American Research Journal of Humanities Social Science (ARJHSS)
E-ISSN: 2378-702X
Volume-04, Issue-08, pp-42-49
www.arjhss.com

Research Paper Open Access

Freight Car Vehicle Brake System as A Traffic Safety Promoter inaccordancewith JBB inTheEra ofTechnologyDisruption

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ABSTRACT: Thispresentstudyfocusedonthediscussionofbrakingsysteminvehiclewith JBB(theallowed-amountofweight).Thisstudyattempts(1)toknowwhattypeofbrakingsystemusedbyfreightandcommercialvehicleinaccordancetoJBB(2)toknowthewaytominimizethenumberofaccidentsduetobrakefailureinIndonesia.Thispresentstudy,lastedfromMarch27toApril142021,was adescriptivequantitativestudywithtwotypes of data: primary(JBBmeasurement,andquestionnaire)andsecondarydata(trafficaccidentdatafromKNKT).Regardingtothefirstresearchquestion,itwasrevealedthat11outof11vehicleswithJBBbelow3500kgusedfluid-braking system. Meanwhile, from 7/11 vehicles with JBB above 3500 used air-braking system and4/11usedfluid-brakingsystem.TheMeanValueofbrakingsystemefficiencyshowedthatair-brakingsystemwasmoreefficientthanfluid-brakingsystem(Me_{fluid}=1548.75<Me_{air}=2071.1)invehiclewithJBBabove3500kg.Theresultofquestionnaireto22driversweresimilar.10respondentsadmittingtohavebrakeproblemwere6fullhydraulicbrakingsystemusers,3air-brakeusersand1airoverhydraulicuser.Inaddition,dataoftrafficaccident2017-2021confirmedthattherewereremoreaccidentsinvolvingfullhydraulicbrakingsystemvehicles(11/11accidents)thanfullairbrakingsystem(11/26accidents).Thesecondresultofferedsomepromotiveandpreventivewaystominimizethenumberofaccidentsduetothebrakefailuresuchas(1)Checkingthe feasibility of braking system regularly, and (2) repairing the damaged part of braking system.*KeyWords:braking-system,FreightVehicle,full-hydraulic-brakingsystem,full-air-brakingsystem,JBB (the allowedamountofweight)*

INTISARI

Penelitian ini membahas tentang system pengereman pada kendaraan dengan Jumlah Berat yangDiperbolehkan(JBB).Penelitianinibertujuanuntuk(1)mengetahuijenissystempengeremanyangdigunakan untuk angkutan barang dan kendaraan niaga sesuai dengan JBB (2) untuk mengetahuicara meminimalisir kecelakaan akibat kerusakan rem di Indonesia. Penelitian yang berlangsungdari tanggal 27 Maret sampai dengan 14 April ini merupakan penelitian deskriptif kuantitatifdenganduajenisdatayaknidataprimer(pengukuranJBB,dankuesioner)dandatasekunder(datakecelakaanlantasdariKNKT).Terkaitdengantujuanpenelitianpertama,terungkapbahwa11dari11kendaraandenganJBBdibawah3500kgmenggunakansystempengeremanfluida,sedangkan7 dari11kendaraanJBBdiatas3500kgmenggunakansystempengeremanudaradan4/11menggunakan system pengereman air. Nilai rata-rata efisiensi rem menunjukan bahwa sistempengeremanudaralebihefisiendibandingkansistempengeremanair ***(Mefluid=1548.75<Meair =2071.1)****. Hasil tersebut didukung oleh hasil kuesioner pada 22 responden. 10 responden yangmemiliki masalah pada rem adalah 6 pengguna rem air, 3 pengguna rem udara, dan 1 penggunaremair-andfluidrem.Selainitu,datakecelakaanlantastahun2017-2021menunjukanbahwalebihbanyakkecelakaanyangmelibatkankendaraandenganremfluida(11/11kecelakaan)dibandingkan dengan kendaraan dengan rem angin (11/26 kecelakaan). Hasil kedua memberikancara promotive dan pencegahan untuk meminimalisir angka kecelakaan akibat kerusakan remseperti (1) memeriksa kelayakan sistem pengereman secara berkala, dan (2) memperbaiki bagiansistempengeremanyangrusak*

