Development and Optimization of Milling Parameters of CNC R-Parametric Programme for Templates to Check Profile of Rolls in Rolling of Rounds and Rebars

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Abstract: *In several roll turning and template milling operations there is need of generating NC programmes which consumes more time and there is also chance of selecting wrong programme by the operator during machining operation. To avoid such errors and develop operating process R-parametric programme can be adopted which reduces the time consumption in generating a programme and also increases the flexibility in changing the design of pass in CNC machine.*

For hot rolling many rolls should be turned, so for turning several NC programmes need to be generated. By using R-programme only one programme can be generated instead of three NC programmes for same profiles with different dimensions. As square profiles used in hot rolling in stands-7,9,11 in wire rod mill(WRM) with different dimensions. The square profile template is milled using R-parametric programme, the roll shape is checked using template to check error in the turned profile. Using the generated R-parametric programme optimization of milling parameters are performed by applying Taguchi's design of experiment. The objective of work is to find surface roughness. Taguchi analysis is done in MINITAB17. Therefore, spindle speed, feed rate, depth of cut are taken as the machining parameters.

Keywords: *NC programme, R-parametric programme, Template, Milling, Rolls, Optimization, Taguchi.*

I. INTRODUCTION

Computer numerical control (CNC) is the most aspect which have revolutionary changed the way of machine production. In order to perform the machining process on CNC machines, it alters a blank piece of work material to meet precise specifications by following the numerical control programme instructions.

Steel plant performs several template milling and roll turning operations in day-to-day production. For hot rolling process, heavy rolls are turned on lathe machines into required profile. To check the errors in roll grooves templates are milled on template milling machine. For turning and milling operations R-parametric programme is programmed as per the requirement. In wire rod mill(WRM) to check the square profile rolls with three different dimensions, R-parametric programme for the template milling is generated instead of NC programme.

Parametric programming in the control system is based on the use of variables that, combined with computational functions and control structures, provide high flexibility in progress, sub-programmes and cycles. The linking sequence is based on the arithmetic calculations incurred in the programme. Using these conditions R-parametric programme is structured for the template. To know the working of the parametric programme on product quality, milling optimization process is performed using Taguchi's design of experiment L9 orthogonal array by taking cutting parameters. In this context, effort is made to estimate the cutting parameters that give surface roughness into satisfactory value.

II. LITERATURE REVIEW

Rafal Golebski [1]: This work describes the possibilities of parametric programming for CNC machine tools for SINUMERIK 840D sl control system. Taking the example of longitudinal cutting cycle, parametric programming possibilities are determined and shown. The principle of parameteric programming for high level language and the programme code implementation in control systems is described.

Mohd Asif Hasan [2]: This paper addresses the main difference of the programming aspects of the CNC machines. The work discusses about the various methods of programming CNC machines which includes the less known method parametric programming. It also describes the new standard for the exchange of product data i.e. STEP NC.

MarekMagdziak [3]:The aim of this work is to focus on the roll and application of process parameters in technological process planning (TPP) and technological documentation (TD). The challenges and complexity involved in the Computer numerical control (CNC) machine tools and coordinate measuring machine (CMM) have been taken to the consideration with reference to the technological documentation. This work involves the development of the process parameters in the CNC programming by implementing new technological process and reduction of the CMM issues by using the technological proces planning.

Neeraj Kumar [4]: This work describes about the milling machining parameters for composite macterials. Machining parameters describes the performance of the machine relative to effective parameters which are taken for the process optimum cutting parameters. The traditional optimization techniques are not suitable for the present constrained nature. So the new modified techniques are adopted such as Genetic algorithm, Response surface roughness for the milling cutting parameters.

D.Sudhakara [5]: This work is about the Optimization Friction stir welding process(FSW) parameters. This FSW welding process is a solid state process which is used for welding similar and dissimilar materials. Using FSW welding process different types of materials can be welded. By FSW method, the aim of this work is to find the best combination of process parameters to join AI5052 and AI6061 alloy materials. The combination of process parameter improves yield strength, ultimate tensile strength, hardness of welded joint and the percentage of elongation. Taguchi based grey analysis was used for the research work.

III. EXPERIMENTAL DETAILS

In this work the template is milled using R-parametric programme. NC programme for three square profiles with different dimensions are programmed into one R-parametric programme.

