ω omega

ISSN: 2502-2318 (Online)
ISSN: 2443-2911 (Print)

Omega : Jurnal Fisika dan Pendidikan Fisika Vol **7**,No **1** (2021)

Homepage :
https://journal.uhamka.ac.id/index.php/omega

Comparison Of Distance To Train Speed During Braking And Movement Using Friction For Station Jakarta City To Bogor

Mutmainah Putri Imansari[1*], Imas Ratna Ermawati[2]

[1]Junior High School Ar-Raudah, Indonesia

[2]Department of Physics Education, Universitas Muhammadiyah Prof. DR. HAMKA

**E-mail: mutmain43mmu@gmail.com*

ABSTRACT

The development of Science has an impact on rapid technological advances, including transportation. One alternative that is often used and becomes public transportation is the train. This study aims to increase students' insight into the mechanisms that occur on trains, especially when the train is moving and braking will cause a comparison of speed to distance and the frictional force that occurs as a result of the wheels and rails touching. The direct method by observing and taking data directly is the method used in this study. What is observed is the initial and final speed that occurs when the train is braking or moving compared to the required travel time. In addition, when calculating the friction force, what is needed is the mass of the train with the coefficient of friction. In the study, the acceleration and braking distance of the train movement was obtained. The formula accepts the distance for uniformly changing straight motion, which means that the braking distance is about 300 m to 400 m so that it stops right at the station. Meanwhile, the distance travelled by train is about 250 m to 350 m from the departure at the station. Other things obtained are the magnitude of the static frictional force of approximately 3456000 N and the kinetic friction of about 422400 N. The distance travelled by train to stop precisely from one station to another is called the braking distance. The distance travelled by train to move at a constant speed after stopping is the definition of the movement distance. In addition, the train also has a regular average rate of around 70 to 75 km/hour. It is very closely related when the acceleration that occurs on the train is getting bigger, it will affect the braking distance, and the movement is gaining closer. However, it was also found that if the frictional force between the wheels and the rail bearings is considerable, it can stop the train right at the station.

Keywords: Train, Braking, Movement, Friction.

INTRODUCTION

The development of Science has an impact on rapid technological advances, including transportation. One alternative often used and becomes public transportation for the community is the train[1]. The train is one of the most reliable modes of land transportation because it has advantages in travel time, comfort, and safety for passengers during the trip[2]. The train is a type of land vehicle that can transport goods and people to move from one place to another[2]. The train is also a reasonably fast transportation mode, practical, cheap, and has unique access, namely rail [3].

In Indonesia, the development of railways is also always considered. Initially dominated by coal or other fossil raw materials, the train now uses electricity, which is its primary source of power. These trains are commonly referred to as Rail Trains or Electric Rail Trains (KRL). Rail carriage is a means of rail transportation that moves with its own traction/power and transport people or passengers. Railroad trains do not need towing (locomotives) to proceed. On both muzzles, there is a control room for the driver. The train power is obtained from diesel or electricity [4].

So many efforts have been made to continuously improve the safety and comfort of passengers when boarding the train. One of the train's efforts to improve its services is to improve the safety system, especially the braking system and its supporting spare parts. The brake block is an extra part of the braking system, a consumable material requiring regular replacement[4].

ω omega

Omega : Jurnal Fisika dan Pendidikan Fisika Vol **7**,No **1** (2021)

ISSN: 2502-2318 (Online)
ISSN: 2443-2911 (Print)

Homepage :
https://journal.uhamka.ac.id/index.php/omega

The brake block also has the primary function as a braking system for trains, namely:

- To slow down the train
- To stop the train
- Holding the train in a stationary state at the station[5].

From the above function, the braking system is a vital component for the entire train system, so the brake block components must always be checked and must be replaced frequently if they are no longer suitable for use. [6].

If we pay close attention, the working system of the train is related to physics. An example that we can take is the uniformly changing straight motion that occurs in the train's movement. In addition to using the working principle of uniformly changing linear motion, the train also uses the working principle of friction in stopping and moving the train.

Force is a pull and push given to an object to change position or position (moves) and shape. In addition, the force can also be interpreted as a pull or push exerted by an object against another object[7]. Force has many branches, one of which is friction[8]. Friction is one of the essential topics in studying kinematics material[9]. Kinematics is the science that deals with motion without considering the causes of movement [10]. The coefficient of friction of the wheels and rails is one of the most critical parameters in the braking process.

Coefficient friction is obtained from the ratio of the tangential (braking) force to the normal force at the wheel and rail contacts[11]. In our daily activities, without realizing it, we have applied the concept of kinematics, one of which is the train's speed. By understanding the concept of friction, the physics theories learned will feel more realistic. In general, many ideas in physics are presented with assumptions without friction, and this is not following everyday experience, for example, in the event of free-fall motion, piston movement, and simple pendulum oscillations. So that with the concept of friction, it is hoped that no one will think that the laws of physics only apply to an ideal world in the laboratory. Furthermore, it also aims to minimize the opinion that the knowledge learned in school is abstract and far from real life; friction is divided into static friction and kinetic friction.[12].

