TBM 700 Trestle Design as Supporting Equipment for the Aircraft Maintenance Care and Practice of Cadets

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Abstract

One of the supporting tools for Socata TBM 700 aircraft maintenance is the trestle, this tool is responsible for helping various aircraft checking processes such as jacking, leveling, and lifting. As a supporting tool, the hangar of the Politeknik Penerbangan Surabaya already has these tools. More specifically, the tool available is a hydraulic jack. This tool has the primary function of supporting the jacking process. However, the jacking tool owned by the Politeknik Penerbangan Surabaya is considered less effective and efficient in operation and safety, so creating a new tool with a more qualified level of efficiency and effectiveness is necessary. The new variant of the supporting tool is called the C17 trestle. The method used in this work is an experimental method that starts by designing a tool from a bottle Jack made from high-carbon steel. The primary purpose of this study is to determine the efficiency of the C17 trestle time working and safety during the maintenance process and practice by cadets. The results of this study show that the C17 trestle can be operated manually by a minimum of two people with an average time of 2 minutes 32 seconds and increases the percentage of work security and safety when the tool is used. This shows that the C17 trestle design is more suitable for use during the jacking process on the Socata TBM 700 aircraft.

Keywords: Socata TBM 700 Aircraft, trestle, jacking, cadets.

INTRODUCTION

The existence of an aircraft hangar at the Politeknik Penerbangan Surabaya is intended to store equipment to support aircraft maintenance. In contrast, equipment storage is implemented to increase intensive aircraft maintenance by established procedures and standards. The Socata TBM 700 aircraft also uses these maintenance support tools to improve performance. On this matter, one of the tools used is a trestle.

A trestle is a tool with the function of facilitating the process of observing and repairing aircraft. Trestle also allows technicians to do the jacking process on aircraft as a form of accident risk prevention measures through maintenance and inspection. The jacking process uses a jack, a tool with the primary function of lifting loads on certain positions using a relatively small force. Jacks are divided into two, namely mechanical jacks and hydraulic jacks. A hydraulic jack is a jack that utilizes liquid disaster to generate pressure. The pressure created by a hydraulic jack is more significant than and requires a relatively more minor force than a mechanical jack (Handoko, et al., 2013).

The jack allows the maintenance and inspection process on the aircraft by lifting the aircraft according to a certain height. The jack has other functions, such as testing the landing gear, removing the landing gear, changing the wheel, and brake service. Two types of jacks are generally used on both commercial and Socata TBM 700 aircraft, the two types of jacks are axle jack and tripod jack.

The jack used by Politeknik Surabaya to support the maintenance of the Socata TBM 700 aircraft is a type of tripod jack. However, the jack used was considered inappropriate and did not support the safety of the cadets when carrying out practices and maintenance. This was because when it was installed in the C17 position two parts did not merge between the jack and the used tires. The jack has a very important function, the suitability of the jack is the main supporting factor in the inspection and maintenance process, so efforts to create a more suitable jack are the first step that is needed by thePoliteknik Penerbangan Surabaya hangar.

METHODS

This research was conducted from September 2022 to April 2023 at the Politeknik Penerbangan Surabaya campus. This research was conducted by following a previously designed flowchart.

2.1 Tool Planning

In an attempt to make appropriate trestle to support the safety of cadet maintenance practices and aircraft inspection, Socata TBM 700 modeling and tool design is very important. The following is the design form for the C17 trestle design of the Socata TBM 700 aircraft at the Politeknik Penerbangan Surabaya.

Picture 01. C17 trestle 3D design

The main material used for the C17 trestle frame is made of high-carbon steel. The tools and materials used in designing and building the C17 consist of at least six materials which are generally made from high carbon steel, that is jacks or jacks (hydraulic units), jack levers, fuselage supports, fixed legs, locking collars, and jack bases. The hydraulic jack used in this study has a specification unit number INGCO HBJ402 with model number HBJ402 as much as one (1) piece, has a height of 190mm, weighs 3.9 kg, and a lifting Force kN (t) 4.