KataKunci: SistemPengereman,KendaraanAngkutan,SistemPengeremanHidrolik,Sistempengeremanudara, JBB (JumlahBeratyand Diperbolehkan)

I. INTRODUCTION

Roadmap to Zero Accident (2011-2020), a UN transportation resolution signed bymorethan100countries,hasbeenoneoftheagendasoftheMinistryofTransportation to reduce the number of accidents in Indonesia. However, it is stillunreachable (Transportasi.co, 2015). A fact was revealed by the Korps Lalu LintasKepolisian Republik Indonesia (Korlantas Polri) that in 2017 there were 3 peopledie from traffic accidents every 1 hour (Marolli, 2017, August 22). In addition, in2019 there were 8.877 cases of road accidents which was higher than the numberof accidents in 2009 with 5,903 cases (Fundrika & Nainggolan, 2020, September29).

Traffic accidents are caused by various factors, one of which is the vehiclefactor. The vehicle factor contributing to most accident was the failure of thebrakingsystem.In2018therewere9,333incidents(or25incidentsperday)duetothebrakefailure(Kumparan,2019).Br eakfailure,accordingtoDanandjaya(2020,August 25), is commonly occurred in freight vehicle. Abrupted use of brakes andmaladjusted types of brakes on certain vehicles that are not in accordance with theJBB can cause a failure of the brake system. JBB or the allowed-amount of weightis the maximum weight of motorized vehicle and cargo according to its design.(Chapter 1 No 16 Peraturan Pemerintah No. 55 year 2012). Unfortunately, thedevelopment of brake system (e.g., ABS, ABS Support System, and EDB) whichNayazri (2017, March 31) called as active safety features, tend to be less effectivetominimizethe number ofaccidents.

Seeing the facts, it is necessary to conduct a research on the problem ofbrake failure in freight vehicle in accordance to JBB. Therefore, the present studyaims (1) to know what type of braking system used by freight and commercialvehicle in accordance to JBB (2) to know the way to minimize the number ofaccidentsdueto brakefailure inIndonesia.

Brakingsystemisacertainstringofparticularcardevicestostrivetheforceon the road in the wheels (Zhiqiang Xu, 2017). Wildan (2021, March 15) explainsthat motorized vehicle has three common types of braking system. They are full-hydraulic braker (using hydraulic power, commonly used in small car), air overhydraulic(usinghydraulicandpneumaticpower,commonlyusedinbusandtruck),andfull airbrakingsystem(usingpneumatic power).

There are several previous studies in this research. First is the study fromQurohman and Syarifudin (2016) who analyzed the braking load on the quality ofcar drum brake with Ogoshi method. The result revealed that the greater the wearandtearofthematerial,thesmallerthevalueofthewearwasadded.However,theyonly examined the wear and tear of the brake lining against the loadwithoutreviewingthe efficiencyof thebrakesystemwith various weight.

The second research was from Sabri and Fauza (2018) which purpose wasto find the attachment between the main kinematic parameters contained in thebraking process such as force, distance and time in the braking process.Theresearch showed that the vehicle had the characteristics of the braking process thattendedtobethesameatanyspeed.However,theresultneededafurtherinvestigation because JBB also affects time; the heavier the vehicle, the slower itacceleration,as in train.

The last research was from Prameswari and Yohanes (2019). This study,analyzed the feasibility of the braking system for use in rural multipurpose cars.Thisstudyonlydiscussedthefeasibilityofbraking inruralareas,withoutdiscussing what types of brakes are suitable. Because in rural areas, the hightemperaturein thecountryside alsoaffects thefluid.

Considering the disparities of the three previous studies, this study focuseson investigating what type of brake system that fits to various type of vehicle,mainlyin freight vehicles.