RESEARCH METHODS

This study aimed to determine the comparison between the speed of the braking distance and the movement of the train. The research time was carried out from February to June 2013, and the place was at PT. KAI at Jakarta Kota Station to Bogor.

From the analysis that I took at the research time, the research method used is the direct method by observing and taking data directly on the train. In this study, observations were made of the initial and final speeds that occur when braking the train and the time is taken when the train moves. Not only that, to use the frictional force that appears on the wheels and rail bearings, it takes the mass of the train series with the coefficient of friction on the railroad tracks.

RESULTS AND DISCUSSION

From the research conducted, it was found that:

1. **The results of the braking distance and movement are as follows:**
   a. **Cross Bogor – Jakarta City**

Table 1. Braking Distance of Trains Cross Bogor – Jakarta Kota

Stasiun	Kecepatan Awal (m/s)	Kecepatan Akhir (m/s)	Waktu (s)	Percepatan (m/s^2)	Jarak Pengereman (m)
Bogor	0	0	0	0	0
Cilebut	20,83	0	45	-0,46	471,6
Bojong Gede	19,44	0	40	-0,48	393,6
Citayem	20,83	0	30	-0,69	314,4
Depok	19,44	0	36	-0,54	349,92
Depok Baru	19,44	0	33	-0,59	320,27

ω omega

Omega : Jurnal Fisika dan Pendidikan Fisika Vol **7**,No **1** (2021)

ISSN: 2502-2318 (Online)
ISSN: 2443-2911 (Print)

Homepage :
https://journal.uhamka.ac.id/index.php/omega

Pondok Cina	20,83	0	30	-0,69	314,4
Univ. UI	20,83	0	28	-0,74	293,16
Univ. Pancasila	20,83	0	25	-0,83	261,37
Lenteng Agung	19,44	0	31	-0,62	304,7
Tanjung Barat	19,44	0	33	-0,58	325,71
Ps. Minggu	20,83	0	40	-0,52	417,2
Ps. Minggu Baru	19,44	0	32	-0,61	309,76
Duren Kalibata	19,44	0	36	-0,52	394,92
Cawang	19,44	0	30	-0,64	295,2
Tebet	20,83	0	31	-0,67	323,79
Manggarai	20,83	0	30	-0,69	314,4
Cikini	19,44	0	33	-0,58	325,7
Gondangdia	19,44	0	34	-0,57	311,5
Gambir	20,83	13,88	26	-0,26	---
Juanda	19,44	0	36	-0,52	394,92
Sawah Besar	19,44	0	30	-0,69	314,4
Mangga Bsar	19,44	0	40	-0,48	388,4
Jayakarta	19,44	0	23	-0,84	224,9
Jakarta Kota	19,44	0	40	-0,48	388,4

From table 1, it is found that the braking of the train carried out on the Bogor to Jakarta Kota route experienced a deceleration of abc 0.46 m/s2 to 0.84 m/s2 until the train stopped the station in front of it. Meanwhile, when goi through Gambir, the train slowed down to 0. m/s but did not stop at that station and continu to the next station. Meanwhile, the braki distance from around 224.9 m to 394.92 m rig at the destination station. For the speed us when driving, the commuter line covers abc 70 km/h.

Table 2. Braking Distance of Trains Cross Bogor Jakarta Kota

Stasiun	Kecepatan Awal (m/s)	Kecepatan Akhir (m/s)	Waktu (s)	Percepatan (m/s²)	Jarak P (
Bogor	0	20,83	30	0,69	310,5
Cilebut	0	19,44	40	0,48	384
Bojong Gede	0	20,83	35	0,59	361,4
Citayem	0	19,44	45	0,43	437,4
Depok	0	19,44	30	0,65	292,5
Depok Baru	0	20,83	30	0,69	310,5
Pondok Cina	0	20,83	25	0,83	259,3
Univ. UI	0	20,83	30	0,69	310,5
Univ. Pancasila	0	19,44	27	0,72	262,4
Lenteng Agung	0	19,44	27	0,72	262,4
Tanjung Barat	0	20,83	25	0,83	259,3
Ps. Minggu	0	19,44	30	0,64	288
Ps. Minggu Baru	0	19,44	32	0,61	312,3
Duren Kalibata	0	19,44	35	0,55	336,87
Cawang	0	20,83	30	0,69	310,5
Tebet	0	20,83	32	0,65	332,8
Manggarai	0	19,44	31	0,62	297,2
Cikini	0	19,44	29	0,67	281,7
Gondangdia	0	20,83	25	0,83	259,3
Gambir	13,88	19,44	20	0,27	---
Juanda	0	19,44	25	0,77	243,1
Sawah Besar	0	19,44	20	0,96	192,8
Mangga Besar	0	19,44	30	0,64	291,6
Jayakarta	0	19,44	35	0,55	336,87
Jakarta Kota	0	0	0	0	0