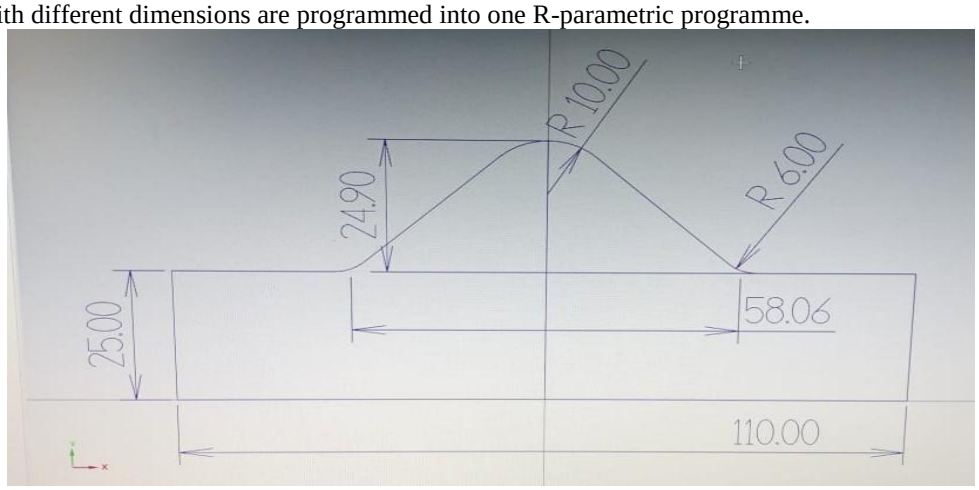


Fig:1 Dimensions of template profile

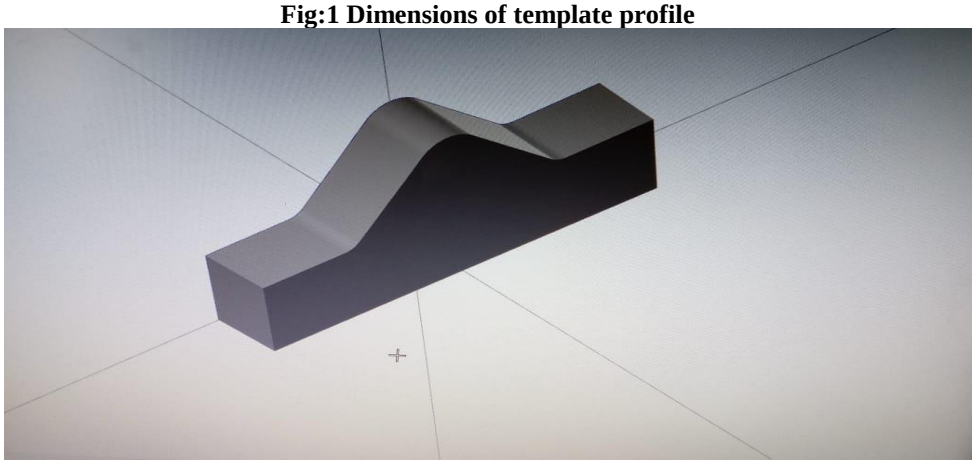


Fig:2 Shape of profile

Part Programming

A part programme comprises a complete string of blocks which define the sequence operations of a machining process on a numerically controlled machine tool.

A part programme comprises:

i) The character for programme start.
ii) A number of blocks.
iii) The character for programme end.

The character for programme start precedes the first block in the part programme. The character end is contained in the last block of the part programme.

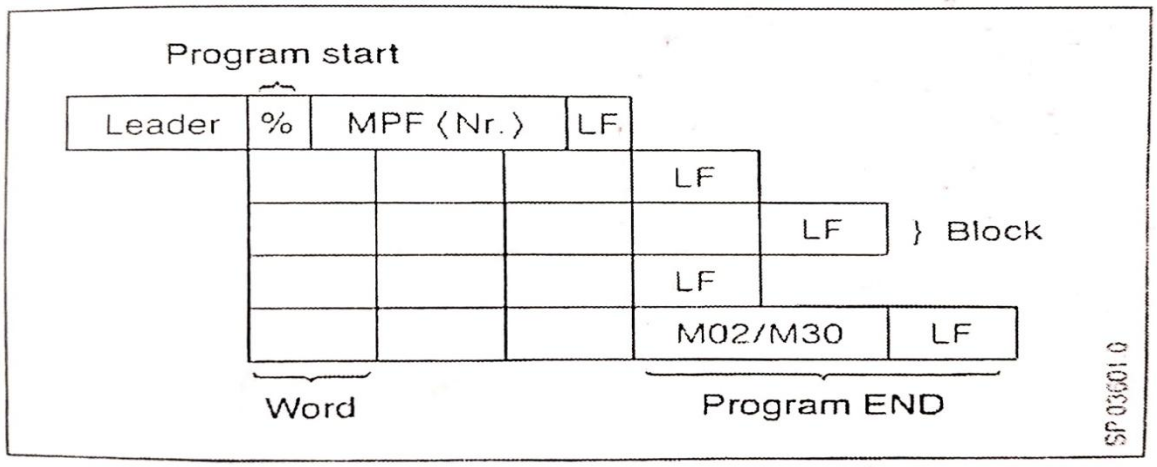


Fig: 3 NC programme format

R-Parametric programming:

