



IJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 Issue: VIII Month of publication: August 2021

DOI: <https://doi.org/10.22214/ijraset.2021.37620>

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Analysis and Optimization of cutting parameters of Carbon Steel EN8D used in the Shaft of Crawler Excavator under Carriage Track Roller Assembly for Model PC 200 - Review

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Abstract: Excavators are popular earthmoving vehicles that consists of a bucket, arm, rotating cab, and movable tracks. These components provide superior digging power and mobility, allowing this heavy equipment to perform a variety of functions. Currently, Industries which uses crawler excavators having Carbon Steel material for movable track roller are facing problem of strength, weight and high cost of track roller material and processes. Hence, selection of proper relevant material and its manufacturing processes will be done which could increase strength as well as decrease weight and overall cost of excavator under carriage track roller assembly parts. Thus, after suitable identification of materials and manufacturing process of track roller assembly parts, optimization and analysis will be done to confirm selected materials. In the present work, by using Taguchi approach, the turning of EN8D carbon steel is carried out in order to optimize the turning process parameters. The present paper deals with the optimization of selected process parameters, i.e., Speed, Feed rate, Depth of cut. Taguchi orthogonal array is designed with three levels of machining parameters and different experiments are done using L9 (3³) orthogonal array. Taguchi method stresses the importance of studying the response variation using the signal to noise (S/N) ratio, resulting the minimization of quality characteristic variation due to uncontrollable parameter. Predicted value of cutting parameters and verification test values are valid when compared with the optimum value. It is found that optimum value of verification test is within the limits of predicted value and the objective of the work is full filled.

Keywords: Crawler excavator, track roller, Taguchi method, Optimization, EN8D carbon steel, signal to noise (S/N) ratio etc.

I. INTRODUCTION

In recent time, a major research is focused on the uses of reduction of material cost keeping desired quality. In general, manufacturing process is classified as Primary and secondary process. The Casting, Welding, Forging, etc. comes under primary manufacturing process and the machining comes under secondary manufacturing process. The selection of objectives of this work includes the validation using surface roughness and the Machining time, are the basic critical factors for production time and the Surface Roughness (Ra) is the most important criteria that to be reduced as far as possible because of its effect of leading to failure in the mating parts due to friction. The work material used for the present study is carbon steel EN8D. It is suitable for shafts, Medium torque shafts, studs, bolts, connecting rods, screws, rollers, Hydraulic rams. It is mostly used in Automobile parts and machine building industry. EN8D carbon steel is a common medium carbon and medium tensile steel, with improved strength over mild steel, through hardening medium carbon steel. It is also readily machinable in any condition, also known as 080A40. An unalloyed medium carbon steel, EN8D is a medium strength steel, good tensile strength. Suitable for shafts, stressed pins, studs, keys etc. These steels are generally used as supplied untreated condition. But EN8D steels can be further surface-hardened by induction processes, producing components. with enhanced wear resistance. These materials, in its heat-treated forms possesses good homogenous metallurgical structures, giving consistent machining properties.\



