A STUDY OF ACOUSTIC EMISSION TESTING ON GALVANIZED IRON MIG WELDING

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A STUDY OF ACOUSTIC EMISSION TESTING ON GALVANIZED IRON MIG WELDING

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Thesis submitted in fulfillment of the requirements
for the award of the degree of
Bachelor of Mechanical Engineering

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I humbly dedicate this thesis to

my lovely mom and dad,

Rohani Binti Wan Khalid and Razali Bin Ngah

who always trust me, love me and had been a great source of support and motivation.

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ABSTRACT

This thesis was carried out to investigate the characteristic of Acoustic Emission signal on galvanized iron MIG welding. The welding joint will be test as a load and there will be a few points of welding joint to be monitoring. For the study AE signal on galvanized iron, all time domain parameter (hit, count, amplitude, and frequency by Fast Fourier Transform) of signal will be observe and process with the aid of Matlab software. The data was taken by the specimen tight at the edge of the table by using clamp. The sensor located at the point and after that the load was applied to enhance the signal of Acoustic Emission. All parameter compared with different points of welding joints. The result obtain will be analyse by using Matlab and then can proceed for analysis. For result by using FFT, the signal pattern can be distinguish between non-defect welding joint and defect welding joint due to the frequency range show a different between them. For the amplitude and count, the average value of defect welding joint shows that it has higher value compare to non-defect welding joint. There are some signals that influence by disturbance noise. Hence, the signal pattern obtain could not be analyse. The factor that influence the signal or disturbance signal is noise around the test run, emission from electric surrounding and from people talking.

ABSTRAK

Tesis ini telah dijalankan untuk menyiasat ciri-ciri isyarat Pancaran Akustik terhadap kimpalan MIG besi tergalvani. Sendi kimpalan akan menjadi ujian sebagai beban dan akan ada beberapa fakta yang kimpalan bersama untuk menjadi pemantauan. Bagi isyarat AE kajian ke atas besi tergalvani, semua parameter domain masa (pukulan, kiraan, amplitud, dan frekuensi oleh Fast Fourier Transform) isyarat akan dianalisis dan memproses dengan bantuan perisian Matlab. Semua parameter akan dibandingkan dengan mata sendi kimpalan yang berlainan. Keputusan yang diperolehi akan dianalisis dengan menggunakan Matlab dan kemudian boleh meneruskan untuk analisis. Bagimendapatkan hasil dengan menggunakan (FFT), corak isyarat boleh membezakan antara bukan kecacatan sendi kimpalan dan kecacatan sendi kimpalan kerana julat frekuensi yang berbeza di antara mereka. Bagi amplitud dan count, nilai purata kimpalan kecacatan sama menunjukkan bahawa ia mempunyai nilai yang lebih tinggi berbanding dengan kimpalan bukan kecacatan sendi. Terdapat beberapa isyarat yang dipengaruhi oleh bunyi gangguan. Oleh itu, corak isyarat didapati tidak dapat dianalisis. Faktor yang mempengaruhi isyarat atau isyarat gangguan bunyi bising di sekitar ujian, pelepasan dari elektrik sekitar dan daripada orang bercakap.

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LIST OF ABBREVIATIONS

AE	Acoustic Emission
AET	Acoustic Emission Test
NDT	Non Destructive Test
MIG	Metal Inert Gas Welding
PZT	Piezoelectric zirconate titanate
FFT	Fast Fourier Transform

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CHAPTER 1

CHAPTER 1: INTRODUCTION

1.1 PROJECT BACKGROUND

The word “acoustic” is come from the Greek word “akoustikos”, which means has to do with “hearing” (Miller, 1987). The Latin synonym is “sonic”. After acousticians had extended their studies to frequencies above and below the audible range, it become conventional to identify these frequency ranges as “ultrasonic” and “infrasonic” respectively, while letting the word “ultrasonic” refers to the entire frequency range without limit. Acoustic emission testing (AET) becomes recognized as Nondestructive testing (NDT). Galvanized iron alloy commonly used in manufacturing of piping generally. As this can imply to its application, hence the results will show the characteristic of the effect before and after of Metal Inert Gas (MIG) welding on galvanized iron alloy. This research and experimental study of acoustic emission signal characteristics on the welding joint between two different types of galvanized iron alloys. Acoustic emission is defined as the transient elastic energy that is spontaneously released when material undergoes deformation, fracture, or both. It forms the basis of one of the new Non-destructive Testing (NDT) methods that provides means of evaluating structural integrity by the detection of active flaw that may ultimately cause failure of the material. Detection of AE represents actual detection of fracture or characteristics events as they occurred when material undergoes to crack (Sachse, et al, 1991).

This project involves research and studies of acoustic emission event in different characteristic before and during welding process of galvanized iron alloy. There will be two types of galvanized iron alloy to be performing as the material in this project. As we know that acoustic emission can only quantitatively gauge how much damage or activity is contained in a structure. In order to obtain quantitative results about size, depth, and overall acceptability of a part, other NDT methods (often ultrasonic testing) are necessary. However in this project is concern about the activity of the welding process, hence the ultrasonic testing not required.

The welding join is used to test a material strength. It is to detect if there is any defects on the welding joint. The testing will be carried out during the welding process as to detect the signal characteristic before and after the joint is defected. This method will apply with acoustic emission equipment by follow the standard experimental procedure and set up of acoustic emission parameters. Then when the data collected, it will be analyzed by using Matlab software to interpret the data.

1.2 PROBLEM STATEMENT

During the welding process, there are two type of acoustic emission signal which is useful and disturbances signal. The useful signal occurs when essential changes in the melted region of the spot weld. Meanwhile for the disturbances signal, it is cause by the noise from surrounding. Noise from surrounding such as noise from the electrical component, noise of cooling liquid and also noise from electrodes knocks. In order to specify the types of signal characteristic of welding process, the acoustic emission device used with some analysis using Matlab software. The acoustic emission testing will be carried out after welding process. The signal that will catch by acoustic device will be interpret to find the variable signal character before and during welding process take place.

1.3 PROJECT OBJECTIVE

The objectives of the project are:

i. To measure Acoustic Emission (AE) signal parameter.
ii. To justify and analyze the different of the AE signal on the non-defect and defect welding joints.

1.4 SCOPE OF STUDY

On focus of this project according to the following aspect:

i. Welding two different types of galvanized iron using MIG welding.
ii. Acquire acoustic emission signal near the welding joint using acoustic emission acquisition system.
iii. Analyze the signal acquired using the acoustic emission acquisition system and Matlab.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Based on the title given, the scope of this project is to study the characteristic on the welding joint between two types of galvanized iron alloy before and after the welding process. The welding process will used MIG welding due to all position capable, higher deposition rates than SMAW welding, it require less operator skill and long welding can be made without starts and stops.

The acoustic emission will applied in this study where the signal can determine after welding process. It also noted that in each material their acoustic signal is totally different. Since phenomenon such as crack initiation and propagation emit high frequency acoustic waves, Acoustic Emission (AE) measurement has been acknowledge as an appropriate technique to monitor the characteristic of the material in this project.

2.2 METAL INERT GAS (MIG) PROCESS

Gas metal arc welding (GMAW) sometimes referred to by its subtype's metal inert gas (MIG) welding or metal active gas (MAG). Gas metal arc welding is an arc welding process in which an electric arc is performed and maintained between a continuously fed filler metal electrode wire and the weld pool. In the arc heat, the electrode wire is melted and the molten metal (droplets) is transferred into the weld pool. The arc and the weld pool are shielded from the atmospheric contamination by an externally supplied shield gas (Raj, B. et al. 2006). In **Figure 2.1**, show the process.

