Inspection of Clamping Force for E-Clip and DE Clip Fastening Systems

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Abstract. Inspections of railway infrastructure components are carried out to determine the condition and function of railway infrastructure. One of the checks carried out is a railway fastening systems inspection. By regulations, fastening systems inspections are carried out to determine the completeness of the components and the strength of the clamping force. In this research, the fastening systems examined were elastic fastening, namely the E-clip and DE-clip types. Checking the strength of the fastening systems using the PPI CF02 tool and test methods based on ISO-22074-7-2021. This research aims to determine whether the clamp strength of elastic fastening systems types E-clip and DE-clip is still in accordance with the requirements, namely 900 – 1300 kgf for newly installed. Based on data analysis of clamping force, the average strength of E-clip clamping force is 870,2 kg and DE-clip clamping force is 1,038 kgf. The amount is bigger if compared with the needs of UIC 54 rail clamping force. Although the clamping force will reduce caused by the railway operation.

Keywords: Clamping Force, Railway Fastening System, E-clip, DE-clip

1. Introduction

In accordance to the constitution number 23 on 2007 about Railway and Government Regulation Number 56 on 2009 about Railway Operation, the railway operator must do the inspection to the railway infrastructure to make sure the railway infrastructure always in a good condition. The inspections done to keep the function and condition of the railway infrastructure. In the regulation mentioned that the inspection is done eventually and randomly not scheduled. The railway infrastructure inspection is done at the railway track, railway station, and railway operation facilities. One of the railway infrastructure components that need to inspect daily and eventually is fastening system. The inspection done to make sure the component is complete and checking the clamping force.

In accordance to the technical regulation in Transportation Minister Regulation number 60 on 2012, fastening clips should be able to keep the rail on position in the sleeper and the clip must have 900 – 1100 kgf clamping force. But with the use of it, it will reduce the strength of the clip. In the railway track inspection known that the clips

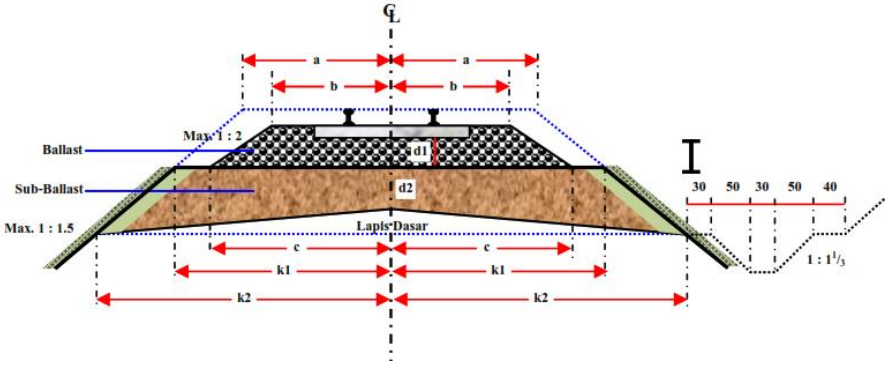
A. Pradipta et al. (eds.), *Proceedings of the 2nd International Conference on Railway and Transportation 2023 (ICORT 2023)*, Advances in Engineering Research 231,
https://doi.org/10.2991/978-94-6463-384-9_23

are not fitted to the shoulder again and some clips is lost. In the Transportation Minister Regulation number 31 on 2011, mentioned that the clamping force inspection could done by seeing it visually and using the clamping force meter tools.

2. Literature Review

2.1 Railway Track Component

Railway infrastructure consist of railway track, railway station, and railway operation facilities that supporting the railway operation. Railway track construction consist of superstructure and substructure. The component which included to superstructure are rail, fastening clips, sleeper, and ballast. The substructure consists of subgrade and base soil. Cross section of the railway track showed in Picture 1.



Source: PM 60/2012

Fig 1. Railway Track Cross-section

2.2 Fastening System

Elastic fastening clips made to muffle the vibration with high frequency caused by train across. Elastic fastening clips consist of single elastic fastening clip and double elastic fastening clips. In the concrete sleeper, the component of the fastening system consists of insert/shoulder, clip, insulator, anf rail pad.

That included to the elastic fastening clips is E-clip and DE-clip. E-clip fastening clip is one of elastic fastening clips. Called E-clip because of the shape like small e letter and like a paper clip. This fastening clips firstly developed by Pandrol, a company that produce railway component from England.

Characteristic of E-clip is described below:

a. Easily to apply the fastening clips to the sleeper
b. Few components make it simple
c. Strong and compact
d. Clamping force until 1400 kgf
e. Noise free when the train across
f. Adding the rubber pad will make the double elastic fastening system

Fig 2. E-Clip fastening clips

DE-clip is an elastic fastening clips that produced in Netherlands [4]. In Indonesia, this fastening clip is produced by PT. Pindad and applied to almost all railway track, specifically in Java Island. But now the use of DE-clip is rare. That is caused of the frequency of the railway operation is bigger and the speed of the train now is faster. So that needs use the elastic fastening clips that has a stronger clamping force and stronger to clamp the rail to the sleeper. The elastic fastening clips that could reserve the use of DE-clip is E-clip.

