"Conference Article

Experimental Investigation of the Effect of Alternative Sandblasting Processes on the Surface Roughness Data of Smooth Rolls

Abdullah Zekai KIVRIM[1]*, Muhammet BOZKURT[2]* Mehmet BAĞCI[3]*

[1] Konya Technical University, zekaikivrim@gmail.com
[2] Yenar Döküm A.Ş, muhammed@yenar.com.tr
[3] Konya Technical University, mbagci@ktun.edu.tr

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Abstract

The process of sandblasting is a method applied to remove oil, dirt, rust, and corrosion from metal surfaces, aiming to extend the metal's service life due to the gradual development of rust and corrosion over time. This procedure involves using various abrasive substances, specially manufactured under the name "grit." Sandblasting, similar to sandpaper, not only eliminates visible or micron-sized rust and corrosion on the metal surface but also aims to achieve a specific level of surface roughness. An essential criterion in this process is to texture the surface with appropriate abrasives.

The sandblasting machine used in this study is designed to achieve the desired average surface roughness level, denoted by the R a value, on the smooth rolls in flour mill rolls and flaking rolls. The machine features a sand recycling system, a filtered vacuum suction line, and employs a blower system to provide a dust-free environment. The majority of the abrasive material sprayed by the nozzle is conveyed to the rear sand tank through vacuuming, allowing dust and abrasive material to accumulate in a closed tank without extensively mixing with the air.

Consequently, the operator can achieve abrasive material recovery through the blower method without being adversely affected by the sandblasting process.

The abrasive particles with a brown aluminium oxide property and a size of 24 mesh aim to create a homogeneous roughness on the surface of smooth rolls using a PLC system. In this study, the rotation of the roll bearings at a constant speed around their axis and the comparison of different surface roughness values with the variable linear velocity h of the nozzle positioned at different angles to this movement are investigated.

Keywords: Sandblasting, Smooth rolls, Surface roughness, Aluminium oxide.

1. Introduction

The sandblasting process is carried out with the aim of mitigating the adverse effects of rust and corrosion that develop on metal surfaces over time, as well as ensuring surface roughness on the processed area. Cracking and Smooth Rolls used in the milling industry are manufactured through a double-layer centrifugal casting method and subsequently transformed into the final product using various methods, with machining being the primary technique to achieve the desired surface profiles. The test sample used in this study is a milling machine component commonly referred to as "Smooth" widely utilized in the market and typically produced with a convexity ranging from 3% to 5%. The main distinctions between Cracking and Smooth rolls lie in surface hardness and the tooth profiles present in Cracking Rolls. After being processed to the desired diameter and length, Smooth Rolls undergo cylindrical grinding. As a result of this process, the surface quality of Smooth Rolls is improved before the sandblasting process. Subsequently, the sandblasting process is conducted to achieve a more homogeneous surface roughness.

Due to its convenient properties (high resistance to corrosion, good mechanical properties, low density etc.) and to a large presence in the earth crust, the aluminum is used in a high extend in various industrial fields. One must mention that not only the technical aluminum is used, but also the aluminum alloys are materials applied to solve various problems in machine building. Even the aluminum and some of its alloys have a high resistance to the oxidation phenomena, there are situation when the surfaces of aluminum parts must be cleaned or prepared for other operations and one of the techniques applied with this aim in view is the sand blasting.[1]

Figure 1 presents a visual depiction of the test sample prior to undergoing the sandblasting procedure.

Figure 1: Smooth Rolls

2. Materials and Methods

2.1. Test Sample

As the test sample dimensions of 250x1000mm were manufactured with a 5% convexity using the double-layer centrifugal casting method, with the first layer made of Gray Cast Iron and the outer layer composed of White Cast Iron. During the selection of the sample, careful attention was paid to ensuring that the hardness values of the surface to be sandblasted were uniformly distributed throughout the material. Following casting, the sample was prepared for testing through flaking and grinding processes. Throughout the duration of the experiment, a total of 3 identical Smooth Rolls, meeting the same standards, were used. Figure 2 illustrates a Smooth Rolls ground through cylindrical grinding.