A. Track & Carrier Rollers

Friction and shock loads are transmitted from the track chain, create heat within the roller. To withstand this, several quality steps are taken in the manufacturing of Komatsu Genuine OEM rollers. • Komatsu rollers are constructed of long wearing, heat resistant stellite material supported by rubber load rings that keep oil in and dirt out • Highly polished shafts and bronze bushings are used in Komatsu OEM rollers to reduce friction and extend roller life • Rollers have heat treated tread and flange areas for increased strength and longer wear life • Heavy duty mounting brackets secure rollers to track frames allowing the transmission of shock loads throughout the track frame, thereby reducing potential damage • Reservoir cavities in roller shells and shafts feed lubricant throughout the roller's interior to reduce damage-causing heat¹² • Surface hardness of the roller's outer shell reduces the wear caused by friction. Hardness decreases toward the inner bore to avoid brittleness and provide absorption of shock loads • Greater flange height on Komatsu OEM rollers provides maximum track alignment and machine stability under any operating conditions • Depending on the application, you can choose from a wide range of track rollers: • Standard and single flange: with internal lubrication. Designed to offer track alignment during operation. • Cold Weather Spec: this track roller has a different seal to withstand cold temperatures and maintain elasticity. 3.2 Roller shaft material the template is used Roller shaft material. • EN8 is a very popular grade of through-hardening medium carbon steel, which is readily machinable in any condition. (Refer to our machinability guide). EN8 is suitable for the manufacture of parts such as general-purpose axles and shafts, gears, bolts and studs. It can be further surface-hardened typically to 50-55 HRC by induction processes, producing components with enhanced wear resistance. For such applications the use of EN8D (080A42) is advisable. It is also available in a free-machining version, EN8D (212A42) • EN8 in its heat-treated forms possesses good homogenous metallurgical structures, giving consistent machining properties. • Good heat treatment results on sections larger than 63mm may still be achievable, but it should be noted that a fall-off in mechanical properties would be apparent approaching the center of the bar. • It is therefore recommended that larger sizes of EN8 are supplied in the untreated condition, and that any heat treatment is carried out after initial stock removal. This should achieve better mechanical properties towards the core.

II. LITERATURE REVIEW

A. Mr. T Bharadwaj, Mr Thushar K T. "Optimization of Process Parameters in Drilling EN8 Steel using Taguchi Technique" Volume 3 ,Issue 07 , December 2016 (IJIRST).

He proposed that work is to optimize the process parameters like cutting speed, feed rate, point angle and diameter of drill bit in drilling EN8 steel, based on key accuracy characteristics of drilled holes like Surface Roughness (Ra) . , Robust Parameter Design technique is used. The matrix experiments are conducted on EN8 steel material.

B. R Ashok Raj, T P Arun, K Sivaraj and T T M Kannan , "optimization of milling parameters of en8 using Taguchi methodology" ISSN 2278 – 0149, Vol. 2, No. 1, January 2013 (IJMERR)

In this experimental investigation was observed the machining performance with various cutting speed, feed and depth of cut using side and face milling cutter. Mainly surface roughness where investigated employing Taguchi design of experiments and analysis of variance (ANOVA)

C. Tasleem Ahmad*,Noor Zaman Khan*, Zahid A. Khan, "Optimization Of End Milling Process Parameters On Surface Roughness Using Taguchi Method" Volume 8, Issue 7, July-2017 (IJSER)

Present study investigated the optimization of CNC End milling process parameters using Taguchi method for minimizing the surface roughness (Ra) of EN8 steel. Carbide end mill was used as a cutting tool for end milling operation on EN8 steel. Taguchi method was used to optimize the end milling process parameters.

D. Pratyusha J1 , Ashok kumar.U2 , Laxminarayana .P, "Optimization of Process Parameters for Milling Using Taguchi Methods" Vol.2 , No.6, Pages : 129-135 (2013) (IJATCSE)

The experiments were conducted on AISI 304 S.S plate material on vertical milling machine using carbide inserts and by using Taguchi's technique including L9 orthogonal array. The analysis of mean and variance technique is employed to study the significance of each machining parameter on the surface roughness.

E. A Venkata Vishnu et.al (ISSN August 2015) *Application of Taguchi Method in the Optimization of Turning Parameters for Material Removal Rate of En-36 Material.*

Turning of EN-36 steel alloy is carried out in order to optimize the turning process parameters. The present paper deals with the optimization of selected process parameters. Taguchi orthogonal array is designed with three levels of machining parameters and different experiments are done using L9 (34) orthogonal array. Taguchi method stresses the importance of studying the response variation using the signal to noise (S/N) ratio,

F. B Pradeepkumar, Dr. N.V.N. Indra Kiran, S. Phani Kumar, “Effect of Cutting Parameters in Drilling of EN8 (080M40) Carbon Steel to Obtain Maximum MRR and Minimum Temperature by Using RSM (Dry conditions)”. Volume-7, Issue-2, March-April 2017 (IJEMR)