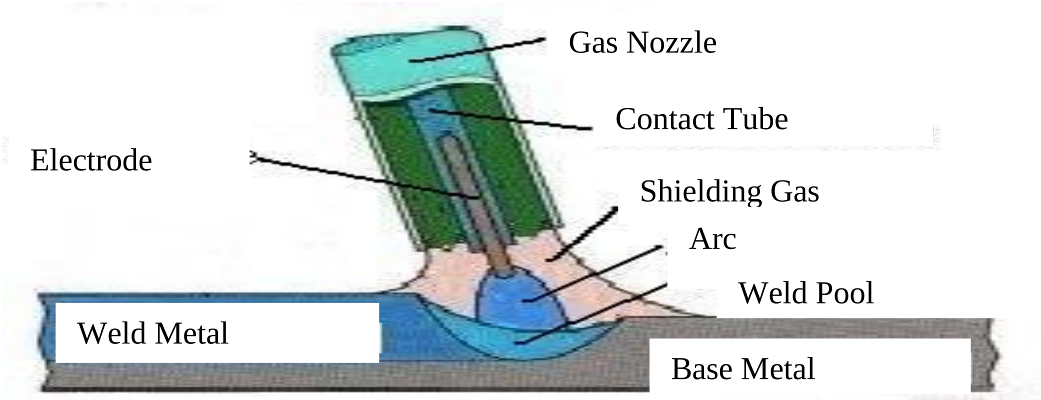

Figure 2.1: Gas shielded metal arc welding process

The process is found to provide a stable arc and good process control when a direct current (DC) power source employee with electrode positive (DCEP) polarity. The DCEP provides stable arc, greater heat input to the cathode base metal for good penetration and a fluid weld pool (Raj et al. 2006).

2.2.1 Metal Transfer

The shielding gas, forms the arc plasma, stabilizes the arc on the metal being welded, shields the arc and molten weld pool, and allows smooth transfer of metal from the weld wire to the molten weld pool. The three basic modes by which metal is transferred from the electrode to weld pool are short-circuiting transfer, globular transfer, and spray transfer (Raj et al. 2006).

2.2.1.1 Short Circuiting Transfer

Short circuiting transfer occurs when the welding current and arc voltage are low. Metal transferred when the electrode is in contact with the weld pool. No metal transferred across the arc gap. The rate of current rise during short circuiting transfer must be properly control, and it must be high enough to maintain a molten electrode tip until filler metal is transferred (Raj et al. 2006).

2.2.1.2 Globular Transfer

Globular transfer is characterized by a drop size of greater diameter than of the electrode wire. The large drop is easily act on by gravity, generally limiting successfully transfer to the flat position. Globular transfer occurs in the current range higher than that of short circuiting transfer. The arc length must be long enough to ensure detachment of the drop before it contacts the molten metal. The non-axial transfer is due to electromagnetic repulsive force acting upon the bottom of the molten drop (Raj et al. 2006).

2.2.1.3 Spray Transfer

In a gas shield of argon or argon rich mixture, the metal transfer from globular to spray type as welding current is increased beyond the transition current. Spray type transfer has a typical fine arc column and pointed wire tip associated with it. Molten filler metal transfer across the arc as fine droplets. The reduction in the droplet size is also accompanied by an increase in the rate of droplet detachment. Most important characteristic is the “finger” penetration that it produces. The spray transfer mode can be used to weld any metal (Raj et al. 2006).

2.2.2 Process Variables

The process variables that effect fusion characteristic and weld geometry in GMAW are:

i. Welding current:

The welding is directly related to the electrode feed rate, welding current has a strong influence on the bead characteristics. With all other variables held constant, an increase in deposition rate, and increase in the size of the weld bead.

ii. Arc Voltage:

In a flat characteristics power source, the required arc voltage is selected at the power source by adjusting the knobs provided. Arc voltage depends on the position of welding, electrode size, shielding gas composition and the type of metal transfer.

iii. Welding Speed

When the welding speed is decreased below this, there will be drastic decrease in the penetration. This is due to the filler metal deposited per unit length is more at very low welding speed. The arc will be acting directly on the molten pool rather than on the plate surface.

iv. Electrode Extension

There is distance between the contact tube and the end of the electrode. As this distance increase, the electrical resistances also increase. Then, then the electrode temperature rise due to resistance heating. The electrode extension length has to be controlled because too long an extension results in excess weld metal being deposited with low arc heat. Proper electrode extension would be 6 to 12 mm for short circuiting transfer welding and 12 to 20 mm for globular and spray type of metal transfer.

v. Shielding Gas

The function of shielding gas is to exclude the atmospheric air from the arc zone. However, the shielding gas has significant influence on the arc characteristics, mode of metal transfer, and speed of welding, cleaning action and bead geometry.

2.2.3 Advantages of MIG Welding

Some of the advantages of MIG or GMAW process as compared to others welding process is as follow:

i. It is a continuous welding process and can be mechanised.
ii. Welding can be done in all position.
iii. Higher welding speed.
iv. Deeper penetration is possible, which permits the use of smaller size fillet welds for equivalent strength.
v. Open arc nature of the process aids monitoring and control of the arc during welding.
vi. Higher metal deposited rate.
vii. Less distortion due to higher welding speed.
viii. Avoids the chore of cleaning a solidified slag from the surface of each weld pass.

2.2.4 Problem Detection of AE

AE is a stress-related phenomenon. To detect discontinuities and damage in equipment, the technique must be applied when the equipment being stress. It cannot detect problems in area where there is no loading of the structure. To get a successfully of AE testing, carefully attention must be paid to loading schedule (Fowler et al. 1989).

Since in this project use welding approach, welding defect is being consider. There are a number of weld problems that produces AE hydrostatic testing. These include cracks developed due to hot cracking, cold cracking, intergranular and transgranular microcracks, base metal cracking in the heat effected zone (HAZ), incomplete fusion, undercut, and lack of penetration, porosity and inclusions (Fowler et al. 1989). Hot dip galvanized is a surface treatment that widely used to prevent oxidation and degradation of steel structure (Gallego and Suarez 2010).

2.3 HISTORY OF ACOUSTIC EMISSION

In eighteenth century, the major advance in acoustics at the hand of great mathematicians of that era, who applied the new technique of the calculus to the elaboration of wave propagation theory. The first such application like that was Sabine's groundbreaking work in architectural acoustics, and many more others followed. Underwater acoustic was used to detecting the submarines in the war. The ultrasonic frequency range enables wholly new kinds of application in medicine and industry. New kinds of transducers were invented and put a use (Yaacob 2009).

It has been often quoted that AE history started in 1950 with publication of Keiser's dissertation (Keiser 1950). J. Kaiser tested tensile specimens of metallic materials, recording AE signals. Back then, he discovered a famous irreversibility which is now called the Keiser effect. Then, B.H Schofield found Keiser's article in USA and study it. Then he published his first work known as "Acoustic Emission" (Schofielde 1961).

Fracture sounds (sonic waves in air) must be original AE phenomena. These are acoustic and audible. In the definition nowadays, AE waves are not sonic waves, but elastic waves in a solid. The frequency range of the waves could cover the inaudible range over the audible range (acoustic or lower than 20 kHz). The sonic waves higher than the audible range are defined as ultrasonic waves (Yaacob 2009).

