total sum of Outer Diameter

$C1=9.95+9.70+9.79$

$=29.44$

At level 2,

$C2=9.92+9.88+9.54$

$=29.34$

At level 3,

$C3=9.89+9.77+9.75$

$=29.41$

So,

Factor Sum of Square for Out of Roundness,

$$S_c = [(C_1^2+C_2^2+C_3^2) \div 3] - C.F.$$

$$=0.0018$$

$S_{error} = SS_T - (S_A+S_B+S_C)$

$= 0.1325 – (0.0782+0.0372+0.0018)$

$= 0.0153$

❑Percentage Contribution:-

ρ_A (Tensile Strength) = S_A/SS_T = 0.0782/0.1325

= 0.5902

= 59.02%

ρ_B (Surface Roughness) = S_B/SS_T = 0.0372/0.1325

= 0.2808

= 28.08%

ρ_C (Out of Roundness) = S_C/SS_T = 0.0018/0.1325

= 0.0136

=1.36%

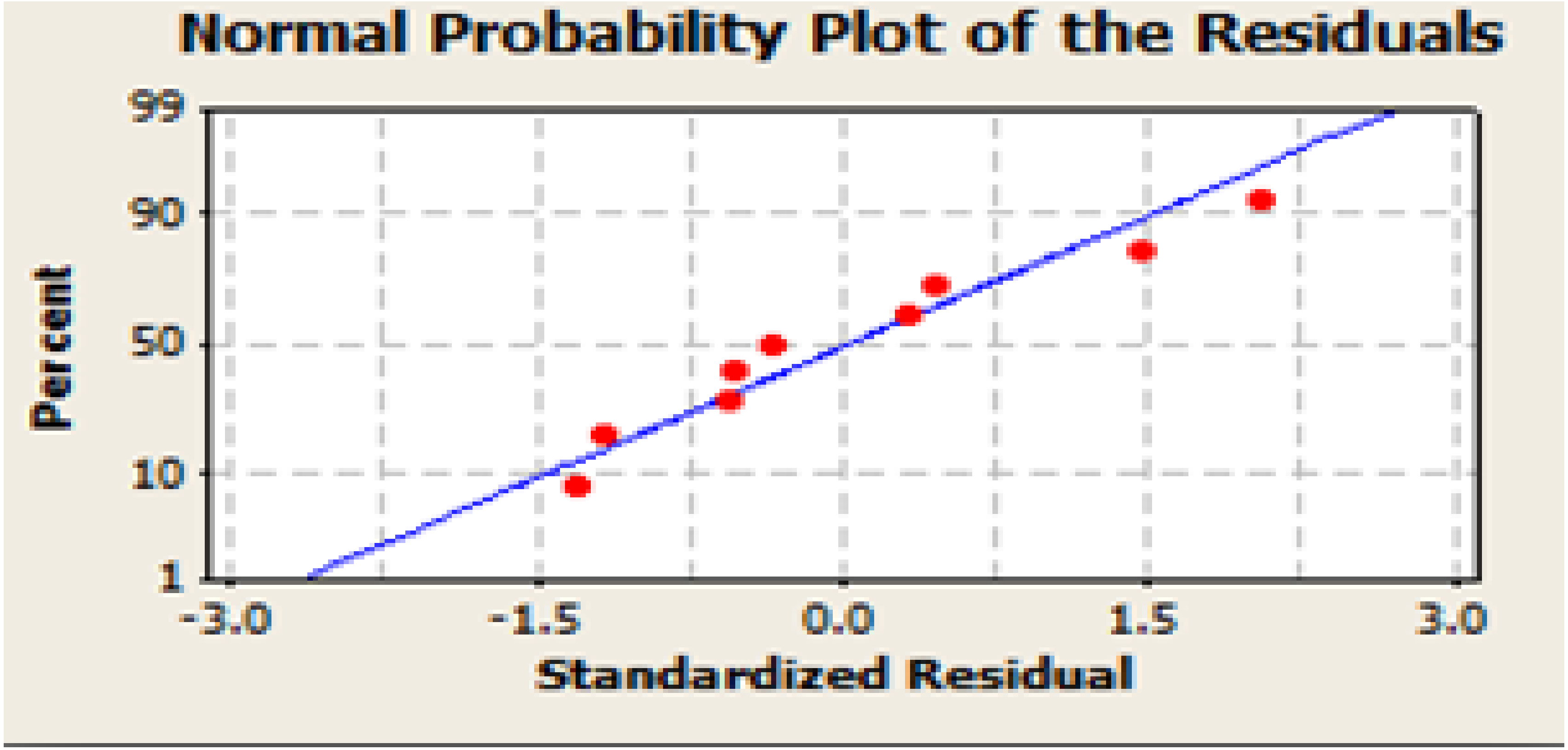
ANOVA Table for Outer Diameter

	PARAMETERS	DOF (F)	SUM OF SQARES (SS)	MEAN SQARES (MS) =SS/DOF	VARIANCE RATIO(F) =MS/MSerror	P	PERCENTAGE CONTRIBUTION (ρ)
A	Tensile Strength	2	0.0782	0.0391	5.14	0.03	59.02%
B	Surface Roughness	2	0.0372	0.0186	2.45	0.042	28.08%
C	Out of Roundness	2	0.0018	0.0009	0.12	0.961	1.36%
	Error	2	0.0153	0.0076			11.54%
	Total	8	0.1325				100%

Regression Analysis

The regression equation I

OD = 10.8 - 0.00162 TS - 0.207 SR - 0.00100 OR



Multiple correlations

In statistics, the coefficient of multiple correlation or the coefficient of multiple determination, R^2 gives information about the goodness of fit of a model.

Mathematically,

$R^2 = 1 - (SSE / SST)$

For values of R^2 0.9 to 1.0, the correlation is very strong.
For values of R^2 0.7 to 0.9, the correlation is strong.
For values of R^2 0.3 to 0.7, the correlation is moderate.
For values of R^2 less than 0.3, the correlation is weak.

So, Here, $R^2 = 1- (0.0153/0.1325)$

$R^2=0.88$

So, Our correlation is strong.

Conclusion

- The Optimum conditions are A1 , B1, C1
  i.e. Tensile Strength=380 N/ mm^2
  Surface Roughness=1.0µm
  Out of Roundness=5µ

- The Outer diameter is 9.95 mm

- The Surface Roughness has very significant parameter for increase the outer diameter of the thread. So, it is conclude that for maximize the outer diameter of thread the good surface finish of the blank required before threading process.

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THANK YOU