This work deals with optimization of cutting parameters on EN8(080M40) carbon steel specimen in drilling operation to obtain Maximum Material Removal Rate(MRR), and Minimum work piece temperature using surface response analysis under dry conditions. In the present work Full Factorial Design is considered with three process parameters: Speed, Feed and Depth of cut. By using the mathematical model the main and interaction effect of various process parameters on MRR and Temperature are studied

G. Vijaykumar H.K, Aboobaker Siddiq and Muhammed Sinan, “Application of Taguchi Method in the Optimization of Turning Parameters for Material Removal Rate of En-36 Material” ISSN : 2248-9622, Vol. 4, Issue 5(Version 6), May 2014 (IJERA)

Taguchi technique is used to find optimum process parameters for turning of hardened AISI 52100 steel under dry cutting conditions. A L9 orthogonal array, signal-to-noise(S/N) ratio and analysis of variances (ANOVA) are applied. The results obtained from the experiments are changed into signal-to-noise ratio(S/N) ratio and used to optimize the value of MRR and surface roughness. The ANOVA is performed to identify the importance of parameters.

H. N Ganesh, M Udaya Kumar, C Vinoth Kumar and B Santhosh Kumar, “Optimization of cutting parameters in turning of en 8 steel using response surface method and genetic algorithm” ISSN 2278 – 0149, Vol. 3, No. 2, April 2014 (IJMER)

This work focuses on CNC turning of EN 8 steel using Cemented Carbide tool for varying Spindle speed, Feed and Depth of cut. The experiment is designed for Second order linear model using Response surface Method (CCD). Mathematical formulation is carried out by correlating the values of responses Machining time and Surface Roughness with the contribution of Spindle speed, Feed and Depth to develop the Empirical models for the responses. The Optimization of cutting parameters is carried out using Genetic Algorithm (GA).

I. P. G. Inamdar, N. S. Bagal, V. P. Patil, K. K. Bhosale, V. V. Mane, “Optimization of Surface Roughness in Turning Operation of EN8 using Taguchi Method”, Vol. 4, Special Issue 1, January 201 (NCDMETE-2017)

The main aim of this paper is to optimise the surface roughness in conventional turning operation using Taguchi Method for the material medium carbon steel EN8. In this work cutting speed, feed rate and depth of cut are taken as performance parameters to achieve better surface roughness. Also analysis of variance (ANOVA) was carried out with the significance factor of 95%. After the experimentation, it was found that cutting speed has more influenced on the surface roughness in conventional turning process than feed rate and depth of cut.

J. Magdum Vishal¹*, S. J. Shaha², “experimental investigation on the effect of cutting parameter on surface finish obtained in CNC turning operation by using Taguchi method: a review”, Volume: 07 Issue: 09 | Sep 2020 (IRJET).

This experiment the material used is stainless steel420. Stainless steel420 is one of the highly used materials in thermodynamic steam trap and manufacturing industries. n turning operation of stainless steel420 was done and influence of cutting parameters on surface roughness, tool wear, material removal rate was studied. The machining was performed using tool such as tungsten carbide tool (0.4).

K. Manu Garg, Munish Kainth, Gaurav Grover, Determination of Optimum Process Parameters during turning on CNC Lathe of EN8 & EN24 Steels using Taguchi method and ANOVA “ Volume-5, Issue-3, July 2016 (IJETR)

This experimental study is to optimize the cutting parameters (feed rate, spindle speed) in turning of EN8 & EN24 steel. In this, turning operation were carried out on EN8 & EN24 steel by cemented carbide coated tool insert in dry condition and the combination of the optimal levels of the parameters was obtained.

Taguchi method has shown that feed rate followed by Spindle speed was the combination of the optimal levels of factors while turning the specimens by cemented carbide coated tool insert of 0.8mm nose radii in dry cutting condition.