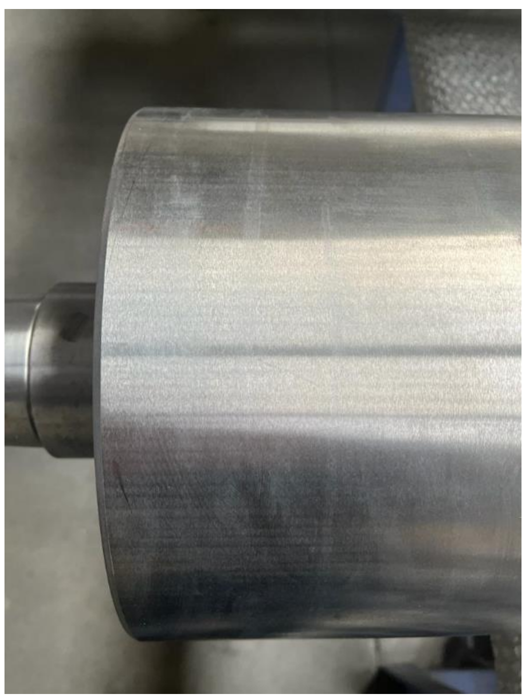

Figure 2: Smooth Rolls ground through cylindrical grinding.

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2.2. Processing Parameters

When determining the parameters used in the experiments, the abrasive sand grain size (mesh 24) was kept constant, while the Nozzle advancement speed and the collision angle values between the Nozzle and the roll (45°, 60°, 90°) were varied. In this experiment, the nozzle advancement speed (ranging from 0.1mm/s to 1mm/s) was tested at 10 different values. Separate samples were tested for each sand impact angle. The rotation speed of the rolls was set at 18 revolutions/min, and this value was kept constant during the testing phase for three samples. The rotation direction of the roll was set counterclockwise.

Figure 3: Processing Parameters

2.3. Abrasive Material

For Abrasive Sandblasting experiments, NK F24 abrasive brown sand was utilized. The visual representation of NK F24 abrasive sand is provided in Figure 4. The chemical and physical components of the sand are listed in Table 1

Table 1: Abrasive Sand Properties

Aluminum Oxide Grit 24 Mesh	
Typical Physical Properties	
Color	Black
Grain Shape	Angular
Crystallinity	Coarse Crstal
Hardness	9 Mohs
Speciflc Gravity	3,94
Proximate Chemical Analysis	
AL_2O_3	95.7 %
TiO_2	2.5 %
SiO_2	0.86 %
Fe_2O_3	0.14 %
CaO	0.39 %
MgO	0.24 %
Na_2O	0.02 %
K_2O	0.15 %

Figure 4: 24 Mesh Abrasive Sand Sample

2.4. Surface Roughness Measurement Device

The surface roughness of the sandblasted surfaces obtained from the experiments was measured using the "MarSurf M 300 C" roughness gauge. The change in average surface roughness was evaluated based on the progression and the collision angle of the Nozzle. Surface roughness measurements were conducted by measuring the surface roughness in three different regions of the samples, with a measurement length of '100 mm,' and then averaging the results. Technical specifications of the surface roughness gauge are provided in Figure 5.