From table 2, it is found that the movement of the train carried out on the Bogor to Jakarta Kota route has an acceleration of about 0.43 m/s2 to 0.96 m/s2 until the train stops right at the station in front of it. Meanwhile, when it has passed Gambir station, the train accelerates up to 0.27 m/s to the next station. Meanwhile, the movement distance from around 192.8 m to 437.4 m right at the destination station. For the speed used when travelling, the commuter line covers about 70 km/h to 75 km/h.

b. Cross Jakarta City-Bogor

Table 3. Braking Distance of Trains across Jakarta City - Bogor

Stasiun	Kecepatan Awal (m/s)	Kecepatan Akhir (m/s)	Waktu (s)	Percepatan (m/s²)	Jarak Pengereman (m)
Jakarta Kota	0	0	0	0	0
Jayakarta	19,44	0	39	-0,49	385,32
Mangga Besar	18,05	0	30	-0,60	271,5
Sawah Besar	19,44	0	32	-0,61	309,76
Juanda	19,44	0	35	-0,55	343,6
Gambir	20,83	12,5	30	-0,27	---
Gondangdia	19,44	0	31	-0,62	304,73
Cikini	19,44	0	36	-0,54	349,92
Manggarai	19,44	0	32	-0,61	309,76
Tebet	18,05	0	30	-0,602	270,6
Cawang	19,44	0	33	-0,58	325,71
Duren Kalibata	20,83	0	30	-0,69	314,4
Ps. Minggu Baru	19,44	0	37	-0,52	363,34
Ps. Minggu	16,66	0	35	-0,47	292,23
Tanjung Barat	20,83	0	39	-0,53	409,31
Lenteng Agung	19,44	0	34	-0,57	331,5
Univ. Pancasila	19,44	0	33	-0,59	320,27
Univ. Indonesia	20,83	0	30	-0,69	314,4
Pondok Cina	19,44	0	32	-0,61	309,76
Depok Baru	20,83	0	30	-0,69	314,4
Depok	19,44	0	34	-0,57	331,5
Citayem	20,83	0	36	-0,58	374,04
Bojong Gede	20,83	0	37	-0,56	387,39
Cilebut	19,44	0	40	-0,48	393,6
Bogor	20,83	0	45	-0,46	471,6

From table 3, it is found that the braking of the train carried out on the Jakarta Kota to Bogor route experienced a slowdown of about 0.46 m/s2 to 0.69 m/s2 until the train stopped at the station in front of it. Meanwhile, when going through Gambir, the train slowed down to 0.27 m/s but did not stop at that station and continued on to the next station. Meanwhile, the braking

ω omega

Omega : Jurnal Fisika dan Pendidikan Fisika Vol **7**,No **1** (2021)

ISSN: 2502-2318 (Online)
ISSN: 2443-2911 (Print)

Homepage :
https://journal.uhamka.ac.id/index.php/omega

distance that occurs is around 270.6 m to 393.6 m right at the destination station. For the speed used when travelling, the commuter line covers about 70 km/h to 75 km/h.

Tabel 4. Distance of Train Movement across Jakarta City – Bogor

Stasiun	Kecepatan Awal (m/s)	Kecepatan Akhir (m/s)	Waktu (s)	Percepatan (m/s²)	Jarak Pergerakan (m)
Jakarta Kota	0	19,44	45	0,43	435,37
Jayakarta	0	18,05	40	0,45	360
Mangga Besar	0	19,44	29	0,67	281,73
Sawah Besar	0	19,44	30	0,64	288
Juanda	0	20,83	30	0,69	310,5
Gambir	12,5	19,44	32	0,21	---
Gondangdia	0	19,44	35	0,55	336,87
Cikini	0	19,44	33	0,58	315,81
Manggarai	0	18,05	37	0,48	328,56
Tebet	0	19,44	33	0,58	315,81
Cawang	0	20,83	34	0,61	352,58
Duren Kalibata	0	19,44	35	0,55	336,87
Ps. Minggu Baru	0	16,66	33	0,50	272,25
Ps. Minggu	0	20,83	35	0,59	361,37
Tanjung Barat	0	19,44	30	0,65	292,5
Lenteng Agung	0	19,44	38	0,51	368,22
Univ. Pancasila	0	20,83	37	0,56	383,32
Univ. Indonesia	0	19,44	34	0,57	329,46
Pondok Cina	0	20,83	35	0,59	361,37
Depok Baru	0	19,44	31	0,62	297,91
Depok	0	20,83	38	0,54	389,88
Citayem	0	20,83	37	0,56	383,32
Bojong Gede	0	19,44	39	0,49	372,64
Cilebut	0	20,83	39	0,53	403,06
Bogor	0	0	0	0	0