Parameters are used in a programme to represent the numeric value of an address. They are assigned values within the programme, and can thus be used to adapt a programme to several applications such as different operating cycles, different spindle speed for various materials, different feedrates. A parameter comprises address R and a number with up to 3 digits. In the basic configuration 300 parameters are available to the controller.

Example:

R0,R5,R35,@630,@632 etc.

In the R-parametric programming the value assignments with arithmetic operations are given in the following form:

<var> = <value 1> + <value 2>
<var> = <value 1> - <value 2>
<var> = <value 1> * <value 2>
<var> = <value 1> / <value 2>

Parameter definition is used to assign certain numeric values with signs to the various parameters. The parameters can be defined either in part programme or in subroutines.

Example:

R1 = 10LF

Steps of Procedure for R-parametric programming:

- Step-1: First the dimensions and shape of the profile are taken as per the requirement for turning of rolls and milling of templates.
- Step-2: Dimensions of profile are taken as R parameters each dimension is assigned to each R value such as R0=25, R2=24.9, R3=90, R4=6, R15=110, R50=90, R100=2.
- Step-3: These R parameters are programmed according to the shape of profile by the linking sequence of parameters. Based on the arithmetic operations with parameters the linking sequence calculations are calculated.
- Step-4: In the linking sequence it is possible to add a parameter to the value of an address or to subtract it. All four basic arithmetic operations are permissible in any sequence. The R parameters taken are linked up together in a parameter string using arithmetic operations.
- Step-5: In R programme, the programming cycles uses @ commands. As the profile shape consists of corner radius, this radius is calculated using trigonometric functions such as sine, cosine, tan. These are denoted by codes @630, @631 and @632.
- Step-6: After the sequential R-parametric programme is programmed, the motion programme is programmed and added with M and G-codes. In the milling motion programme the X, Y values are assigned with calculated R values.
- Step-7: Now the programme is feed in the computer and command is transferred to the template milling machine. This data is transferred using RS232 communication type. This serial type of communication checks the amount of bit data send and received by the machine.
- Step-8: Before milling operation the simulation of programme is checked to see if any error. The template is cut on the template milling machine and the type of profile is punched on the template.
- Step-9: The milled template is then used to check profile of turned rolls to check the error in the rolls.

Experimental Setup

For milling of the template the work part is set on the bed of template milling machine.

Fig:4 Work part setup

Design of Experiment

In this experiment three levels of factors are taken such as feed, spindle speed, depth of cut and each factor comprises of three levels. The factorial is designed using L9 orthogonal array. This fractional factorial is designed to check the best capability factor among the each matrix and each matrix row is considered as one experiment.

Table-1: Process parameters levels

S.NO	SPINDLE SPEED(rpm)	FEED (mm/min)	DEPTH OF CUT (mm)
1	2500	1500	0.1
2	2000	1600	0.2
3	1500	750	0.3

Experimentation

Table-2: L9 Orthogonal array:

JOB NO	SPINDLE SPEED (rpm)	FEED RATE (mm/min)	DEPTH OF CUT (mm)	SURFACE ROUGHNESS (µm)
1	2500	1500	0.1	0.842
2	2500	1600	0.2	1.203
3	2500	750	0.3	2.327
4	2000	1500	0.2	0.773
5	2000	1600	0.3	1.431
6	2000	750	0.1	3.149
7	1500	1500	0.3	1.112
8	1500	1600	0.1	3.561
9	1500	750	0.2	2.921

Fig:5 Milled work part

Surface Rougness (Analysis of Results)