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MarSurf M 300 / M 300 C

Teknik Bilgiler

MarSurf M 300 / M 300 C		
Ölçüm prensibi		Tarama ucu yöntemi
Tarama hızı	mm (inç)	0.5 mm/s (0.02"/sn)
Ölçüm aralığı		350 µm (0.014")
Profil çözünürlüğü		8 nm
Filtre		Gauss Filtresi, Ls-Filtresi (değiştirilebilir)
Cut-off	mm (inç)	0.25, 0.8, 2.5 (0.010", 0.032", 0.100")
Kısa Cut-off		seçilebilir
DIN / ISO / ASME / JIS uyarınca tarama uzunlukları	mm (inç)	1.75, 5.6, 17.5 (0.070", 0.2242, 0.700")
EN ISO 12085 (MOTIF) uyarınca tarama uzunlukları	mm	1, 2, 4, 8, 12, 16
Değerlendirme uzunlukları	mm (inç)	1.25, 4, 12.5 (0.05", 0.16", 0.5")
Seçilebilir örnek uzunluklarının sayısı		1-5
Parametreler	DIN / ISO: JIS: ASME: MOTIF:	Ra, Rq, Rz, Rmax, Rp, Rv, Rpk, Rk, Rvk, Mr1, Mr2, A1, A2, Vo, Rt, R3z, RPc, Rmr, RSm, Rsk, R, AR, Rx, W, CR, CF, CL Ra, Rq, Ry (Rz ile eşdeğer), RzJIS, Rp, Rv, Rpk, Rk, Rvk, Mr1, Mr2, A1, A2, Rt, tp (Rmr ile eşdeğer),), RSm, Rsk, S, R, AR, Rx, W, CR, CF, CL RpA, Rpm, Rmr, RSm, Rsk R, AR, Rx, W, CR, CF, CL
Düşey ölçek		Otomatik/seçilebilir
Yatay ölçek		Kesime bağlı
Kayıt içerikleri		R profili, MRK, P profili (MOTIF), sonuçlar
Baskı		Otomatik/manuel Zamanla birlikte kayıt
Kalibrasyon fonksiyonu		Dinamik
Hafıza		Entegre hafıza 40000 ölçüme ve 30 profile kadar depolama için
Ölçüm birimleri		µm/µinç seçilebilir
Seçilebilir Diller:		İngilizce, Almanca, Fransızca, İtalyanca, İspanyolca, Portekizce, Hollandaca, İsveççe, Çekçe, Lehçe, Rusça, Japonca, Çince, Korece, Türkçe
Cihaz ayarlarını engelleme		Evet
Parola koruması		Evet
LCD		Yüksek çözünürlüklü renkli ekran 3,5", 320 x 240 piksel
Yazıcı		Termal yazıcı, 384 nokta/satır, 20 karakter/satır
Baskı hızı		yaklaşık 6 satır/saniye yaklaşık 25 mm/sn (1"/sn)'ye denk düşmektedir
Termal kâğıt		40,0 mm-1,0 mm çap, 57,5 mm-0,5 mm genişlik, kaplamalı
Arayüz		USB, MarConnect
Güç kaynağı		NiMH (Nikel-metal hibrit) pil, kapasite: yaklaşık 500 ölçüm (kayıt çıktılarının sayısına ve uzunluğuna bağlı olarak), üç şebeke fişiyle birlikte takılabilir güç paketi, 90 V ila 264 V giriş gerilimi için
Güç yönetimi		Evet
Bağlantılar		Tahrik ünitesi, güç paketi, USB, MarConnect
Koruma sınıfı	M 300 / M 300 C RD 18 / RD 18 C	IP 42 IP 40
Depolama için sıcaklık aralığı		-15°C ila +55°C (5°F ila 131°F)
Çalıştırma işlemi için sıcaklık aralığı		+5°C ila +40°C (41°F ila 104°F)
Bağıl nem		30 % ila 85 %
Boyutlar (U x G x Y)	M 300 / M 300 C	190 x 140 x 75 mm (7.5" x 5.5" x 3")
Boyutlar (U x G x Y)	RD 18	130 x 70 x 50 mm (5.1" x 2.7"x 2")
Boyutlar (U x çap)	RD 18 C	139 x 26 mm (5.5" x 1")
Boyutlar (U x G x Y)	RD 18 C*	82 x 34 x 59 mm (3.2" x 1.3" x 2.3")
Ağırlık	M 300 / M 300 C RD 18 RD 18 C RD 18 C*	ca. 1 kg ca. 300 g ca. 165 g ca. 55 g

Figure 5: MarSurf M 300 C Technical Information

2.5. Sandblasting Machine

The sandblasting machine used in the experiment was manufactured by YENAR DÖKÜM A.Ş, and its technical specifications are provided in Figure 6. The working principle involves projecting abrasive material (sand) onto the metal surface through the use of compressed air, thereby achieving surface roughness. A vacuum element called a blower is employed in the nozzle to recover the abrasive material that hits the workpiece and return it to the system. This allows the abrasive material to circulate in the system.

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With the competence provided by driver-controlled operation, the machine can precisely adjust the mirror rotation speed and nozzle advancement speed. The sandblasting machine used during the experiment is illustrated in Figures 7 and 8. Thanks to an adjustable jack length, it has the capability to perform the sandblasting process for rolls ranging from 200mm to 1800mm.

