Tarumanagara International Conference on the Applications of Technology and Engineering 2018

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OF ACHIEVEMENT

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Paper Title: Optimization of open gear design for dryer paper machine transmission system

November 22nd - 23rd, 2018 | Universitas Tarumanagara, Jakarta

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Tarumanagara International Conference on the Applications of Technology and Engineering

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"The Implementation of Research Results and Innovation for People's Prosperity"

November 22nd - 23rd, 2018

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Academicians, scientists, researchers, scholars, and students are invited to submit papers on topics which include, but are not limited to :

- Mechanical Engineering and Technology
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- Industrial Engineering
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- Informatic Engineering & Technologies
- Medical & Health Technology

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International Presenters	USD 135
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Participants

International	USD 75
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Important Dates

Tarumanagara International Conference on the Applications of Technology and Engineering will be held in Campus I, Universitas Tarumanagara, Jakarta, Indonesia on November 22nd - 23rd, 2018.

Full Paper Submission Deadline	October 17th, 2018
Acceptance Notification	October 24th, 2018
Camera Ready (with Payment)	October 31st, 2018
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Submission

Submitted conference papers will be reviewed by technical committees of the Conference. Completed papers (PDF format) should be submitted to **easychair system** or by email **ticate@untar.ac.id** before the deadeline.

By submitting a paper an author and all co-authors are assumed to agree with the terms of the Proceedings licence.

We look forward to receiving your papers and to welcoming you to the TICATE 2018, Universitas Tarumanagara, Jakarta, Indonesia .

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IOP Conference Series: Materials Science and Engineering

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Tarumanagara International Conference on the Applications of Technology and Engineering

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1st Tarumanagara International Conference on the Applications of Technology and Engineering 2018

Preface

On behalf of the organising committee of 1st Tarumanagara International Conference on the Applications of Technology and Engineering (TICATE) 2018, I would like to welcome all delegates to the Campus of Universitas Tarumanagara (UNTAR) in Jakarta, Indonesia with great pleasure. Being held from November 22 to 23, 2018 the international conference is organized by UNTAR and technically sponsored by IOP Conference Series: Materials Science and Engineering (MSE).

Universities play an important role in facing the rapid development of technology and engineering in recent digital era. The rapid developments of technology and engineering impact various aspects of people's life in welcoming the era of Industry 4.0. The biggest challenge faced by universities due to these rapid developments is how the results of research and technological innovation can contribute to the people's prosperity. As a form of contribution from universities in responding this challenge, Universitas Tarumanagara hold the 1st TICATE 2018 with the theme of: "The Implementation of Research Results and Innovation for People's Prosperity".

This international conference activity is expected to be a forum of discussion, networking and exchanging ideas among researchers, academicians, and practitioners to work together to pursue research and technological innovation that can be used to contribute to people's prosperity.

Over 160 papers have been submitted to 1st TICATE 2018 from 6 different countries, those are Germany, France, Australia, Taiwan, Malaysia, and Indonesia. We categorized the papers under seven groups, namely Mechanical Engineering and Technology; Electrical Engineering; Industrial Engineering; Civil and Environmental Engineering; Food and Agriculture Technology; Informatic Engineering & Technologies; and Medical & Health Technology. All papers, regardless of their standing or initial classification, were available for general discussion at the committee's meeting.

Our special thank goes to our Rector, Prof. Dr. Agustinus Purna Irawan, who has initiated this conference, Dr. Svann Langguth as Head of Science and Technology Division from the Embassy of the Federal Republic of Germany in Jakarta, Prof. Dr. Mohd. Zulkifly bin Abdullah as Professor from Universiti Sains Malaysia, and Dr. Ir. Yono Reksoprodjo, DIC as Vice President Corporate Affairs of Sintesa Group, as our pleanary speakers and Bank DKI, Bank Mandiri, Tarzan Photo, Hyperzone Computer, as our patrons. I would like to give special thanks to all of you for the interesting keynote speech at this international conference.

