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Application of Mechanical Waves in Rock Media for Earthquake Disaster Risk Analysis as an Enrichment of Physics Practicum

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ABSTRACT

The phenomenon of mechanical waves propagation in rock media is difficult to detect without the use of tools. To "see" the propagation of seismic waves, tools can be used in the form of a main unit monitor on a set of digital Seismograph-16S24-P 24 geophone channel tools. The community service activity aims to provide an understanding of the basic concepts of mechanical wave propagation in rocks to senior high school students throughout Bengkulu City as an enrichment for Physics Practicum. The method used to achieve the objectives of this community service activity is carried out through the stages of Focus Group Discussion (FGD), field data acquisition, data processing, data analysis and interpretation. Activity evaluation is carried out by observing activity participants in data acquisition, data processing, data analysis and interpretation. The results of the activity show that the activity participants have a good understanding of the basic concept of mechanical wave propagation in rocks. Furthermore, Bengkulu City Physics Teachers can transmit this knowledge to senior high school students as an enrichment for Physics Practicum. The material on the application of mechanical waves to rock media can also be used as a learning tool based on disaster risk reduction in the main physics subject, according to the characteristics of the study area.

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INTRODUCTION

The basic concept of waves is one of the materials in the physics subject given to grade 11 senior high school students. One of the materials given on the basic concept of waves is mechanical waves. Mechanical waves are waves that require a medium to transmit energy (Sunardi et al., 2021). To understand the concept of mechanical wave propagation in a medium, students are given practicums using several media such as ropes, springs, etc. However, most high school students do not know and understand the application of mechanical wave propagation in rock media. The propagation of mechanical waves in rock media is one of the events that occurs when an earthquake occurs. Mechanical waves in seismology are usually also called seismic waves. The phenomenon of seismic wave propagation in the rock medium is difficult to detect without the use of tools. To be able to "see" the propagation of seismic waves, tools can be used in the form of a main unit monitor on a set of digital Seismograph-16S24-P 24 geophone channel tools (PASI, 2017). This device can help students understand the symptoms of the phenomenon of seismic wave propagation.

Understanding the phenomenon of seismic wave propagation is very important, especially for senior high school students in Bengkulu as an enrichment of Physics Practicum related to discussing basic wave concepts which are applied directly in the field. On the digital Seismograph-16S24-P 24 geophone channel, the phenomenon of propagation and movement of seismic waves can be recorded in both longitudinal, transverse and surface waves through visualization on the main unit monitor layer. Furthermore, from the field data, an earthquake disaster risk analysis was made as an application of the basic concepts of mechanical waves as stated in the Physics subject material. The application of mechanical waves for earthquake analysis is closely related to the Bengkulu area which is an area with high earthquake potential because it is located in the zone of movement of the Indo-Australian tectonic plate in the ocean and the movement of the Sumatran fault on land (Petersen et al., 2007, Petersen et al., 2004, Megawati et al., 2005, PUSGEN, 2022, Hadi et al., 2021).

As an area that has a high potential for earthquake disasters, the application of mechanical waves for earthquake analysis is carried out as a form of applying local wisdom as well as an effort to prepare learning tools based on disaster risk reduction to enrich the Physics Practicum. According to the Ministry of Education, Culture, Research, and Technology/Kemdiknas (2010) and Maknun (2015) in the current era of decentralization of education, various efforts to reduce disaster risk into learning activities in schools are still minimal, teachers' knowledge and understanding regarding disaster risk reduction knowledge also still very minimal. Apart from that, it is necessary to integrate educational learning materials for disaster risk reduction into the main subjects, according to the characteristics of disasters in the local area. This activity is very important to carry out as an effort to understand the basic concepts of mechanical waves as well as an effort to apply local wisdom related to reducing disaster risk. So that this understanding can be distributed evenly to high school students in Bengkulu City, this Community Service activity is carried out through collaboration between the Community Service Team and the Senior High School Physics Teachers' Deliberation (MGMP) of Bengkulu City. This collaboration takes the form of Focus Group Discussion (FGD) activities, acquisition, processing and analysis of field data. It is then hoped that the results of the FGD can be applied to high school students throughout Bengkulu City through Physics Practicum related to the basic concept of mechanical waves.

This activity aims to provide an understanding of the basic concepts of mechanical wave propagation in rocks to senior high school students throughout Bengkulu City as an enrichment of Physics Practicum using digital Seismograph equipment-16S24-P 24 geophone channels through FGD activities, acquisition, processing and analysis of field data. Apart from that, this activity also provides input in preparing learning tools based on disaster risk reduction for the MGMP into main subjects, in accordance with the characteristics of disasters in the Bengkulu area.