YENAR

YTK-45150	
ROLL SPECIFICATIONS	
Roll Diameter	200 - 350 MM
Roll Body Length	1.500 MM
REQUIRED COMPRESSOR SPECIFICATIONS	
Minumum Air Pressure Required	5 bar
Air Consumption	2,5 m3/Min
ELECTRICAL SPECIFICATIONS	
Total installed power	7,5 Kw
Electrical ratings	380V / 3PH / 50HZ
DIMENSIONAL SPECIFICATIONS	
Total load on the table	1.300 Kg.
Approx. net weight	800 Kg
Approx. gross weight	850 Kg
Dimentions of machine (WxLxH)	160x320x167 cm
SPEED SPECIFICATIONS	
Max. Nozzle Speed (Z Axis)	150 mm/ Min
Max. Roll Speed (C Axis)	30 rpm

Figure 6: YTK 40150 Technical Information

Figure 7: YTK 40150 Sandblasting Machine

Figure 8: YTK 40150 Sandblasting Machine

3. Results

Surface roughness measurements were conducted on the test sample's surface, considering the varying nozzle angles and nozzle advancement speeds. Based on the data outputs, the optimal parameters for achieving the desired average Ra value of 3.0 were determined to be a nozzle advancement speed of 0.5mm/s for a 45° nozzle angle and a nozzle advancement speed of 0.5mm/s for a 90° nozzle angle. The distance between the nozzle and the test sample was kept constant during the experiment.
Meanwhile, the 90° spraying angle produced the highest roughness value because the sand collision did not affect by friction effect, unlike the 45° and 60° spraying angle.[2]

Average Ra values of 4 and above were not observed in experiments conducted with a 60° nozzle angle.

Analyzing Figure 9 reveals a reduction in the Ra value as the nozzle advancement speed increases. Considering the desired Ra values for Smooth Rolls to be in the range of 3 – 3.5, it is concluded that these values can be achieved with a nozzle advancement speed of 0.4 mm/s.