We also thank all individuals and organisations such as the members of international editorial board, the conference organisers, the reviewers, and the authors, for their contribution in making TICATE 2018 as a successful international conference and a memorable gathering event. I am also grateful for the support of publication service of IOP Conference Series: Materials Science and Engineering (MSE).

We hope that the conference could present you wonderful memories to bring home in addition to new insights and friendship congregated during the event. We truly value your participation and support for the conference. We hope that you will enjoy TICATE 2018 and Betawi culture and tradition in Jakarta.

Dr. Hugeng, S.T., M.T. (SMIEEE)

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1st TICATE 2018
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Optimization of open gear design for dryer paper machine transmission system

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Optimization of open gear design for dryer paper machine transmission system

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Abstract. In this research, design optimization of the dryer paper machine gear (driven gear) is performed by adding a stress-relieving hole feature. The aim of this research is to find the effect of hole features with a specific position and diameter size in reducing the value of stress that occurs so that the lifetime of the gear will increase. Design optimization begins with finding problem data that occurs in work field and continues with the analysis by mathematical calculations and software simulation by using Autodesk Inventor 2017 education version to find stress distribution that occurs on the gear with the current operating load used. From the analysis carried out on the gear in operational working conditions, the maximum stress value occurs on the fillet radius area with 22.7 MPa. With the addition of a stress-relieving hole feature in the area around the fillet radius, the optimal stress reduction was obtained by 7.05% to 21.08 MPa. Keywords: gear, analysis, optimization, hole feature, stress.

1. Introduction
In the present time, the mechanical design of machine cannot only focus on functional aspect but also must emphasize aesthetic design factors. Therefore, designers these days have many considerations in designing a machine. In addition to designing, there is also a term that is familiar in the world of design, namely re-design. Re-design is a method that is carried out to optimize the design that already exists with the aim of improving the performance of a component that has previously been operating; this component re-design will have a big influence in production and work efficiency [1].

The study will mainly discuss the optimization of gear (driven) with helical type by using 20^0 full-depth involute system that is used as a transmission for dryer section of paper machine at PT. XYZ. This research was conducted to overcome the problems that occur in the work field where the gear often experiences failure by operating loads with an average lifetime ranging from 1-2 years, which afterwards causes failure in the gear tooth and therefore it must be replaced. Bending stress and tooth surface stress are ones of the main factors of failure that occur in gears [2]. By looking at these problems, an optimization of gear design is carried out by adding a stress-relieving hole feature that can alter the stress distribution occurring in the gear and at the same time reduce the stress value which has an impact on increasing lifetime.

2. Method
The method used in the optimization of gear design in dryer paper machine transmission system at PT. XYZ is an analytical method for analyzing the strength by using mathematical calculations with two standard calculations of DIN (Germany) and AGMA (America) [3], [4]

and by using software simulation design to obtain a comparison of results between calculations and simulation [5], [6], [7]. Gear design will be optimized by placing a stress-relieving hole feature by using various position and various diameter in gear tooth to find the optimal condition. The final result of the optimization is data with a reduced stress value and failure analysis is done by using the educational version of Autodesk Inventor Professional 2017 software.

3. Result and discussion

The following is the problem data of dryer paper machine component occurring in the work field that has been seen over the past three years and also the specifications of the gears used in operations.

Table 1. Problem data of dryer paper machine component

No	Failure Component	Frequency	Time of Failure	Type of Failure
1	Pinion (helical)	1 time in the last 3 years	February, 2018	Fracture tooth leg, cracked tooth wall
2	Gear (helical)	4 time in the last 3 years	April, 2016 March, 2017 March, 2018 August, 2018	Fracture tooth leg, cracked tooth wall (surface stress), deformation
3	Shaft	No failure in the last 3 years	-	There has been no failure in the past 3 years
4	Gearbox and motor drive	No failure in the last 3 years	-	There has been no failure in the past 3 years