Based on the historical development, AE technique is now in the practical stage. Rationally in the case of cracking sources, AE waves are elastic waves due to dislocation motions (discontinuity of displacements as cracking) in a solid. As a result, they consist of P-wave (longitudinal wave or volumetric), S-wave (transverse wave or shear), and such other interfacial waves as surface waves (Rayleigh wave and Love wave), reflected waves, diffracted waves and guided waves (Lamb wave and other plate waves). The latter portion of AE waveform, in addition, often is associated with resonance vibration of AE sensor, which turns wave motions into electrical signals. Consequently, it is noted that AE waveforms and waveform parameters are not completely associated with generating mechanisms, but mostly responsible for the effects of travel paths, media and detection systems (Yaacob 2009).

2.3.1 Work Flow of Acoustic Emission

The study about propagation, absorption, and reflection of the sound waves is called acoustics. The unwanted sound was referring to a term known as noise. In engineering and science, noise is undesirable component that obscures wanted signals. There are many ways to obtain the sound such as Sound intensity (*I*), Sound intensity level (SIL), Sound power (Pac), Sound power level (SWL), Sound energy density (*E*), and lastly is Sound energy flux (*q*). The study of acoustics revolves around the generation, propagation and reception of mechanical waves and vibrations (Yaacob 2009).

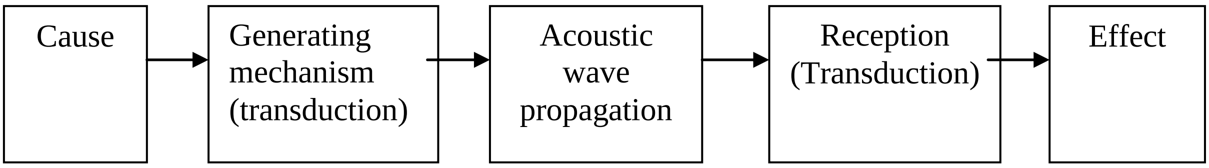

Figure 2.2: Work flow of Acoustic Emission

The steps shown in diagram above can be found in any acoustical event or process. There are any kinds of transducer process that convert energy from others form into acoustical energy and producing the acoustic wave. The wave carries energy throughout the propagating medium. Eventually, this energy is transduced again into other forms, in ways that again may be natural or volitional contrived (Yaacob, S. 2009).

2.3.2 Acoustic Emission Theory

Acoustic Emission, according to ASTM, refers to the generation of transient elastic waves during the rapid release of energy from localized sources within a material. The source of these emissions in metals is closely associated with the dislocation movement accompanying plastic deformation and the initiation and extension of cracks in a structure under stress. Other sources of Acoustic Emission are melting, phase transformation, thermal stresses, cool down cracking and stress build up (Grosse and Ohtsu 2008).

The Acoustic Emission NDT technique is based on the detection and conversion of these high frequency elastic waves to electrical signals. This is accomplished by directly coupling piezoelectric transducers on the surface of the structure under test and loading the structure. Sensors are coupled to the structure by means of a fluid couplant and are secured with tape, adhesive bonds or magnetic hold downs. The output of each piezoelectric sensor during structure loading is amplified through a low-noise preamplifier, filtered to remove any extraneous noise and furthered processed by suitable electronic equipment (Grosse and Ohtsu 2008).

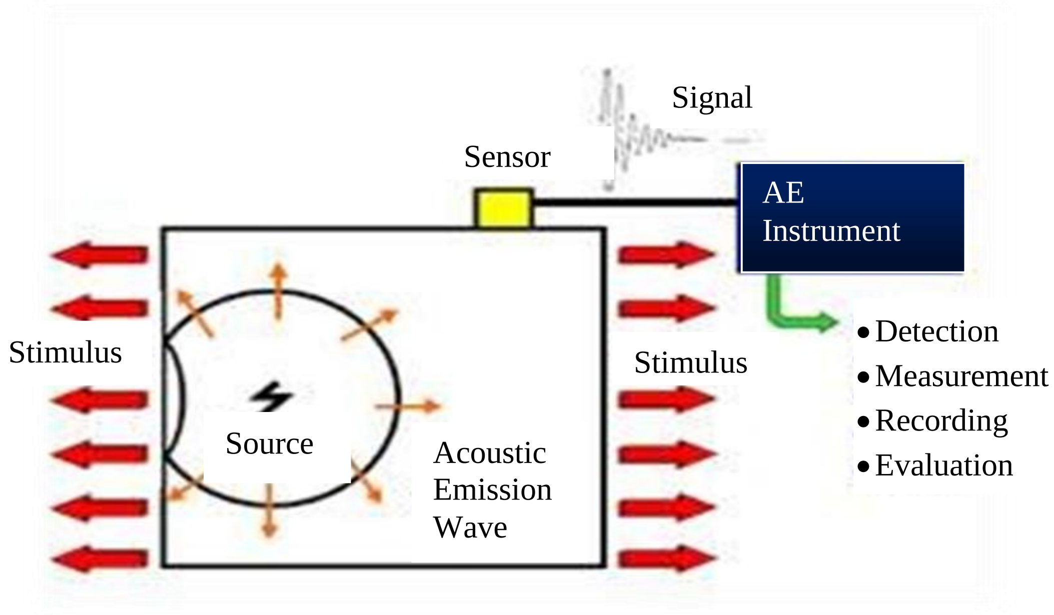

Figure 2.3: Acoustic Emission Process

When more than one sensor is used, Acoustic Emission source can be located and, thus, the area is defective. Location is based on the wave propagation principles within the materials and is effectuated by measuring the signal's arrival time to each sensor. By comparing the signal's arrival time at different sensors, the flaw's location can be defined through triangulation (Grosse and Ohtsu 2008).

2.3.3 Sensor and Instrument

Fracture in materials takes place with the release of stored strain energy, which consumed by nucleating new external surfaces or cracks and emitting elastic wave and generally defined as Acoustic Emission (AE) waves. It propagates inside the material and detected by sensor (Grosse and Ohtsu 2008). Acoustic Emission sensors are directly attached on the surface as shown in Figure 2.4**,** except from any those contactless sensors.