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To achieve the expected target, efforts need to be made to increase understanding of the basic concepts of mechanical waves through enriching the Physics Practicum using digital Seismograph equipment-16S24-P 24 geophone channels, so that the wave propagation can be seen through visualization on the main unit monitor. The results of this FGD can later be conveyed to high school students through Physics Practicum activities as enriching teaching materials. This is very possible because almost all senior high school physics teachers are members of the MGMP of the Bengkulu City (MGMP, 2023).

METHODS

The method used to achieve the objectives of this activity is through the following stages:

1. Stages of Focus Group Discussion (FGD)

   The FGD was conducted to discuss Physics Practical material on the topic of studying the propagation of mechanical waves in rocks. Apart from that, there is a need to integrate educational learning materials for disaster risk reduction into the main subjects, in accordance with the characteristics of disasters in the Bengkulu area.

2. Stages of Field Data Acquisition/Field Practicum

   This activity takes the form of field data acquisition using the application of mechanical waves that propagate in rocks using digital Seismograph equipment-16S24-P 24 geophone channels. The Service Team explained how to acquire field data properly and correctly to MGMP Team.

3. Stages of Data Processing

   After the data is obtained from the field, data processing is then carried out. The data was processed using win-MASW 5.0 Professional Software from PASI, Torino, Italy (PASI, 2017). In this activity, the Community Service Team explains how to process field data, so that output is obtained in the form of S-wave velocity values (1-D Vs profile) at each sediment layer thickness and rock density, at each measurement point. In processing this data, P-waves and other mechanical parameters are also obtained, namely shear modulus, Young's modulus and Poisson ratio.

4. Stages of Data Analysis and Interpretation

   Data analysis and interpretation was carried out on the parameters of S-wave velocity, density, shear modulus, Young's modulus, and Poisson's ratio. These parameters are then connected for earthquake disaster risk analysis. If the values of S-wave velocity, density, shear modulus, Young's modulus are small and the Poisson's ratio is large, then the rock through which the mechanical wave passes is less sturdy and vice versa. In these rock conditions, if an earthquake occurs, the rock is easily deformed and can result in a greater level of damage.

This community service activity is closely related to the condition of Bengkulu, which is an area prone to earthquake disasters. So far, the physics practicum material in high school which is related to mechanical waves still uses conventional equipment, so students cannot understand it clearly, especially regarding the propagation of mechanical waves in rocks. Activity evaluation is carried out by observing activity participants in data acquisition, data processing, data analysis and interpretation. An indicator of the success of this activity is if each activity participant can acquire data, process data, analyze and interpret data properly and correctly. The flowchart of implementing community service is briefly shown in Figure 1.

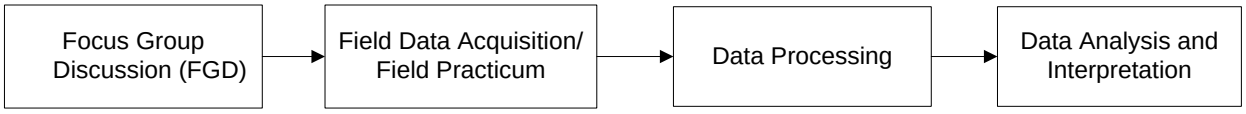

FIGURE 1. Flowchart of implementing community service. Source: Author's, 2023

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RESULTS AND DISCUSSION

This community service activity was attended by members of the MGMP of the Bengkulu City as many as 27 people. This activity began with a presentation on the application of mechanical waves to enrich high school Physics practicum through a Focus Group Discussion (FGD) by the Community Service Team which involved all activity participants as shown in Figure 2. After the presentation, a discussion was held, especially regarding the integration of practical material into Physics subjects. Based on this discussion, it can be concluded that the use of the Multichannel Analysis of Surface Wave (MASW) seismic tool can help students understand the propagation of mechanical waves in rock media. Because so far senior high school students in carrying out practicums still use simple equipment, for example to understand the propagation of mechanical waves in the form of longitudinal waves using springs and for the propagation of mechanical waves in the form of transverse waves using ropes. This cannot be separated from the material in standard senior high school textbooks (Sunardi et al., 2021). Using the MASW seismic tool, the propagation of mechanical waves in the rock medium in the form of longitudinal waves, transverse waves and surface waves can be "seen" through the digital Seismograph monitor layer-16S24-P 24 geophone channel (Park et al., 1999). As a result of the discussion, senior high school physics teachers also better understand the application of mechanical waves for earthquake disaster risk analysis in accordance with the characteristics of Bengkulu City, which is an area prone to earthquake disasters.