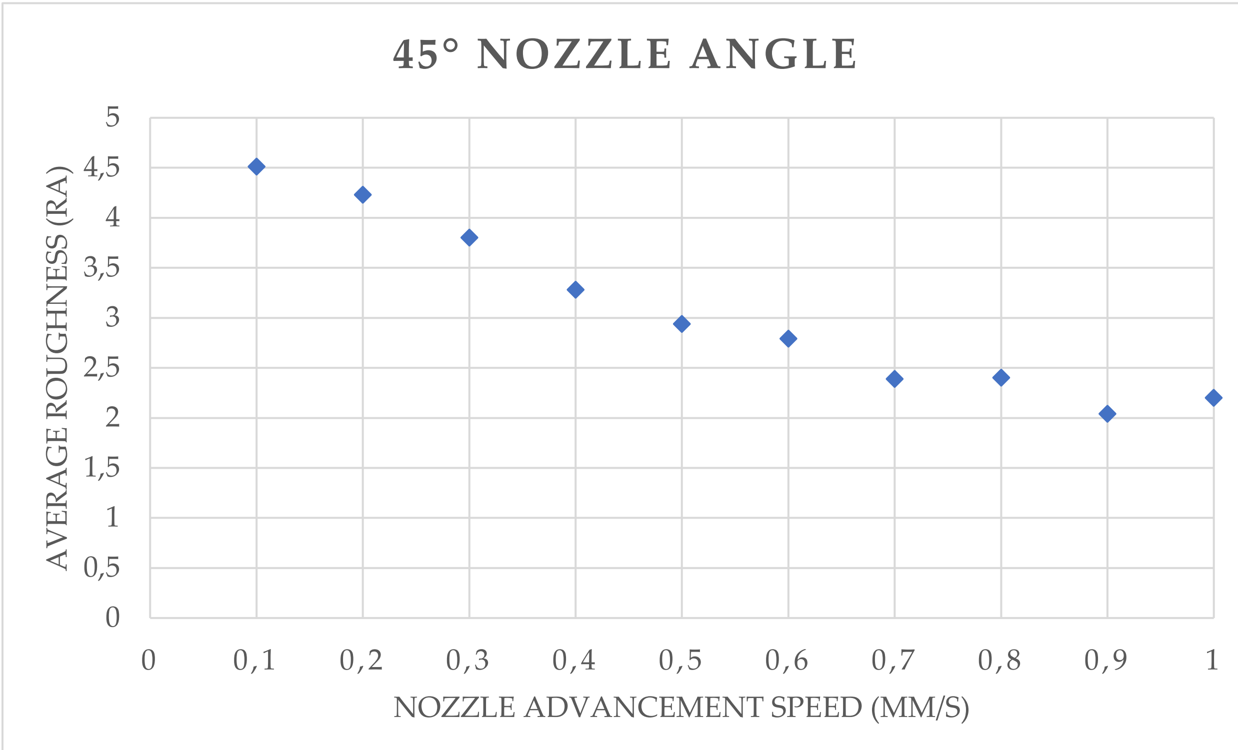

Figure 9: 45° Nozzle Angle Graph

In accordance with the results obtained from Figure 10, a decrease in roughness values for the 60° nozzle angle (Figure 11) is observed compared to other experimental outcomes.

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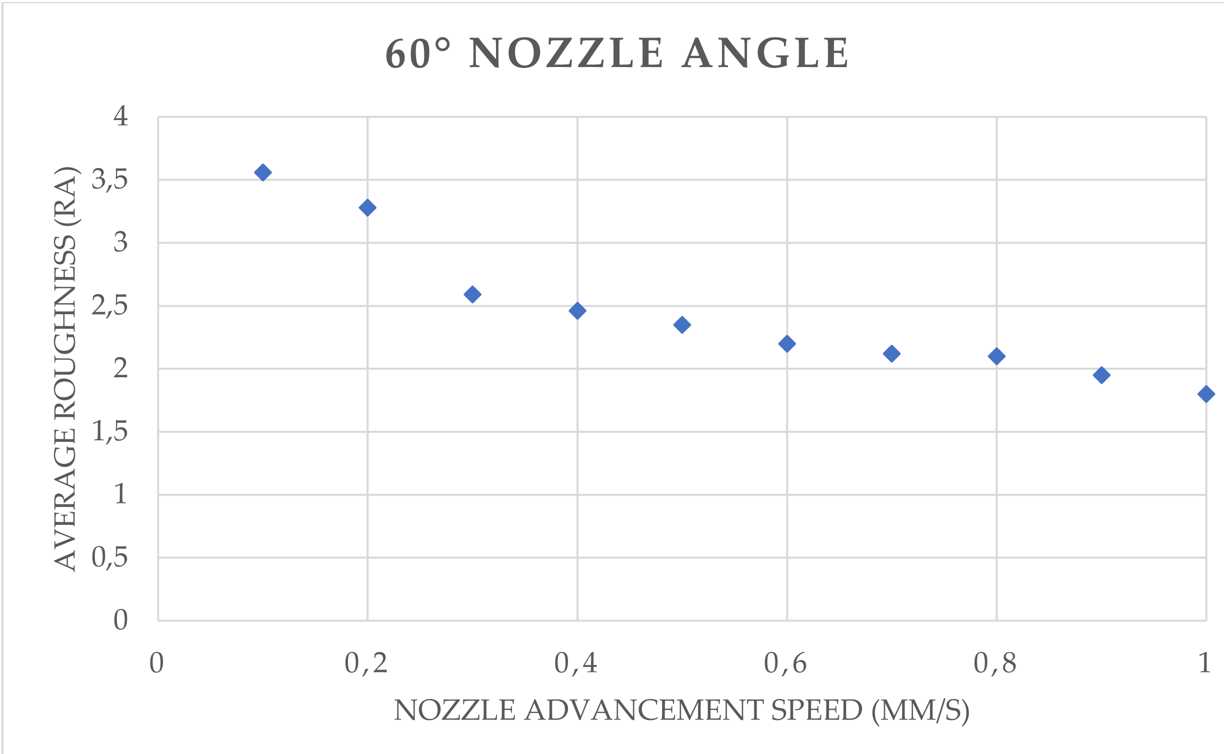

Figure 10: 60° Nozzle Angle Graph

Figure 11: 60° Nozzle Angle

In Figure 12, it is observed that the nozzle advancement speed required for the ideal Ra value of 3.0 to 3.5 is 0.3 mm/s, providing the desired roughness value up to a speed of 0.6 mm/s.