Table 2. Gear design specification in work field

No	Technical Data	Symbol	Gear (driven)	Pinion (drive)
1	Helix angle	β	8^0	8^0
2	Normal pressure angle	α_n	20^0	20^0
3	Gear several	z	189	45
4	Module	m	10 mm	10 mm
5	Pitch diameter	D_g , D_p	1908.57 mm	454.42 mm
6	Outside diameter	OD	1928.57 mm	474.42 mm
7	Face width	b	135 mm	135 mm

Gear (driven) used in the dryer paper machine uses thermoplastic material Nylatron MC901 with a tensile strength of 82 MPa. The simulation is done by giving a resultant (tangential and radial) force of 12432.3 N to the 20^0 full-depth involute gear model with specifications according to table 3 and adding a hole feature with variations in position and diameter size to see the optimal results which can reduce the stress that occur on gears.

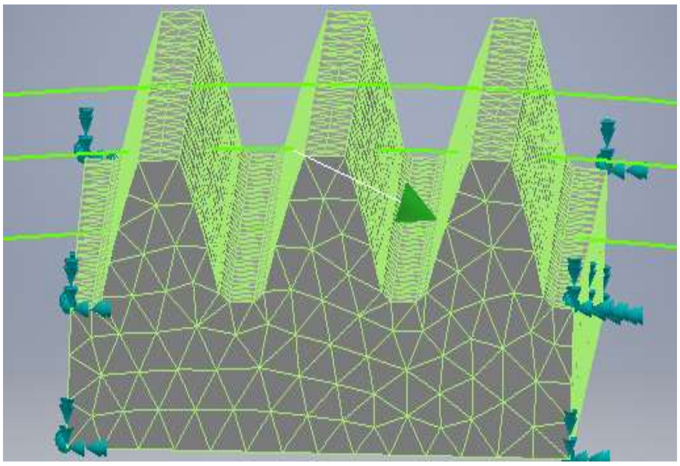

Figure 1. Force direction on teeth

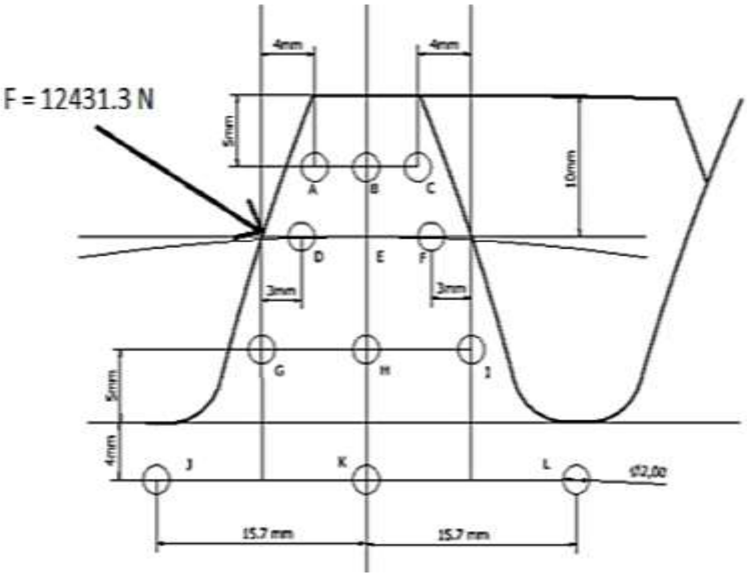

Figure 2. Location of hole placement in teeth

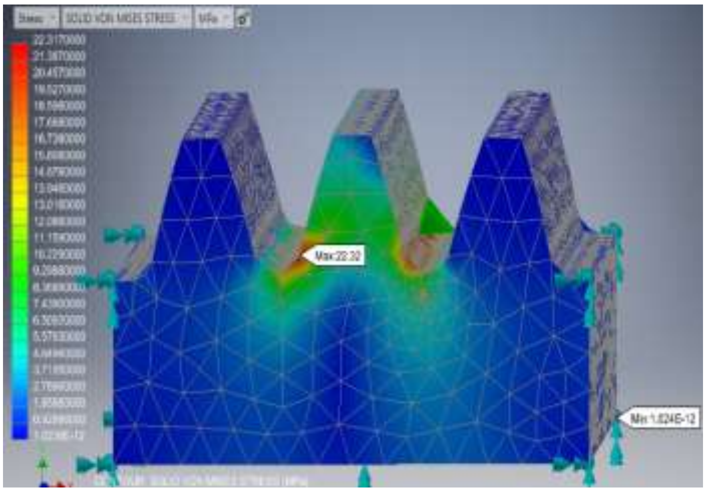

Figure 3. Stress at point L with 1 mm hole

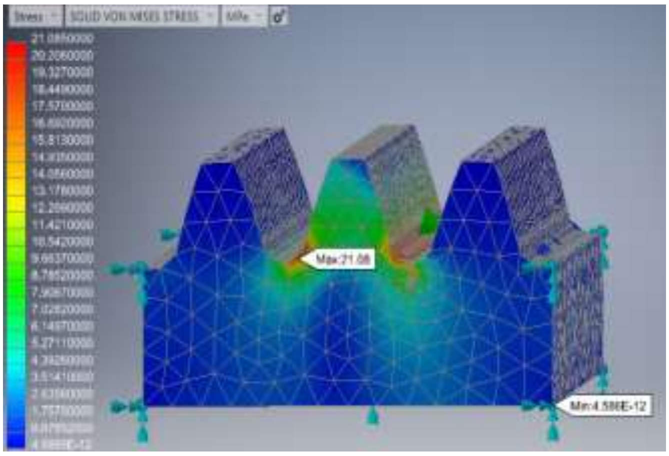

Figure 4. Stress at point L with 2 mm hole

Table 3. Stress value with variations of hole placement position

No	Hole diameter (mm)	Position	Stress Value (MPa)	Reduction (%)
1	0 (without hole)	-	22.70	-
2	2	A	22.94	-0.97
3	2	B	23.06	-1.59
4	2	C	23.23	-2.33
5	2	D	21.80	3.96
6	2	E	22.02	3.00