Tool Testing Techniques

Testing of this tool is carried out to ensure that trestle C17 is in accordance with the applicable standard security procedures. The specific purpose of this test was to find out whether trestle 17 can lift the fuselage of the Socata TBM 700 aircraft which incidentally weighs around 6614 lbs or 3000 kg with a 4 ton jack without any damage to each component, to ensure that the jack does not slip, as well as to test the length of time . For this test, researchers used several research instruments such as a stopwatch to calculate the jacking process time using trestle C17.

Data Analysis Techniques

This data analysis technique is conducted to find out and ensure that trestle C17 has safety according to predetermined standards and the length of time in the jacking process using trestle C17. In testing the length of time for the jacking process, researchers involved research participants in 4 groups with 6 members each. The data analysis technique used in this paper is to find out how safe it is to use the C17 trestle using a research instrument in the form of a questionnaire related to the safety level of using the C17 trestle for 42 participants who are members of the 7th batch of Aircraft Engineering Cadets.

The data obtained will then be analyzed using a Likert scale data analysis technique. The Likert scale is a data analysis technique used to measure the perceptions, opinions, and attitudes of a group of people or individuals regarding phenomena that occur. In this regard, the phenomena in this study have been determined and then used as one of the variables (Sugiyono, 2013). To overcome the results of data analysis using a Likert scale, there are several determining indices based on the responses obtained, that is: 1) SS which means strongly agree; 2) S which means agree; 3) N is neutral; 4) TS means disagree; 5) STS which means strongly disagree. The index is obtained by calculating the weight value of each item (Sugiyono, 2011). The following is the index calculation formula on a Likert scale.

$$\textbf{Rumus Index \%} = \frac{\textit{Total Skor}}{X} \times 100$$

Picture 02. Likert scale percentage index formula

Information:

Total score: The total of the multiplication of each indicator with the total value.

X : Total multiplication of all respondents to the highest indicator.

The index value from the calculation results is then classified based on the number of values, that is 0-19.9% means STS, 20%-39.9% means TS, 40-59.9% means N, 60-79.9% means S , and 80-100% means SS.

RESULTS

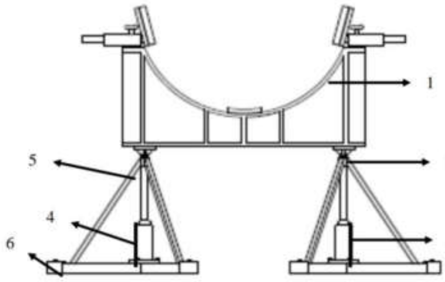
Tool Making

The basic material used to make the C17 trestle is made of high carbon steel with the aim that the resulting tool has more power but the tool is relatively lightweight so it is practical to use and carry anywhere. The tools for making the C17 trestle consist of 6 different tools including jacks or jacks (hydraulic units), jack levers, fuselage supports, fixed legs, locking collars, and jack bases. Based on the experiments conducted, the weight of the trestle C17 reaches 110 kg.

The manufacture of the C17 trestle tool is carried out through six main steps, that is:

1) Setting up the C17 trestle tool design.

   Making the design of the C17 trestle tool is conducted by involving software with the aim of facilitating the making of the design of the C17 trestle tool. The software used in this process is Autocad.



Picture 03. C17 trestle 2D design

2) Selecting the hydraulic jack that will be used.

The selection of the hydraulic jack in this process is carried out by ensuring that the selected hydraulic jack has a capacity of 4 tons so that it will maximally be able to jack the Socata TBM 700 aircraft.

Picture 04. Hydraulic jack

3) Prepare the tools and materials for trestle C17.

Making trestle C17 consists of 6 tools and materials. To create a perfect C17 trestle, 6 tools and materials made of high carbon steel must be available in complete.

Picture 05. High carbon steel material

4) Cutting, drilling, and turning of the material used.

The fourth step in making the trestle C17 is to cut, drill, and turn the material according to the size on the working drawing design.

Picture 06. Drilling process

5) Welding on trestle tool C17.

Picture 07. Material welding process

6) Stringing the material.

The stringing of materials on the C17 trestle tool is executed according to the design made.