L. S.Sathiyaraj, A.Elanthiraiyan, G.Haripriya, V.Srikanth Pari, “optimization of machining parameters for en8 steel through Taguchi method” , (ICRAMET’ 15)

This experiment they consider the parameters of alloy of steel to attain best surface finish and undertake speed, feed and depth of cut as machining parameter. Taguchi method is further implemented to find the various levels of chosen parameter and thus using statistical analysis they find the optimum range of speed, feed and depth of cut to minimize the surface roughness and employed in working model for real time experiment. Work material of EN8 steel and tungsten carbide tipped tool is used.

M. Anil choubey¹ , Vedansh Chaturvedi² ,Jyoti Vimal³, “Optimization of process parameters of CNC Milling machine for mild steel using Taguchi design and Single to Noise ratio Analysis”, Vol. 1 Issue 6, August – 2012 (IJERT)

This paper signal-to-noise ratio method is applied to find optimum process parameters for finishing operation of mild steel with the help of CNC milling machine and high speed steel tool used. The signal-to-noise ratio applied to find optimum process parameter for CNC finishing machining .A L9 orthogonal array and analysis of variance(ANOVA) are applied to study the performance characteristics of machining parameter (spindle speed, feed, depth, width) with consideration of high surface finish and high material removal rate(MRR)

N. Ranganath M. S. 1 , Vipin² , R. S. Mishra³ , Prateek⁴ , Nikhil “Optimization of Surface Roughness in CNC Turning of Aluminum 6061 Using Taguchi Technique

This paper aims to investigate the effect of the cutting speed, feed rate and depth of cut on surface roughness, in CNC turning of Aluminum (6061) in dry condition. The effect of cutting condition (cutting speed and feed rate) on surface roughness were studied and analyzed.

III. CONCLUSION

Following findings can be summarized from the Experiment:

- 1) The Taguchi method was a good method to find out the optimum combinations. The predictions using Taguchi’s parameter design technique is in adequate agreement with the confirmation results, with a confidence interval of 90%, and this technique saves 75% of the time taken to perform the experiment in this research.
- 2) The objective of the present work is to find out the set of optimum parameter in order to improve surface roughness and reduce machining time considering the control factors for the EN8D work piece material.

In the present work, Optimization problem has been solved by using an optimal parametric combination of input parameters such as Speed, Feed and Diameter on CNC lathe. These optimal parameters ensure in producing high surface quality turned product. Taguchi method is successfully implemented for optimizing the input parameters. This project produces a direct equation with the combination of controlled parameters which can be used in industries to know the Value of Surface Roughness . The implementation of this gives direct equation in manufacturing industries

- a) reduces the manual effort
- b) reduces the production cost
- c) reduces the manufacturing time.
- d) Increases the quality of the product which is the ultimate goal of an industry.

From results of Experiment, it can be concluded that

- In the present experimentation using Taguchi method , optimum value obtained
- For Surface Roughness: Speed is 800 rpm., feed is 0.15 mm/rev, Depth of cut is 1.5mm
- For Machining Time: Speed is 800 rpm., feed is 0.40 mm/rev, Depth of cut is 0.5mm.
- It is found that values of speed, feed & depth of cut are within the limits of the predicted value and the objective of the work is full filled.
- Analysis of Variance suggests that feed is the most significant factor for both surface roughness and machining time followed by speed. Whereas, Depth of Cut has very little effect.
- It is found that values of speed, feed & depth of cut are within the limits of the predicted value and the objective of the work is full filled

IV. SCOPE OF THE FUTURE WORK

In this Experimental work, it was optimized parameters for minimizing

- A. This experiment can be done for the same cutting parameters by other DOE methods or other optimization techniques.
- B. This method can also be used for alternative material types
- C. This method can also be used for materials.
- D. From concluding remarks, it is clear that EN8D can be used as a track roller shaft. EN8D has good performance characteristics. There are so many experiments carried out. The calculations will be done by Taguchi's design approach for experiment

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