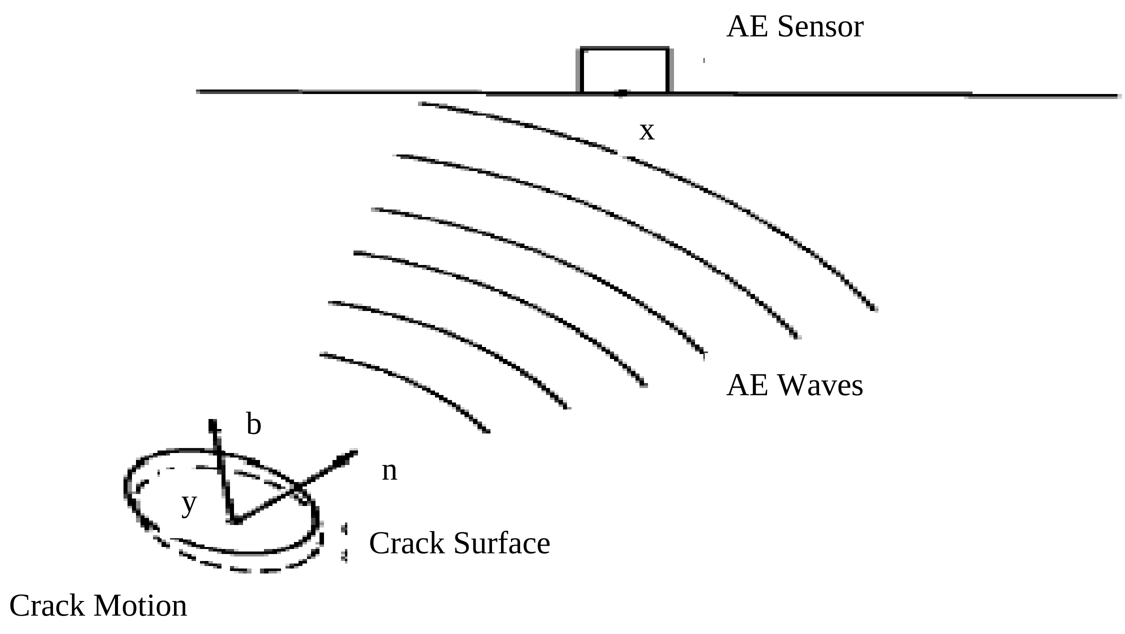

Figure 2.4: Detection of AE waves

Source: Grosse and Ohtsu 2008

A contact type of the sensor is normally employed in AE measurement, and is commercially available. In the most cases, a piezoelectric element in a protective housing as illustrated in Figure 2.5 is applied to detection. Thus the sensors are exclusively based on the piezoelectric effect out of lead zirconate titanate (PZT) (Grosse and Ohtsu 2008).

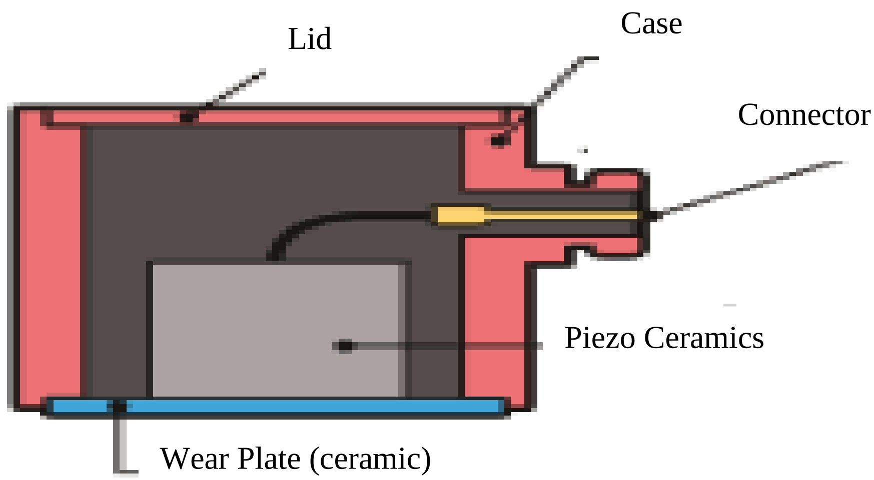

Figure 2.5: AE sensor of the piezoelectric element

For a specialized purpose of sensor calibration, a capacitive sensor or transducer is developed. Compared with other types of AE sensors, it is well known that piezoelectric sensors provide the best combination of low cost, high sensitivity, ease of handling and selective frequency responses. Although PZT sensors are not normally suited for broad-band detection in basic studies of AE waveform analysis, they are practically useful for most AE experiments and applications (Grosse and Ohtsu 2008).

The sensor usually operates in resonance such as PZT sensors. The signal recorded in a small frequency range due to the frequency characteristics of the sensor to enhance the detection of AE signals. The damper is bonded on the top of the detector element to suppress the resonance. Damped sensor operated outside their resonance frequencies allowing a broadband detection, although they usually less sensitive to wave motions (Grosse and Ohtsu 2008).

So far, various analyses of PZT sensors have been performed. These can be classified into two groups. One employed equivalent electric circuit (Mason 1958) and the other applied solutions of the field equations. These are based on one-dimensional analysis, and thus results cannot be readily extended to three-dimensional (3-D) analysis. This is because the PZT element used in an AE sensor is neither an infinite bar nor an infinite plate (Grosse and Ohtsu 2008).

In the case of free vibration, more than ten peak frequencies are found to the 400 to 600 kHz range. A strong peak is observed at around 500 kHz both in the free vibration and after bonding to the steel block. Result of the conical element show in Figure 2.6 below (Grosse and Ohtsu 2008).

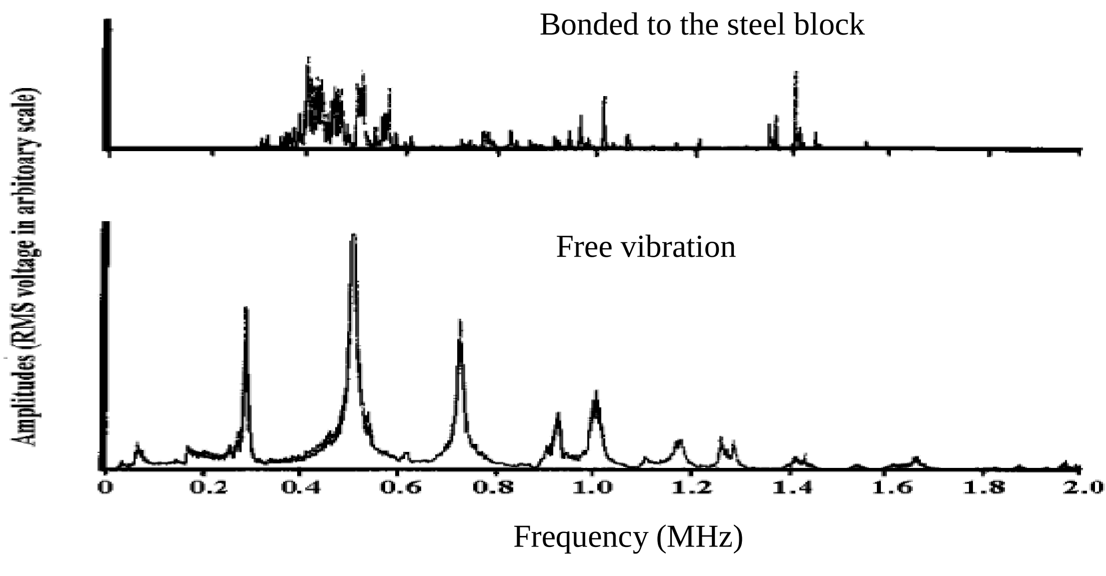

Figure 2.6: Frequency response of the conical element.

Source: Grosse and Ohtsu 2008

A NIST (National Institute for Standards and Technology, USA) conical transducer developed has been known as a reference sensor of flat response. Because the sensor consists of a conical element of 1.5 mm truncated-end in diameter bonded to a brass cylinder (Grosse and Ohtsu 2008).

2.3.4 Calibration and Detection

A typical AE sensor of PZT element transform elastic motion of 1 pm displacement into electrical siganl of 1 μV voltage. For example, Figure 2.7 show the frequency response of AE sensor commercially (Grosse and Ohtsu 2008).