FIGURE 2. Presentation of the application of mechanical waves to enrich senior high school physics practicum

To better understand the material provided, in this activity field data acquisition was carried out around the service location, namely SMAN 2 Bengkulu City. Senior high school teachers are given the opportunity to independently acquire seismic data. In this data acquisition activity, high school teachers were given the opportunity to try installing a seismograph, connecting cables, and analyzing the seismic signals recorded on the monitor screen (Figure 3).

FIGURE 3. Practice of independent field data acquisition, installing seismographs, connecting cables, and analyzing seismic signals recorded on the monitor screen

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Field data obtained in the field is shotgather data which is ready for further processing using win-MASW 5.0 Professional software from PASI, Torino, Italy (PASI, 2017). The stages of shotgather data processing are shown in Figure 4. After the data processing stage, the next stage is carried out in the form of data analysis and interpretation. Before carrying out data analysis, it is necessary to analyze the results of data processing first by looking at the curve obtained, as shown in Figure 5.

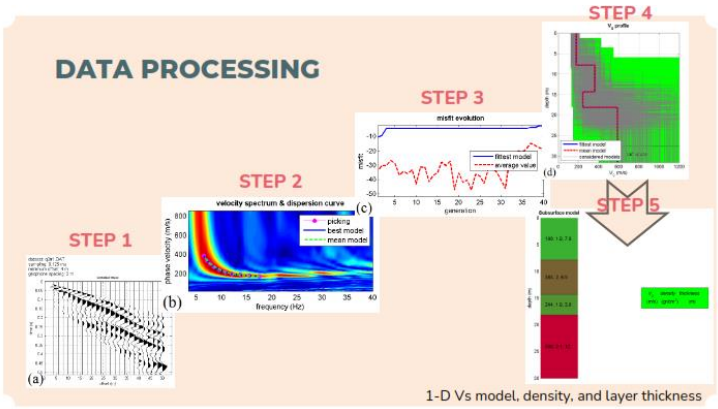
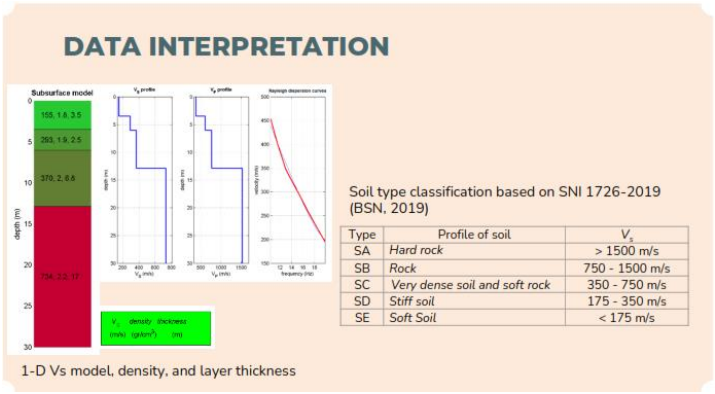


FIGURE 4. Stages of shotgather data processing using win-MASW 5.0 Professional Software from PASI, Torino, Italy



Type	Profile of soil	V_s
SA	*Hard rock*	> 1500 m/s
SB	*Rock*	750 - 1500 m/s
SC	*Very dense soil and soft rock*	350 - 750 m/s
SD	*Stiff soil*	175 - 350 m/s
SE	*Soft Soil*	< 175 m/s

FIGURE 5. Example of curve results resulting from data processing

Figure 5 shows that the data processing results are very good as indicated by the misfit value which is quite small. The smaller the misfit value, the more appropriate the field data and model data produced. This means that the field data produced is accurate. Data analysis and interpretation refers to the type classification according to the National Standard Agency of Indonesia (BSN, 2019) based on the S-wave velocity value. After obtaining the S-wave velocity value, the density, shear modulus, Young's modulus and Poisson's ratio values are obtained which are associated with earthquake disaster risk analysis. In the long term, earthquake disaster risk analysis also needs to be carried out on the impact it has on humanitarian recovery, for example a sense of security, access to social, physical, emotional assistance, and feelings of being able to help oneself as an individual and community (Andriani et al., 2024).

CONCLUSION AND RECOMMENDATION

Through a series of community service activities that have been carried out, activity participants can carry out acquisition, processing, analysis and interpretation well. Activity participants also have a good understanding of the basic concepts of mechanical wave propagation in rocks. Furthermore, members of the MGMP of the Bengkulu City can transmit this knowledge to high school students as an enrichment for the Physics Practicum. The material on the application of mechanical waves to rock media can also be used

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as a learning tool based on disaster risk reduction in the main physics subject, in accordance with the characteristics of disasters in the Bengkulu area.

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