7	2	F	22.03	2.95
8	2	G	31.02	-36.65
9	2	H	22.36	1.50
10	2	I	33.81	-48.94
11	2	J	22.46	1.06
12	2	K	22.15	2.42
13	2	L	21.08	7.05

Table 4. Stress value with variations of hole diameter

No	Position	Hole diameter (mm)	Stress Value (MPa)	Reduction (%)
1	L	0.5	22.43	1.19
2	L	1	22.32	1.67
3	L	1.5	21.63	4.71
4	L	2	21.08	7.05
5	L	2.5	22.25	1.98
6	L	3	22.62	0.35
7	L	3.5	24.87	-9.56
8	L	4	27.13	-19.52
9	L	4.5	29.13	-28.33
10	L	5	34.39	-51.50

Based on the results of the simulations that have been done, it can be seen that the most optimal position of the hole is at the L point. The greatest decrease in voltage value occurs at the L point, so it can be concluded that the best distribution of stress concentration is in the position close to the fillet radius hole diameter of 2 mm. The stress which occurs is 21.08 MPa and the stress is reduced by 7.05% (Table 3). Likewise, with variations in hole diameter at point L, the most optimum value is with a hole diameter of 2 mm (Figure 5). Thus, based on the results of this simulation, the most optimal hole diameter is 2 mm. If observed from a hole diameter of 3-5 mm, the stress value increases continuously, so it can be concluded that after passing a diameter of 3 mm, the stress concentration on the gear will move from the fillet radius to the hole. Therefore, a diameter of more than 3 mm will not produce an optimal value.