II. RESEARCHMETHODOLOGY

This present study, which lasted from March 27 to April 14 2021, is a descriptivequantitative study with two types of data (primary and secondary data). Nassaji(2015)andLoeb*etal.*(2017)definedescriptiveresearchasresearchwhichdescribes a phenomenon, a population, or a situation. It answers 'what' instead of'how'.Theprimarydataweretakenfromquestionnaire,andtheweightmeasurement in UPPKB Trosobo Weigh Bridge. The secondary data, taken fromtheNationalTransportationSafety Committee(KNKT),werethedataoftheaccidentfrom2017-2021.Inaddition,somerelatedliteratureswereusedassupplementary.Descriptiveanalysis wasthe methodused toanalyzethedata.

III. RESULTANDDISCUSSION

Result and discussion are divided into two sub topics; they are 'Type of BrakingSystem in accordance to JBB' and 'Procedure to Minimize Accidents due to BrakeFailure'

A. Typeof BrakingSysteminaccordancetoJBB

Toknowthebrakingsysteminfreightandcommercialvehicles,thedataofvehicleweightwereinitiallycollectedandwereca

tegorizedintotwo(vehiclesweighedlessthan3500kgandvehicleweighedmorethan3500kg).Therewere22carunits(11carsbelow3500kgand11carsabove3500kg)assample.Then,thebrakeefficiency was measured by using this formula: G=50% x Vehicle Weight. The results are asseenin appendix1 and 2.

In the figure of brake efficiency in vehicles weighed less than 3500 kg (seeappendix 1), it can be seen that all 11 vehicles used full hydraulic braking system.Meanwhile,inthefigureofthesecondcategory(seeappendix2),from11vehicles,there were 7 vehicles using full air braking system and 4 vehicles using fullhydraulic braking system. To compare the efficiency between the two, Mean wascounted. The Mean in full air braking system cars (1) and in full hydraulic brakingsystemcars (2)areas follow:

$$Me=\frac{E1+E2+E3+E4+E5+E6+E7}{n}$$

Then:

(1) $$Me=\frac{572+1983+2185+2470+1964+3165+2159}{7}$$

14498

$Me = \frac{}{7}$

$\boldsymbol{Me = 2071.1}$

(2) $Me = \frac{1964+1182+1573+1476}{4}$

$Me = \frac{6195}{4}$

$\boldsymbol{Me = 1548.75}$

From the Mean of the two different brake system efficiencies, it is clearlyseenthatinthecategoryofvehicleweighedabove3500kg,carswithfullairbrakingsystem had a higher brake efficiency compared to cars with full hydraulic brakingsystem.Therefore,itisrecommendedforvehiclewithabove3500kgweighttousefull air braking system instead of full hydraulic braking system. This was echoedbyZhao*etal.*(2016)whostatedthatavehiclewithJBBabove3500kghasenoughmotor power to manifold air from the engine. It can be used to increase wind fromthetubestorageinfull air brakingsystem.

Similarresultwasalsoseenfromtheresultofquestionnaires.Somequestionsthat areindicatorsof good brakesystem areasfollow:

1. Do youoftenloseorfailthebrakepedal?

Result: 10 respondents answered 'yes': 3 full air braking system users, 1 air overhydraulic, and 6 full hydraulic braking system users. This means that for problemswiththepedal component, thetypeof brakefluidis moredominant.

2. Are there frequent pipe leaks / fluid / wind connections in the brake system?Result:7respondentsanswered'yes':4forfullhydraulicbrakingsystemusers,2combinationbrakeusers,and1fullairbrakingsystemuser.Thismeansthatforconnecting problems, the type of brake fluid is more dominant. This is because thematerialofthepipeitselfisanon-ferrousmaterial.Itismoreflexibleinplacement,but it is easilytorn.

3. Whenyoupressthebrake pedalwhile driving,doesthe brake feellike itisnotworking?

*Thepurposeofthisthirdquestionistoensuretherespondentanswersthefirstquestion.Result:3respondentsanswered'yes':the3respondentswereusersofthefullhydraulicbrakingsystematJBBabove3,500kg.Thismeansthatfullhydraulicbraking system with a higher intensity experiences false pressure. Basically, thebrakefluidonavehiclethathasaJBBtendstobelarge,sotheoilthatispressedisalso greater. Thus, the temperature is higher and will result in water bubbles thatcancreatefakepressure.