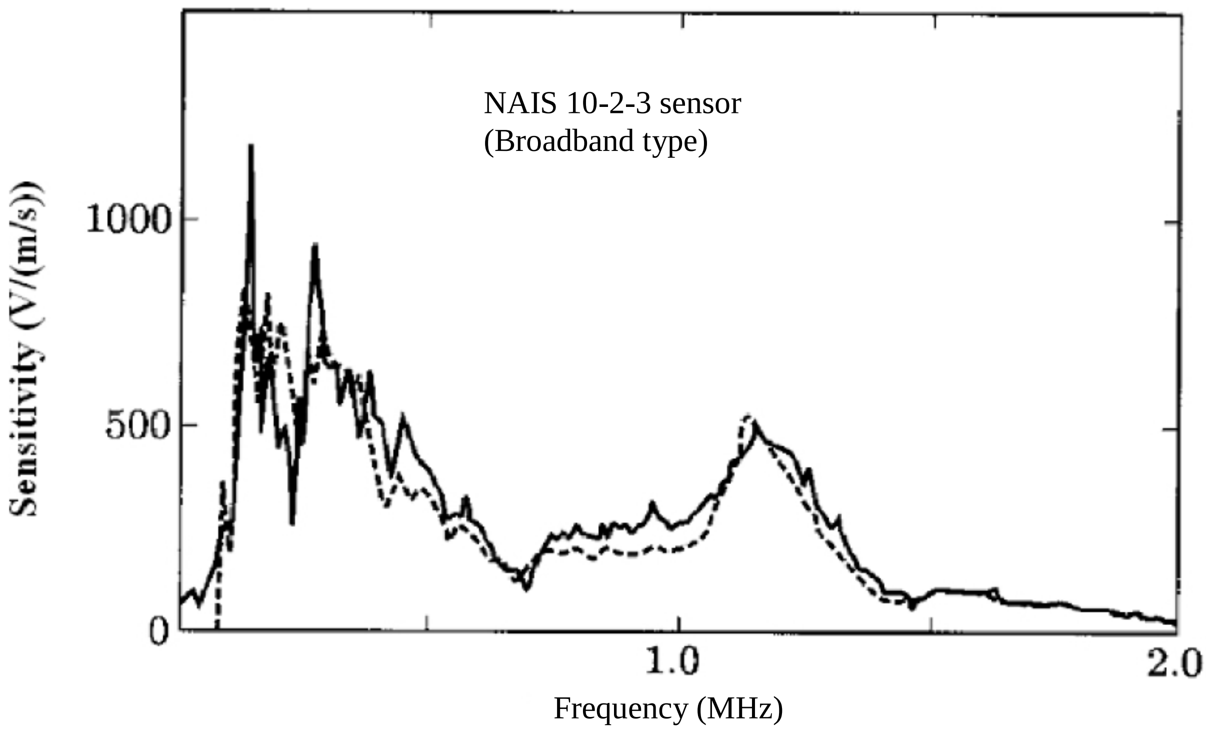

Figure 2.7 (a): Calibration curves of frequency response of commercial AE sensor broadband type.

Source: Grosse and Ohtsu 2008

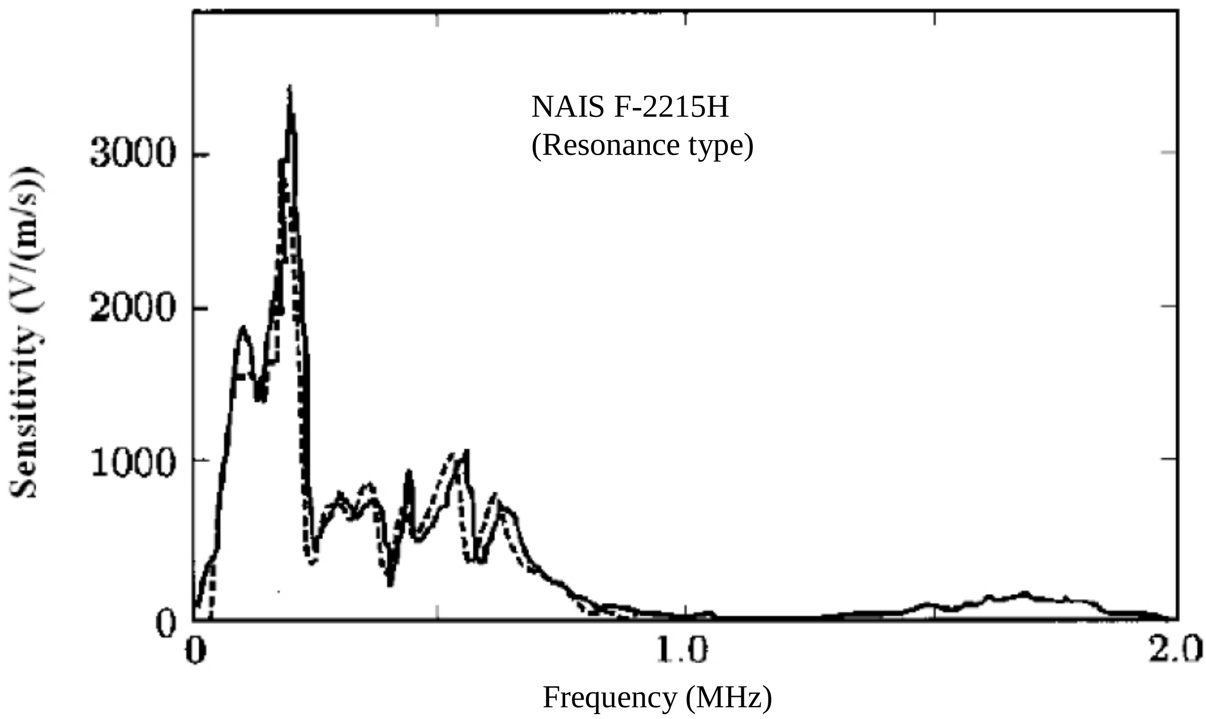

Figure 2.7 (b): Calibration curves of frequency response of commercial AE sensor resonance type.

Source: Grosse and Ohtsu 2008

Both of these sensors respond irregularly, hence the sensitivity of the broadband type is lower than the resonance type. The selection of AE sensor should be based on either the sensitivity (resonance type) or the flat response in frequency (broadband type). This fact is so general that selection of AE sensors should be based on either the sensitivity (resonance type) or the flat response in frequency (broadband type). In any case where AE waves are detected by AE sensor, frequency contents are smeared by the transfer function *W(f)* of the sensor (Grosse and Ohtsu 2008).

When the sensor cannot directly be attached to the structure, waveguides as illustrated in Figure 2.8 are employed. It is noted that the use of waveguides introduces further complexity to frequency contents of AE waves (Grosse and Ohtsu 2008).

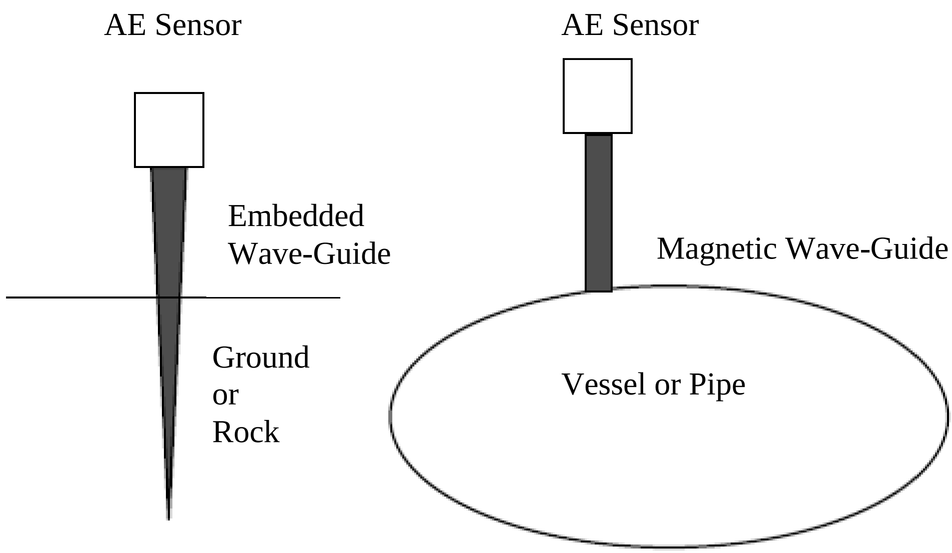

Figure 2.8: Examples of AE wave-guides.