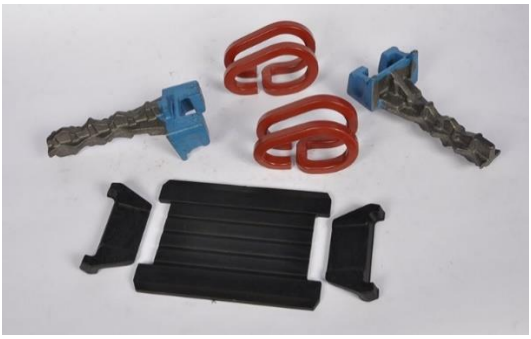


Fig 3. DE-clip fastening clips

Characteristic of DE-clip is described below:

a. Clamping force 750 kgf - 1300 kgf.
b. Could contrary to torsional force.
c. Classified to double elastic in use of rubber pad in its systems.
d. The elastic fastening clips has a few component and simple

3. Research Methods

The research method showed in the flow chart Picture 4 below.

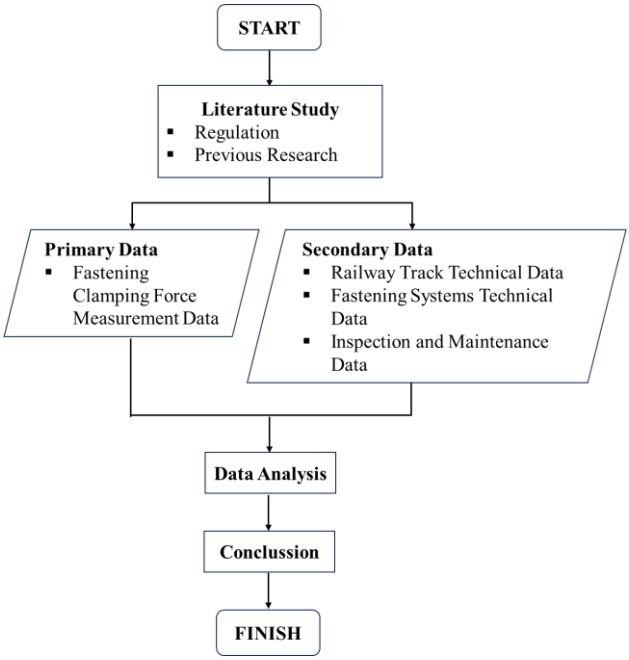


Fig 4. Research Flow Chart

Based on the flow chart, the research steps described below:

1. Literature Study
   Literature study done by collecting the theory about clamping force from the books, or another references. Also collect from the past research that done about the clamping force to knowing the gap analysis.
2. Secondary Data Collection
   The secondary data collection is done to known the fastening clips and get the fastening clips technical specification. The data obtained from the internet, journals, and the website of the company that produce the fastening clips. The secondary data collection done is to get the tool specification of the clamping force meter PPI CF02 and the operating procedure.
3. Premiere Data Collection
   The premiere data collection done with measuring the E-clip and DE-clip clamping force. 10 sample of E-clip and DE-clip fastening clips is tested 3 times each and the clamping force data will be calculated.
4. Data Analysis
   Data analysis done after the fastening clip clamping force data collected. The clamping force data will compare with the technical standard of the Transportation Minister Regulation number 60 on 2012 and the SNI 11-3677-1995.
5. Conclusion
   The conclusion obtained after the fastening clips clamping force data get analysed and compare with the technical standard of the Transportation Minister Regulation number 60 on 2012 and the SNI 11-3677-1995.

The clamping force measurement procedure is according to ISO-2274-7-2021. The procedure is described below:

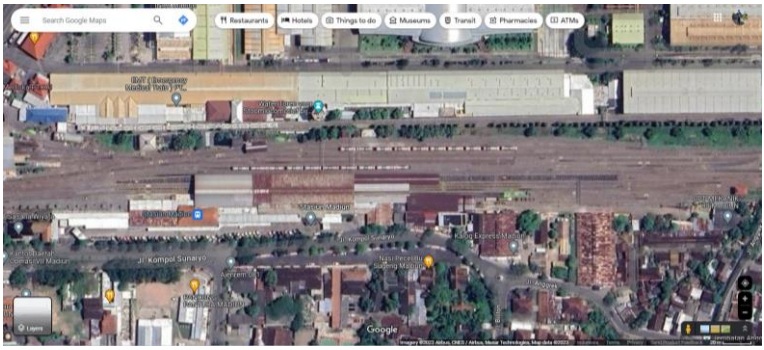
1. Rotating the lever to gives pulling force to the fastening clips. The fastening clips will lift because of the force.
2. After the fastening clips get lifted, insert a 0,3 mm plate in the gap of lifted fastening clips.
3. Loose the pulling force until the plate get pinched.
4. Gives the pulling force again until the plate gets pulled easily.
5. Record the clamping force at the moment that the plate can pulled easily, that is the amount of the clamping force.