Furthermore,dataoftrafficaccident2017-2021(seeappendix3)alsoconfirmed that 11 out of 26 accidents involving vehicles with full air brakingsystem. This number was lower than accidents involving full hydraulic brakingsystem(11accidents outof 11vehicles).

B. ProceduretoMinimizeAccidentduetoBrakeFailure

Dealingwiththeeffortofreducingnumberoftrafficaccident,NationalTransportation Safety Committee (KNKT) work to investigate and to analyze eachcaseinIndonesia.ThedataoftrafficaccidentfromKNKT2017-2021(seeappendix3) shows that brake failure still became the biggest factor contributing to accident.Therefore, all stakeholders should pay more attention to vehicle, especially on itsbrakingsystem.

The numbers of accident, based on the data in appendix 5, were mostlyoccurredinvehicleswithfluidbrakingsystem.Asaresult,surveillanceandtendance for this type of vehicle should be enhanced, for the full hydraulic brakingsystemhasacertainlevelofheat.Thisfluid,atacertaintemperaturewillbeturnedintobubbles causingbiased-pressure.

It was confirmed by Wildan (2021) that water content exceeding thresholdwillcauseahighpressure.Thistriggersthecontentofbrakefluidtobecomevaporlock. Then water vapor can cause the brake to fail. As a solution, During the pre-test in vehicle testing, examiner need to check it by putting the tool into reservoir.Iftheparametershowsred,itmeansthefluiddoesnotmeetthestandardthatis3%out ofthecontent.

Anotheralternativewasproposedby Sabri(2018)thatistorepairthefluid-brake. The repair procedures including the replacement of brake pads, brake fluidandto remove bias pressurein brakefluid.

The last solution is to identify the damaged components of brake system. Itcan be done by carrying out an inspection both visual inspection or measurement.The measurement is through comparing the maximum and the minimum brakecomponentsfeasibilitytostandard components(Pratiko, 2015)

Apartfromtheabovefact,althoughfullairbrakingsystemhaslowerpossibilitytoanaccident,stillthecareandcheckingneed tobedone.Oncetheairleaks,thevehiclewithmorethan3500kgweightwillbehardtocontrol.Therefore,preventionshouldb

epriority.However,springbrakecanbeagooddevicetoavoidbrakefailureinthisbrakingsystem.Itcanovercomethehold-offoftheairpressureinthesecondarychamber,andthebrakewillautomaticallystop.(Jeff,*etal.*,2014)

Then, the third type of braking system, that is air over hydraulic brakingsystem is not common to be used in Indonesia. However, the users of this vehicletype should take an extra care of their vehicle as this brake is the combinationbetweenhydraulicand pneumatic.

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- Appendix1 APPENDICES

Table1.1
JBBdataandvehiclebrakeefficiencybelow3500kg

No.	No.Police	VehicleName	JBBVehicle(Kg)	Main BrakeEfficiency(Kg)
1	W8617 XH	MitsubishiL-300	2540	745
2	W8527YB	MitsubishiL-300CC	1165	294
3	L9039WC	MitsubisihiL-399FB-R	2540	951
4	W5347 RU	DaihatsuS041RP	1950	2222
5	L4512RT	SuzukiCarryPickUPWideDeck	22015	800
6	W8323 XZ	MitsubishiFE34 S	3360	752
7	W 8249P	MitsubishiFE74StandardPick Up	1760	572
8	W8254 XR	MitsubishiT120SSWayWide deck	2540	702
9	W9703 NY	DaihatsuS91	1655	652
10	W8953 YES	ToyotaWU342R	2520	1537
11	S8157NH	MitsubishiFE34 S	3360	1848