Source: Grosse and Ohtsu 2008

2.4 OTHER TYPES OF SENSORS

There are new types of sensors under development, besides the already one PZT sensor. The laser system has been applied for AE detection. It is a contactless measurement but less sensitive than PZT sensors. The example shows in Figure 2.9 (Nishinoiri and Enoki 2004). PZT sensors have a limitation in application at elevated temperature, because PZT has Curie point. The laser system is applied to AE measurement in ceramics under firing. This is because cracking under firing of structural ceramics causes a serious problem for fabrication. Cracks are generated in heating, sintering or cooling, so that AE monitoring was applied to optimize firing conditions (Grosse and Ohtsu 2008).

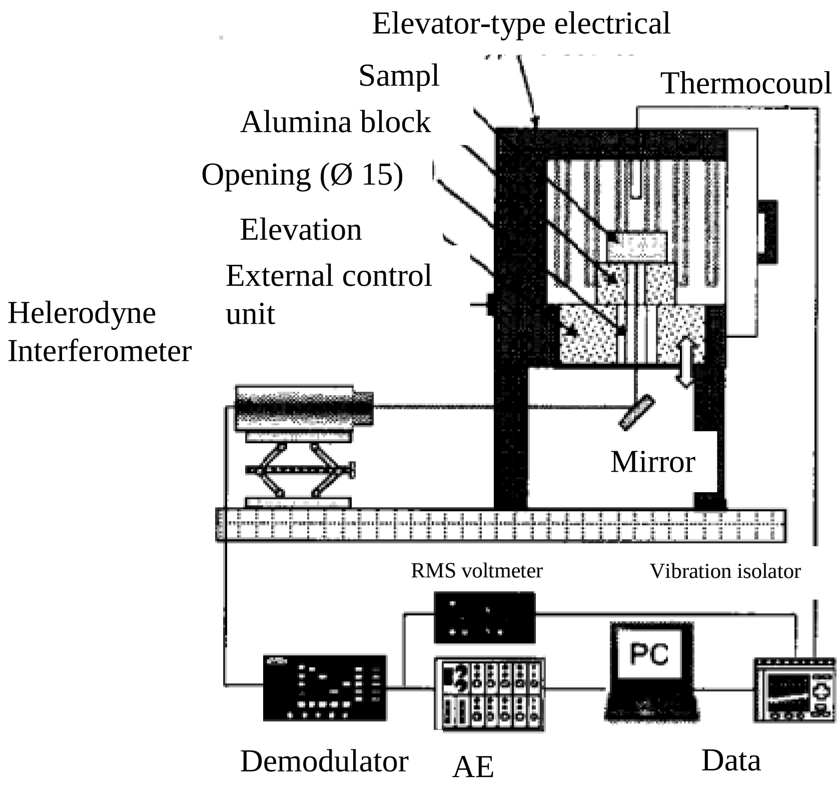

Figure 2.9: Laser AE system at high temperature.

Source: Grosse and Ohtsu 2008

The alternative to the PZT sensor is optical fiber sensor. It can do a number of advantages such as the long term monitoring, the condition free from electro-magnetic noises, and the use of corrosive and elevated environments. The example applied to pipe system show in Figure 2.10 (Cho, Arai and Takemoto 2004). Based on their results, the sensitivity depends on the number of fiber winding, and is still 10 times lower than a conventional PZT sensor (Grosse and Ohtsu 2008).

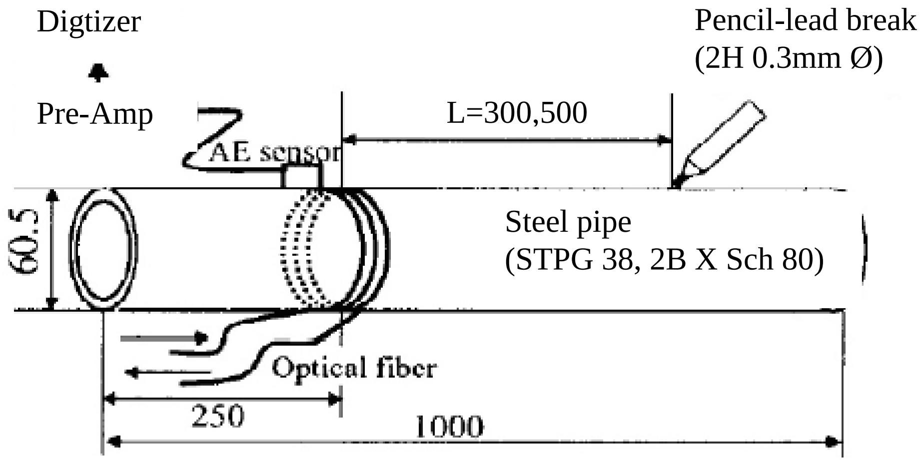

Figure 2.10: Fiber-optic AE sensor for pipe structure.

Source: Grosse and Ohtsu 2008

AE sensors transform surface motions into electric signals. Thus, the amplifiers are usually employed to magnify AE signals. Because cables from the sensor to the amplifier are subjected to electro-magnetic noise, specially coated cables of short length shall be used. Preamplifiers with sate-of the- art transistors should be used to minimize the amount of electronic noise. Amplifiers with a flat response in the frequency range are best use (Grosse and Ohtsu 2008).

A filter of variable band-width between 1 kHz and 2 MHz is generally employed. The choice of the frequency range depends on noise level and attenuation property of concrete. As given in Figure 2.11, it is noted that the use of the band-pass filter drastically changes AE signals as the time records (Grosse and Ohtsu 2008).

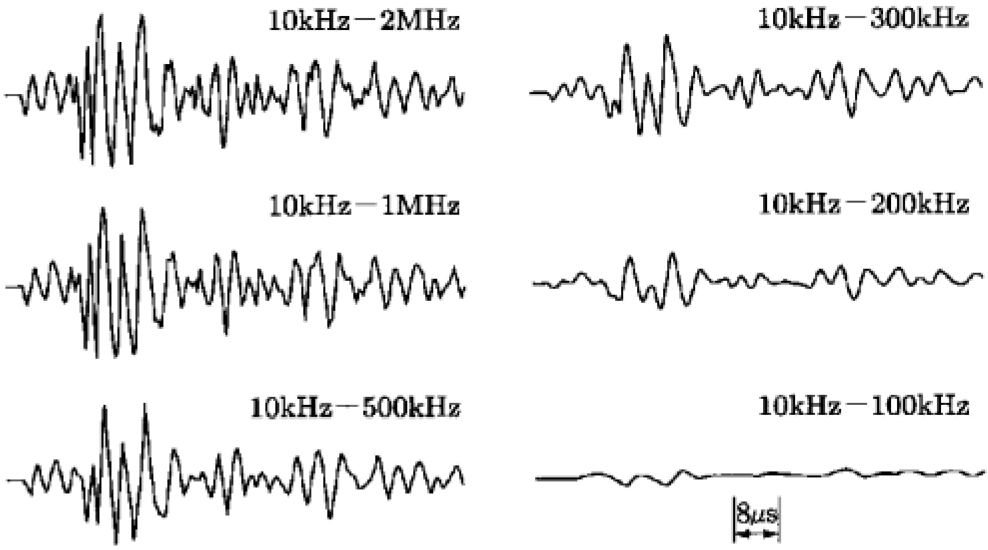

Figure 2.11: Effect of the band-pass filter on AE waveforms.