Consequently, the 90° nozzle angle currently in use has been observed to be effective in the experimental results, and in subsequent studies, experiments with different angles and different numbers of nozzles are planned to be continued. Figure 13 shows the difference in surface roughness on the Roll, obtained through sandblasting up to half, as illustrated.

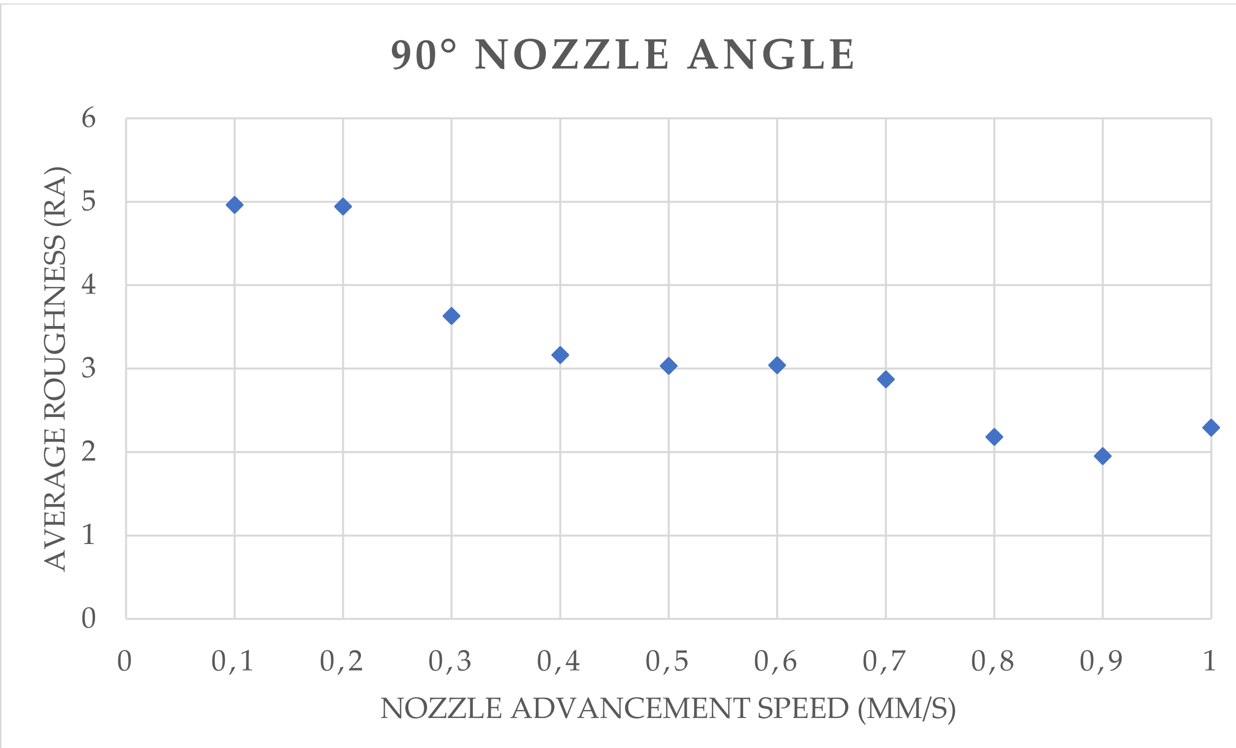

Figure 12: 90° Nozzle Angle Graph

There are several optimum sandblasting conditions proposed for YTZP surfaces in literature. The use of 90° angle and 110 µm alumina particle as the optimum conditions in YTZP sandblasting process was reported.[3]

Figure 13: 90° sample made with nozzle

4. Discussion

Based on the results of the conducted experimental study, the currently used 90° nozzle angle has been identified as ideal. In the subsequent research, the aim is to observe the effects on surface roughness by increasing the number of nozzles to two and three.

The goal is to test the impact on roughness by using variations of aluminum oxide sand with different particle structures (mesh sizes) as the abrasive material. Additionally, our ongoing studies involve the use of laser beam method as an abrasive material, and comparisons will be made with the results of this experiment.

5. Acknowledge

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