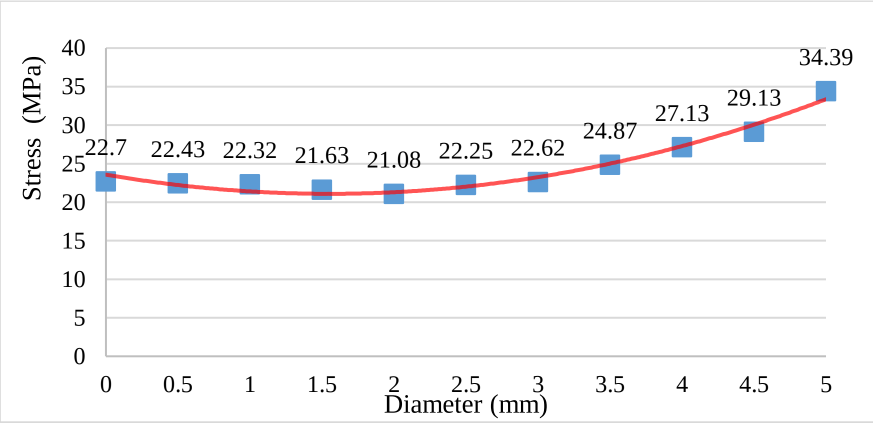

Figure 5. Stress value with variations of hole diameter

4. Conclusion

Based on the results of the analysis, it can be seen that many gear failures occur in the fillet radius which is the area of the largest stress concentration in the gear at 22.70 MPa (simulation) and 24.1 MPa (DIN calculation). From the design optimization, it can be concluded that the addition of the hole feature is done as a construction optimization step when the specifications of one of the gear pairs cannot be changed. Design optimization with the addition of hole feature results in the greatest reduction in stress at point L, where the maximum stress (fillet) on the gear decreases by 7.05 % to 21.08 MPa.

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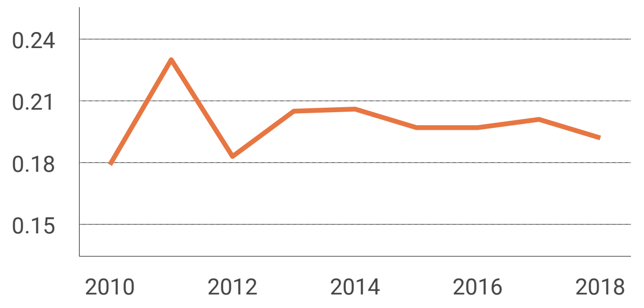