Source: Grosse and Ohtsu 2008

Main concern for data acquisition results from the A/D (analog to digital) conversion and the triggering. Fast A/D units have to be used to ensure that a large number of events are recorded. Usually, the A/D converter is equipped for each channel of the recording unit. Anti-aliasing filters are required so that the signals can be properly transformed to the frequency domain. A sketch of AE instrument is shown in Figure 2.12. Signal data are mostly digitized by employing a personal computer system (Grosse and Ohtsu 2008).

Figure 2.12: AE instrument

.

Source: Grosse and Ohtsu 2008

A monitoring system can analyze such parameters as count, hit, event, rise time, duration, peak amplitude, energy, RMS (root mean square) voltage, frequency spectrum, and arrival-time difference. Normally AE signals are processed after the amplitude becomes larger than the threshold level (Grosse and Ohtsu 2008).

2.5 PARAMETER ANALYSIS

A signal triggering is conventionally made by setting threshold. The signal which have amplitude exceeds the threshold level are recognized as AE signal. Termination of AE signal or duration was determined as the period when the signal does not exceed the voltage threshold. The duration sets by the users and set as a constant time. For the digital recording, the start time record the wave forms is the same as the parametric feature extraction. The length or duration of wave form to be recorded is determined by the users (Tomoki et al. 1994).

2.6 Acoustic Emission Signal Parameter

AE signal was generated by fracture phenomena and transform to electric signal as AE signal. In these follow are AE parameter used from definition (ISO 12716 2001):

i. Hit:

Any signal that exceeds threshold and causes a system channel to accumulate data. Frequently use to show the AE activity with counted number for a period (rate) or accumulated number. In Figure 2.13, one waveform correspond one hit.

ii. Count/emission count:

The number of times within the duration, where one signals (waveform) exceeds a present threshold. In Figure 2.13, nine counts are observed.

iii. Amplitude:

A peak voltage of the signal waveform is usually assigned. Amplitudes are expressed on a decibel scale instead of linear scale where 1µV at the sensor is defined as 0 dB AE. The amplitude is closely related to the magnitude of source event. As mentioned the AE signals are detected on the basis of the voltage threshold, the amplitude is also important parameter to determine the system’s delectability. Generally the detected amplitude shall be understood as the value does not represent the emission-source but the sensor response after losing the energy due to propagation. The magnitude of amplitude in each signal has been often analyzed in relation with frequency distribution.

iv. Duration:

A time interval between the triggered time of one AE signal (waveform) and the time of disappearance is assigned. The duration is expressed generally on microseconds, which depends on source magnitude and noise filtering.

v. Rise time:

A time interval between the triggering time of AE signal and the time of the peak amplitude is assigned. The rise time is closely related to the source-time function, and applied to classify the type of fracture or eliminate noise signals.

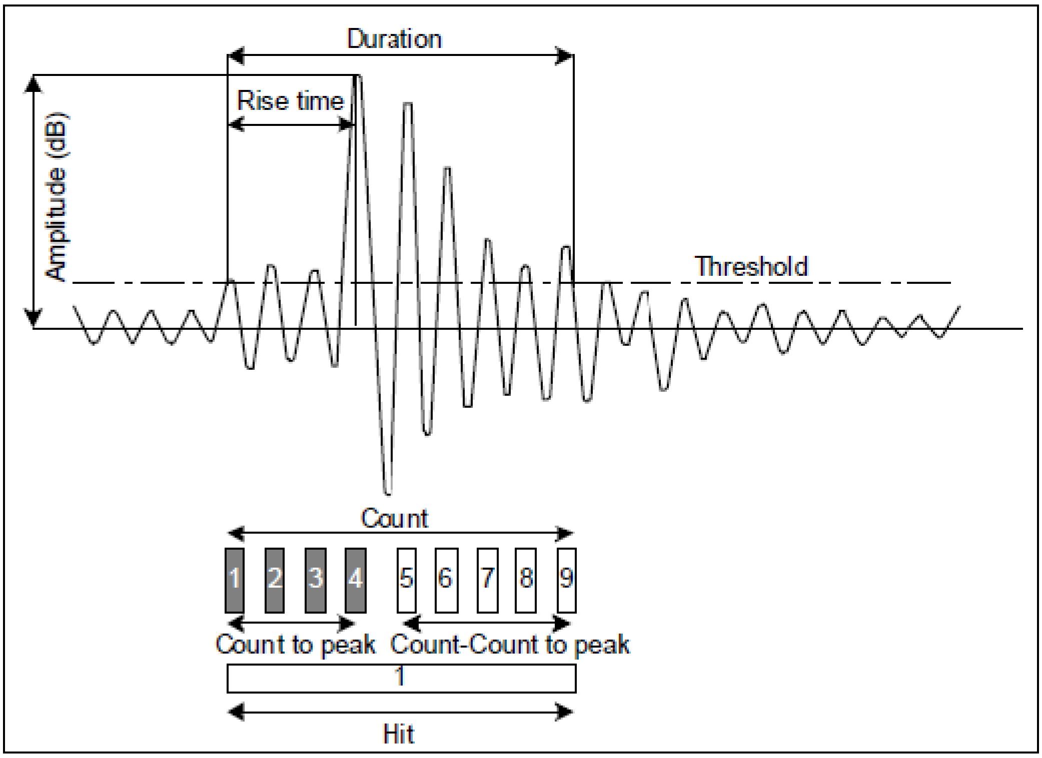

Figure 2.13: Conventional AE signal feature

Source: Grosse and Ohtsu 2008

CHAPTER 3

METHODOLOGY

3.1 IINTRODUCTION

In general, this project involve about material analysis of characteristic of galvanize iron alloy before and after welding process using Acoustic Emission technique (AE). To weld by using MIG welding, the minimum thickness that it required is more than 3 mm. With the general approach, the experiments were conduct in order to get the result and achieve the objective.

3.2 TEST RIG AND TOOL PREPARATION

Typical of AE apparatus consist of various component. To detect AE event and its function to convert acoustic waves energy emits by the source is sensor. The preamplifier used to amplify initial signal that is the first stage of the instrumentation system and the main function of preamplifier is to enhance the signal level against noise. The sensor produces charge proportional to the source intensity. Hence the amplifier must be located near the sensor. Normally, a preamplifier used along with the transducer and the two together forms that front-end of the AE instrumentation. For the typical amplification gain is about 4 dB and it was the right choice to ensure minimum errors.

Then, filter function is to allowing the amplifier signal from sensor and unwanted noise. An ideal filter of passive or active network allows the desired frequency with gain unit and rejects unwanted unit. And also, filter were design with a different bandwidth and can be plugged to meet the specific requirement. Figure 3.1 show the diagram of typical of AE apparatus.