Results and Discussion

This research was conducted with the aim of testing the C17 trestle tool in terms of the length of time and the percentage level of work safety when used. Based on the test results and questionnaires distributed, it is known that the average length of time using the C17 trestle tool when jacking is 2 minutes 32 seconds. The number is obtained by adding up the total length of time for the 4 groups to use the C17 trestle tool. Group 1 needed 2 minutes 43 seconds to operate the C17 trestle tool, group 2 needed 2 minutes 32 seconds, group 3 needed 2 minutes 23 seconds, while group 4 needed 2 minutes 27 seconds.

The next test for the C17 trestle tool in this study was to test the percentage of work safety level for the C17 trestle tool. To find out the percentage of work safety using the C17 trestle tool, a research instrument was used in the form of giving a questionnaire to research respondents.

The following is an indicator of the Linker value in this study.

Indikator	Bobot Nilai
Sangat Setuju (SS)	5
Setuju (S)	4
Netral (N)	3
Tidak Setuju (TS)	2
Sangat Tidak Setuju (STS)	1

Picture 08. Linkert value indicator table

The research questionnaire consists of 6 questions to ensure that trestle C17 has a high percentage of work safety.

Based on the questionnaire answers given by the respondents, the following results were produced:

Pernyataan \ Indikator	SS	S	N	TS	STS
1	23	14	5	-	-
2	20	18	4	-	-
3	26	12	4	-	-
4	23	16	3	-	-
5	23	13	6	-	-

Picture 09. Table of results of the answers to the occupational health questionnaire C17 trestle tool

The first question in the questionnaire is used to find out that a visual inspection of the trestle C17 is to check whether the trestle C17 is damaged or vice versa as a preventive measure and to minimize unwanted things from happening during the jacking process. The results obtained through the questionnaire then will be analyzed using the Likert scale analysis formula. Each index shows that out of a total of 42 respondents, 23 strongly agree, 14 others agree, and the remaining 5 are neutral. Based on these results, the score of 186 was obtained and a percentage index of 88%. Referring to the percentage of calculation results which reached 88%, it can be concluded that the average response strongly agrees that carrying out a visual inspection of the C17 trestle tool can ensure that it prevents or minimizes the occurrence of unexpected things that can threaten the work safety of members cadets while carrying out aircraft maintenance practices.

- Sangat setuju = 23 responden x 5 = 115
- Setuju = 14 responden x 4 = 56
- Netral = 5 responden x 3 = 15
- Total Skor = 186
- Skor maksimum = 42 responden x 5 = 210
- Indeks (%) = (total skor/skor maksimum) x 100%

  = (186/210) x 100%

  = 88%

Picture 10. An example of calculating data using a Likert scale

Second question in the questionnaire is used to find out that briefing activities related to how the C17 trestle tool or SOP work are conducted with the aim that the implementation of cadet practices can be carried out optimally, well, and safely. The questionnaire given to participants who were members of the cadets based on the Likert scale produced data that 20 participants strongly agreed, 18 others agreed, and the remaining 4 felt neutral about the questions asked. The total score from the sum of the values of each indicator reaches 184, which means that the percentage index for the second question reaches 86%. Based on the resulting index, it is known that many respondents agree that the act of giving directions or briefings related to the use of the C17 trestle tool can increase the success rate and maximize the process of practicing aircraft maintenance done by Cadets members. Referring to this, it is highly recommended for the authorities to make directives before starting the practice.

The third question in this study is used to find out whether the presence of the C17 trestle tool at the Politeknik Penerbangan Surabaya is safer during the jacking process. It is known that the previous trestle had a big risk to safety, therefore the creation of the C17 trestle at the Politeknik Penerbangan Surabaya was carried out to increase the percentage of safety when Cadets members carry out practices. Based on the results of the questionnaire obtained through research, out of a total of 42 respondents 26 people expressed their agreement in the form of SS or strongly agreed, 12 other respondents agreed, and the remaining 4 were neutral. The results of the questionnaire obtained in this study resulted in a total value of 190, meaning that the percentage index in this question reached 90%. These results prove that many respondents agree and admit that the existence of the C17 trestle tool at the Politeknik Penerbangan Surabaya is safer to use during the jacking process, so the use of the C17 trestle tool in the aircraft maintenance or practice of Cadets is safer than the tools used before.