From table 4, it is found that the movement of trains carried out on the Jakarta Kota to Bogor route has an acceleration of about 0.43 m/s2 to 0.69 m/s2 until the train stops right at the station in front of it. Meanwhile, the train accelerates up to 0.21 m/s to the next station when it has passed through Gambir. Meanwhile, the braking distance that occurs is around 281.73 m to 435.37 m, right at the destination station. For the speed used when travelling, the commuter line crosses about 70 m/s.

2. The result of the frictional force of the train wheels against the train bearings:

Table 5. Static and Kinetic Friction

Jenis Gaya Gesek	Massa	Grafitasi	Koefisien Gesek	Gaya Gesek
Gesek Statis	48000 kg	10 m/s^2	0,72	345600 N
Gesek Kinetik	48000 kg	10 m/s^2	0,88	422400 N

Based on table 5, the coefficient of static friction is 0.72, and the coefficient of kinetic friction is 0.88.

CONCLUSION

From the research conducted, it can be concluded that braking distance is the distance travelled by train to stop right at the station and the movement distance is the distance travelled by train to be able to move at a constant speed after stopping. The train speed is consistent from one station to another, around 70 to 75 km/hour. If the acceleration that occurs is more significant, the distance, both braking and movement are getting closer. In the results of the study, it was shown that at the Gambir station, the train only passed through the station. Because the station is usually used for trains that want to cross Jakarta City to Bogor, and it was also observed that the friction between the wheels and the rails was so great that they could stop the train right at the station.

ACKNOWLEDGEMENT

The research team would like to thank ar-raudah junior high school and muhammadiyah university Prof DR HAMKA

REFERENCES

[1]AB Rms and E. Wahyuningsih, "Analysis of Frictional Forces of Two Homogeneous Objects as Energy Sources (Case Study: Friction of Electric Train Wheels With Rails)," vol. 1, no. 1, pp. 41–51, 2021.

[2]L. Zakaria, "Comparison of Braking Distance Performance Comparison of Metallic and Composite Brake Blocks on Trains," *J. TEDC*, vol. 15, no. 1, pp. 113–124, 2021.

[3] IB Setiawan, "Community Responses to the

ISSN: 2502-2318 (Online)
ISSN: 2443-2911 (Print)

Homepage :
https://journal.uhamka.ac.id/index.php/omega

Construction of Railway Roads in Bagan Sinembah Village," *Let's Fisip*, vol. 2, no. 2, pp. 669–679, 2017.

[4]R. Julaidi, R. Intan, and R. Adipranata, "Application of Fuzzy Control for Train Braking in Simulation Games," *J. Infra Petra*, 2019.

[5] Tubagus and E. Supriyanto, "Review of the Incompatibility of Purchases and Lab Test Results of Composite Brake Blocks with those received at Cikudapateuh Warehouse Pt. Indonesian Railways (Persero)," *J. INDEPT*, vol. 8, no. 2, pp. 10–18, 2019.

[6] L. Zakaria, T. Machinery, FT Industri, and U. Kebangsaan, "Comparison of braking distance performance of metallic and composite brake blocks on trains," vol. 15, no. 1, 2021.

[7]Y. Tiandho, "Misconceptions of friction in students," *J. Educator. Fis. and Science*, vol. 4, no. 1, pp. 1–9, 2018.

[8] IW Hardiansyah, "Application of Frictional Force in Human Life," *INKUIRI J. Educator. IPA*, vol. 10, no. 1, pp. 67–70, 2021.

[9]D. Kurniawan and I. Sucahyo, "Design of Uniform Variable Straight Motion Experiment Kit on an inclined plane," *Journal of Inov. Fis. Indonesia.*, vol. 04, no. 03, pp. 84–88, 2015.

[10]T. Setiawan, SK Handayanto, and Wartono, "Exploration of the use of procedural E-Scaffolding and strategies in solving linear motion kinematics problems," *Quantum Semin. Nas. Fis. and Educator. Fis.*, vol. 0, no. 0, pp. 323–332, 2018.

[11]Paryanto, AJ Simajuntak, and Rusnaldy, "The Effect of Particle Size and Sand Feed Rate on Railroad Sanding Systems on Rotational Speed and Surface Roughness of Wheels and Rails,"*J. Rotation*, vol. 22, no. 4, pp. 229–235, 2020.

[12]B. Katresnan, "Experimental Test of Friction Resistance in Energy-Efficient Cars," *Fac. Tech. Univ. Muhammadiyah North Sumatra*, vol., no., p. , 2019.