Fig 5. *Clamping Force* Meter PPI CF02

4. Result

Data Pickup Location

In this research, the location determined on the clamping force measurement is at the Madiun Railway Station railway yard. Picture 6 is showing about the Madiun Railway Station railway yard.



Source: google.com

Fig 6. Madiun Station Railway Yard

Needs of Clamping Force

In accordance with the standardization that regulated on SNI 11-3677-1995, the clamping force needed of the elastic fastening clips is 750 kgf to 1300 kgf after the testing. However, the needs of clamping force should be calculated in order to make a standard and conclude that the applied fastening clips is worth to clip the rail to the sleeper. The calculation is using the equation (1).

$$H = M \times a$$

…… Equation (1)

$$H = 18000 \times 0{,}0478 \times 9.81 mdet$$

$$H = 8440\ kg\ m/det^2$$

$$H = 860{,}4\ kgf$$

Clamping force need for UIC 54 rail can calculate with equation (2):

Untuk R.54, h = 159 mm, b = 140 mm

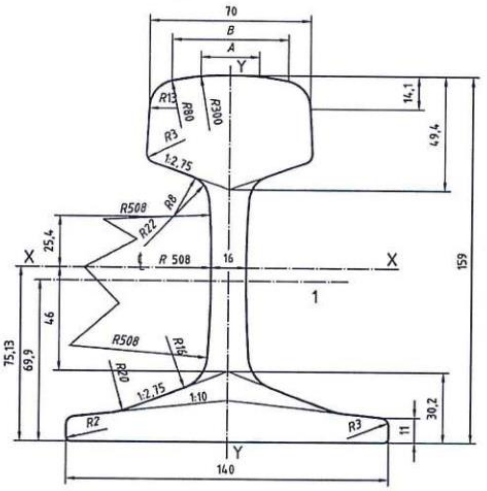


Fig 7. Cross-section UIC 54 rail

Explanation.

h = rail high

b = rail feet wide

$$H(h-10) = F(b-x) + (x)$$

…… Equation (2)

$$F = \frac{H(h-10)}{b}$$

$$F = \frac{H(159-10)}{140}$$

$$F = 915{,}71\ kgf$$

From the calculation we can conclude that the minimum needs of clamping force for UIC 54 rail is 915,71 kgf.

Testing Data Analysis

E-clip testing data on Table 1 below.

Table 1 Clamping Force Data of E-Clip fastening Systems

Sample	Fastening Clip Clamping Force (kgf)			
	1st Test	2nd test	3rd test	Average
1	888	879	884	883,7
2	883	896	915	898,0
3	816	824	820	820,0
4	872	861	878	870,3
5	885	869	881	878,3
6	838	847	850	845,0
7	876	886	880	880,7
8	864	869	875	869,3
9	884	871	887	880,7
10	859	879	889	875,7
Testing Result Average				**870,2**

Based on the E-clip clamping force testing data on Table 1, the average of clamping force of E-clip fastening clips is 870,2 kgf. The amount is smaller if compared with the needs of UIC 54 rail clamping force. It is caused by the railway operation that could reduce the clamping force of fastening clips.

DE-clip testing data on Table 2 below.

Table 2 Clamping Force Data of DE-Clip fastening Systems

Sample	Fastening Clip Clamping Force (kgf)			
	1st Test	2nd test	3rd test	Average
1	1018	1038	981	1012,3
2	863	907	942	904,0
3	1022	1032	1013	1022,3
4	1040	1044	1020	1034,7
5	971	989	979	979,7
6	982	1138	1155	1091,7
7	1087	1039	1049	1058,3
8	1062	1066	1084	1070,7
9	1168	1086	1122	1125,3
10	1115	1060	1067	1080,7
Testing Result Average				**1038,0**

Based on the DE-clip clamping force testing data on Table 2, the average of clamping force of DE-clip fastening clips is 1.038,0 kgf. The amount is bigger if compared with the needs of UIC 54 rail clamping force. Although the clamping force will reduce caused by the railway operation.

5. Conclusion

According to the fastening clips clamping force data analysis can concluded that:

1. The needs of UIC 54 rail clamping force are 915,71 kgf, this amount is according to the calculation from the SNI 11-3677-1995.
2. Based on the clamping force measurement result of E-clip and DE-clip fastening clips, the clamping force of the E-clip fastening clips is not in accordance when compared with the Transportation Minister Regulation number 60 on 2012 in amount of 900 – 1100 kgf, but the DE-clip fastening clips clamping force is in accordance with it.

To get the more comprehensive result on the next research could consider several things like: Doing analysis to the frequency and the weight of the train across. Adding the calculation of the clamping force reduction caused of the railway operation. The clamping force regulation for the newly installed fastening clips, not calculate the reduction of the clamping force caused of the railway operation.

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