General linear model: RA versus Spindle speed, Feed, Depth of cut

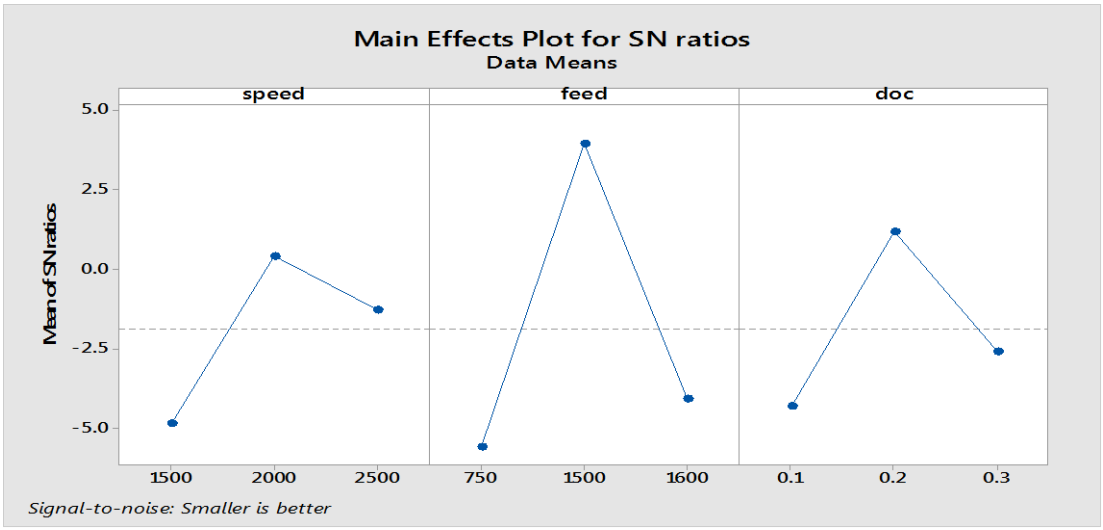
Table-3: Factor Formation

FACTOR	TYPE	LEVELS	VALUES
Spindle speed	Fixed	3	2500,200,1500
Feed	Fixed	3	1500,1600,750
Depth of cut	Fixed	3	0.1,0.2,0.3

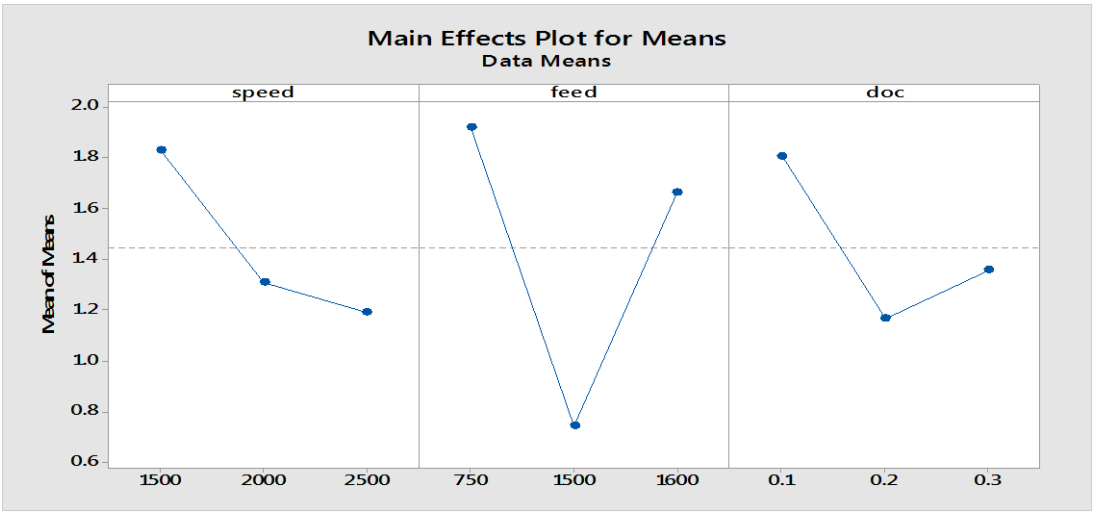
Table-4 : Analysis of Variance for RA:

SOURCE	DF	SEQ SS	ADJ SS	ADJ MS	F	P
SPEED	2	43.06	43.06	21.531	2.47	0.288
FEED	2	157.06	157.06	78.531	9.01	0.100
DEPTH OF CUT	2	47.17	47.17	23.585	2.71	0.270
ERROR	2	17.42	17042	8.712		
TOTAL	8	264.72				

Main Effects Plot for SN Ratio:



Main Effects Plot for Means:



IV. RESULT AND CONCLUSION

The aim of this work is to develop one R-parametric programme for template of three square profile grooves with different dimensions. Using parametric programme optimize the milling parameters by L9 orthogonal array. Here, three process parameters spindle speed, feed, depth of cut are varied to know the influence of response on Surface roughness.

The surface roughness is shown minimum of 0.773µm at job-4 in the experimental work performed. The minimum value is obtained at spindle speed of 2000rpm, feed 1500mm/min and depth of cut 0.2mm.

V. REFERENCES

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