The fourth question in the questionnaire is given in order to determine whether the use of the C17 trestle tool in the jacking process does not cause defects in components or workpieces. 23 out of a total of 42 respondents strongly agreed, 16 others agreed, and the remaining 3 were neutral. The total value of the sum results reaches 188 and the percentage index obtained from the results of the Likert scale calculation is 89%. Based on the results of the index percentage of the question, it can be concluded that the use of the C17 trestle tool did not cause damage to materials and work tools on the Socata TBM 700 aircraft when jacking was used by cadets or during aircraft maintenance.

The fifth question in the questionnaire is intended to determine whether using the C17 trestle tool can improve work safety during cadet practice and maintenance of the Socata TBM 700 aircraft. The results of the respondent's questionnaire stated that 23 respondents out of a total of 42 people strongly agreed with this statement, 13 others agreed with the statement, and the remaining six stated neutral responses to the questionnaire. Based on the responses given, the total value of the fifth question reaches 185, with a Likert scale percentage index reaching 88%. Thus it can be concluded that using the C17 trestle tool is very effective in adding to the hell of work safety when used by Politeknik Penerbangan Surabaya Cadets members for practice or during aircraft maintenance.

Basically, the C17 trestle tool is intended to facilitate various activities related to aircraft inspection and maintenance, such as jacking, leveling, and lifting on aircraft, especially the Socata TBM 700 aircraft. This underlies the emergence of the sixth question, namely to confirm whether the use of the C17 trestle tool can help cadets of the Politeknik Penerbangan Surabaya to carry out various practices such as jacking, leveling, and lifting on the Socata TBM 700 aircraft. The questionnaire results here by respondents show that 23 out of a total of 42 respondents strongly agreed with the idea, 16 others agreed, and three others responded neutral. The total score obtained is 188, with a total Likert scale index reaching 89%. Based on the results of these calculations, the use of the C17 trestle tool can help Politeknik Penerbangan Surabaya Cadets during the jacking, leveling, and lifting process on the Socata TBM 700 aircraft.

The trestle C17 has several advantages and disadvantages based on the experimental procedures. The advantages of the C17 trestle tool are the efficiency of use, the relatively small size that allows it to be moved around, and effectively assist the jacking process on the Socata TBM 700 aircraft. Meanwhile, the drawback of the C17 trestle tool is that the tool must be used manually, namely using human power and requiring a minimum of two people to operate this C17 trestle tool.

DISCUSSION

After several experimental procedures and analysis of research data, it can be concluded that the use of the C17 trestle tool on the Socata TBM 700 aircraft is very effective in facilitating the practical processes conducted by Cadets of the Politeknik Penerbangan Surabaya and aircraft maintenance such as jacking, leveling, and lifting. Using the C17 trestle tool is also effective in increasing the percentage of work safety and security so that it is safe to use when Politeknik Penerbangan Surabaya Cadets carry out practices or when maintaining aircraft. The difference between this C17 trestle and the previous trestle is how this C17 trestle can adapt and perform various inspection and maintenance activities on the Socata TBM 700 compared to the previous trestle. The results of the C17 trestle design have many limitations, especially in how the C17 trestle is used. Therefore, in the future, future research is expected to find effective and efficient C17 trestle tools in various aspects, including the operating process.

AUTHORS' CONTRIBUTIONS

Y. R. A. I contributed to all research procedures starting from designing, experimenting with making tools, analyzing data, and compiling scientific papers.

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REFERENCES

[1] Sahjehan, M.M. (2019). Design of a Cessna 152 Aircraft Hydraulic Jack. (Final Project, Sriwijaya State Polytechnic, 2020). Taken from http://eprints.polsri.ac.id/6985/

[2] TronAir. (n.d). The 2 Most Common Types of Aircraft Jacks and When to Use Which. Ohio, USA: Author. Diambil 25 December 2022 dari https://www.tronair.com/resources/types-of-aircraft-jacks/

[3] Sugiyono. (2005). Business Research Methods. Bandung: Alfabeta.S.

[4] Sugiyono. (2008). Quantitative Research Methods, Qualitative, and R&D. Bandung.