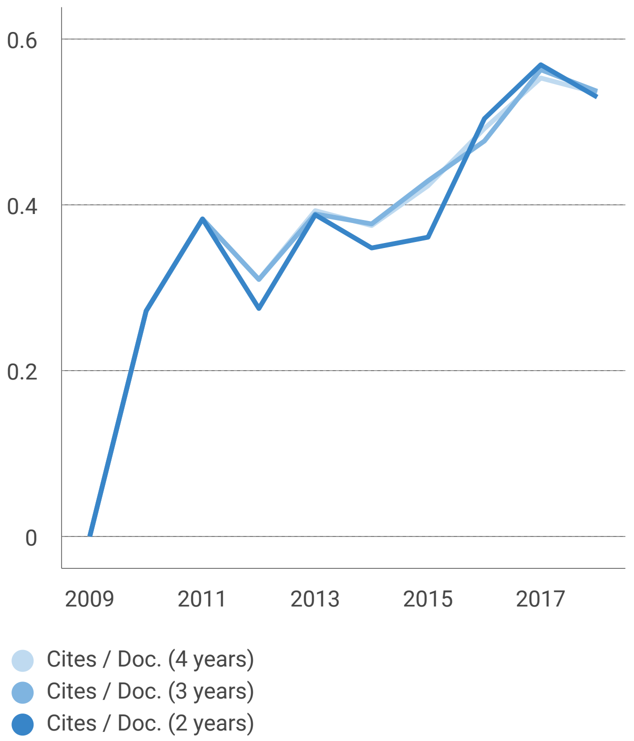

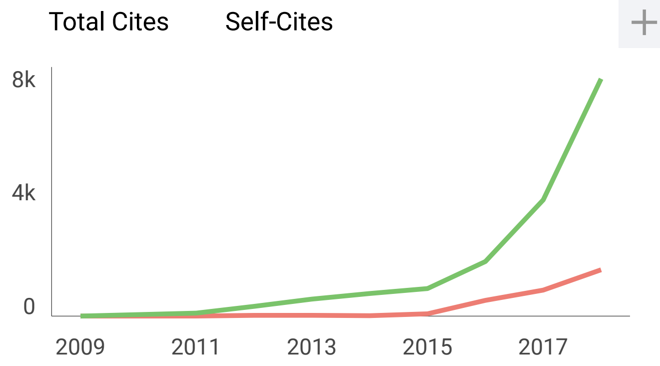

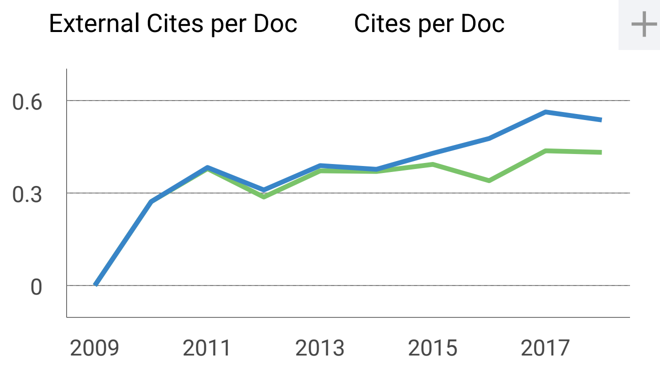

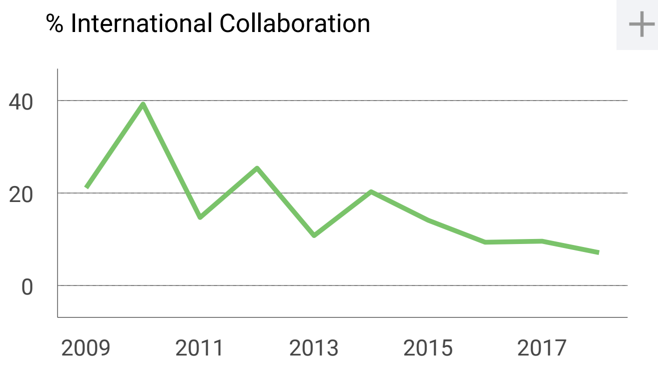

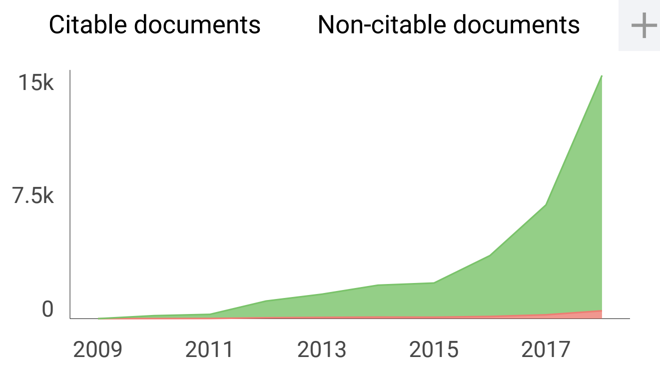

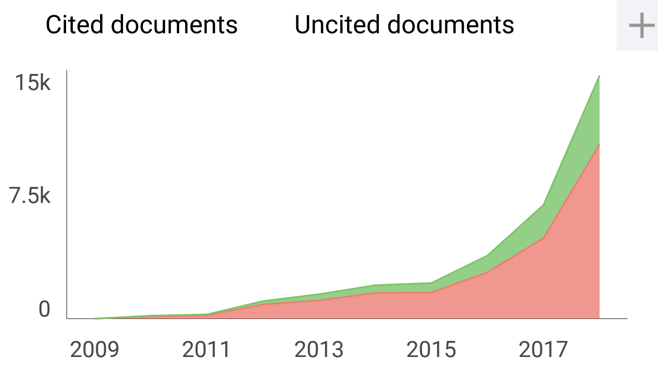

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