- Appendix2

Table1.2
JBBdataandvehiclebrakeefficiencyabove3500kg

- Appendix3

No.	No.Police	Transportationtype	JbbVehicle	BrakeEfficiency
1	AE90933 BE	MitsubishiFM215F	14030	572
2	AD1529 PU	IsuzuNMR71TSD	8250	1983
3	W9003 NZ	ToyotaBU 303R	7500	2185
4	W9004NZ	ToyotaWU 342R	7750	2470
5	L8013RY	MitsubishiFE334	7000	1964
6	L15698NV	ToyotaBU 34 ETS	7500	3615
7	S84979S	ToyotaWU34 HTS	8250	21599
8	S815NH	ColtDieselFE74S	7500	1964
9	W 9877 BH	IsuzuNHR55	5100	1182
10	L1879EP	Toyota342R	5200	1573
11	AE9895 EH	Mitsubishi2008	5150	1476

Table1.3
Data ofAccidentsfor2017-2021 sourcedfromKNKT

No.	Vehicle	BrakeSystemUsed	Factors CausingAccidents
1	BA8146-QUTankCar	Full air braking system	Fullair braking system
2	AKAPBUS	Full air brakingsystem	Fullairbrakingsystem
3	AKAPBUSAD-1666-CF	Full air braking system	OtherCauses
4	DUMP TRUCKB-9410-UIU	Full air braking system	OtherCauses
5	TANKTRAILERTRUCKB9851SHE	Full air braking system	OtherCauses
6	AKAPBUSH.1469.CB	Full air braking system	OtherCauses
7	PERSONALPASSENGERCAR	Fullhydraulicbraking system	Full hydraulic brakingsystem
8	ELFE-7027-KACAR	Fullhydraulicbraking system	Full hydraulic brakingsystem
9	AKAPBUSPO.DJATIKRAMAT	Full air braking system	OtherCauses
10	BUSA7520 CS	Full air braking system	OtherCauses
11	TANKITRUCKSNOE9890YES	CombineBrake	CombineBrake
12	BUSBK-7136-FY	Fullhydraulicbraking system	Full hydraulic brakingsystem
13	TIBANINTENBUS	Full air brakingsystem	OtherCauses
14	MAXIBUSBM-7524-JU	Full air braking system	Othercauses
15	TANKTRAILERTRUCK L-8121-UF	Full air braking system	Fullair braking system
16	TrontonTruckH1996 CZ	Fullhydraulicbraking system	Full hydraulic brakingsystem
17	MIRABUSS-7526-US	Full air braking system	othercauses
18	TRAILERCARB 9013TEA	Full air brakingsystem	othercauses
19	DUMP TRUCKB9167	Full air braking system	othercauses
20	CARELFE-7548-PB	Fullhydraulicbraking system	Full hydraulic brakingsystem
21	TOURISMBUSF7959 AA	Full air braking system	Fullair braking system
22	DUMPTRUCKSDA1983TN	Full air braking	OtherCauses

		system	
23	T-9580-Etanksemitrailertruck	Full air braking system	Fullair braking system
24	METROMINIBUSMB7921EM	Full air brakingsystem	OtherCauses
25	CARPICKUPBL-8158	Fullhydraulicbraking system	Full hydraulic brakingsystem
26	BUSTRANSK1515 EX	Full air braking system	OtherCauses
27	AVANZAT-1316-SL	Fullhydraulicbraking system	Full hydraulic brakingsystem
28	SEMITRAILERH-1636-BP	Full air braking system	Fullair braking system
29	TRUCKCRANE N9065 UA	Full air braking system	Fullair braking system
30	MASMEDALBUSN-7130-UA	Full air braking system	OtherCauses
31	BUSROSALIAAD.1505 AU	Full air braking system	Fullair braking system
32	MINIBUSISUZUELFS-7485-N	Fullhydraulicbraking system	Full hydraulic brakingsystem
33	DAIHATSUGRANMAXB-9092-PCM	Full air braking system	OtherCauses
34	TANKITRAILERTRUCKB-9283-UU	Full air brakingsystem	Fullairbrakingsystem
35	HINOFM260JD	Fullhydraulicbraking system	Full hydraulic brakingsystem
36	TANKITRAILERTRUCKB-9283-UU	Full air braking system	Fullair braking system
37	LBUSELF-R-1724-EA	Fullhydraulicbraking system	Full hydraulic brakingsystem
38	TANKISEMITRAILERTRUCKSB-9195-SHE	Full air braking system	Fullair braking system

- Appendix4