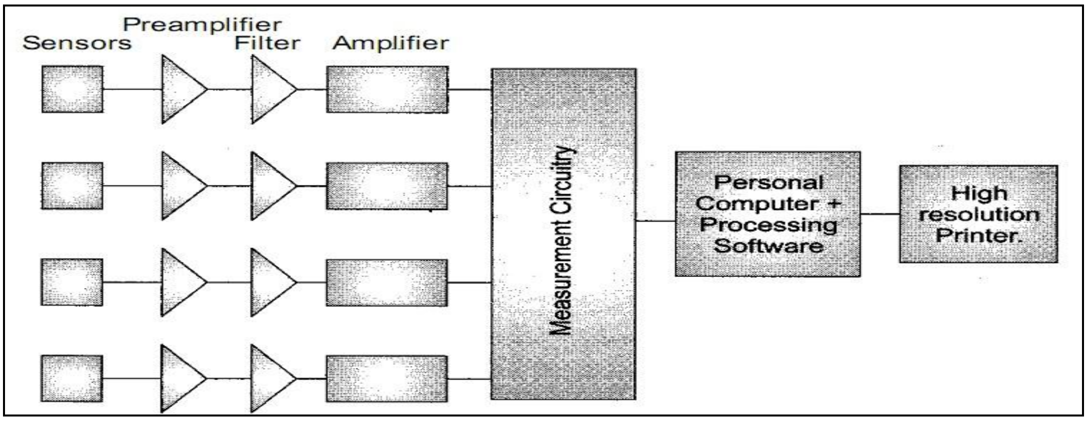

Figure 3.1: Typical of AE apparatus

Source: Kalyanasundaran, Mukhopadhyay and Subba 2007

The AE sensor that used was a broadband acoustic emission technique. In Figure 3.2 shows a broad band acoustic emission sensor. This type was made by piezoelectric material that was discussed in Chapter 2. In this project, the sensor that will use had the optimum frequency of 400 kHz. An integral preamp AE sensor, i400 with 400 kHz resonance, 40dB gain and BCN coax connector were used. MAG-1 is the magnetic attachment for the model i400 integral preamp sensor while Coax25 is the Coaxile RG-58 cable, and BNC coax connector.

Figure 3.2: Broadband acoustic sensor

The sensor that will use had a frequency range from 100 kHz to 1 MHz. Grease will use on the surface to optimum the transfer of acoustic energy signal transfer to the sensor.

To analysis data from acoustic emission signal that work with the Window-based PC was 1283 USB AE Node, can see in Figure 3.3 below. It was to provide complete setup and data acquisition control, real time graphics and data storage. The new features in the instrument were parametric inputs, alarm output and external hold. It also provides single serial cable. The software that will used to analyze is AEwin for USB E3.34 software.

Figure 3.3: 1283 USB AE Nodes

3.3 Flow Chart

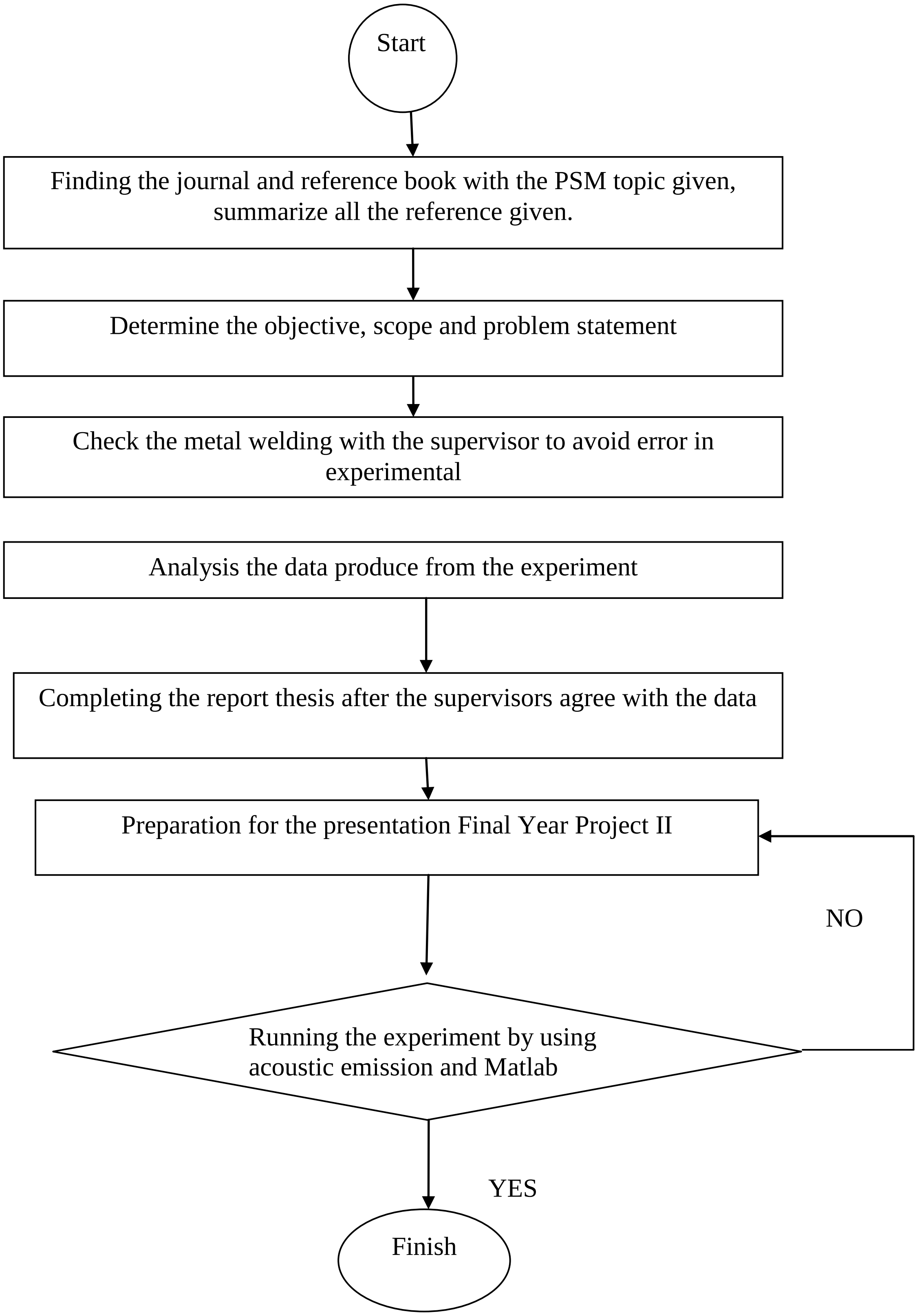

Figure 3.4: Flow Chart

3.4 SETUP MIG WELDING FOR GALVANIZED ALLOY

Firstly the table need to set up and the welding material. The recommended process is to do outside for optimal ventilation of the zinc fumes. The zinc fumes will cause a “metal fume fever” and it is hazard for us. Also wear a respirator or any protective equipment to avoid zinc fumes during welding process.

Then, there is more prefer to grind a little bit of zinc coating to minimum the zinc fumes during welding. It need a higher heat input to remove the zinc coating and a lower welding speed to burn out the coating.

Lastly, the minimum thickness required is 3 mm. Hence, for the set up of the electrode current is at a low setting such as 2.8 amp and 0.35 volts for the thickness of 3 mm.

Figure 3.5: Typical MIG machine

3.4.1 Localization Techniques

Source of AE detect related processes such as crack extension and plastification of material in highly stressed zone adjacent to the crack tip. The AE capable to measure crack closure during fatigue cycling (Zain et al. 2010). Quantitative methods in AET rely on localization techniques to determine the coordinates of the emission source, to image cracks in the material. The method used to localize AE events depends on the geometry of the object being tests. There are one, two and three dimension available in localization technique, it depend on the geometry of the object to use which one (Grosse et al. 2006).

Since this project used MIG welding process, then the object of the material would be in plate form or planar form. Hence, the planar localization method will be use.

3.4.2 Planar Localization Method

Planar localization method sometimes referred as 2-D localization. It applied to 2-D structures that the thickness is small compared to the length extent of the object and source coordinates only required in two directions. Since the sources coordinates and time of origin unknown, three sensors are sufficient (Grosse et al. 2006). Refer to the Figure 3.6 for illustrated.

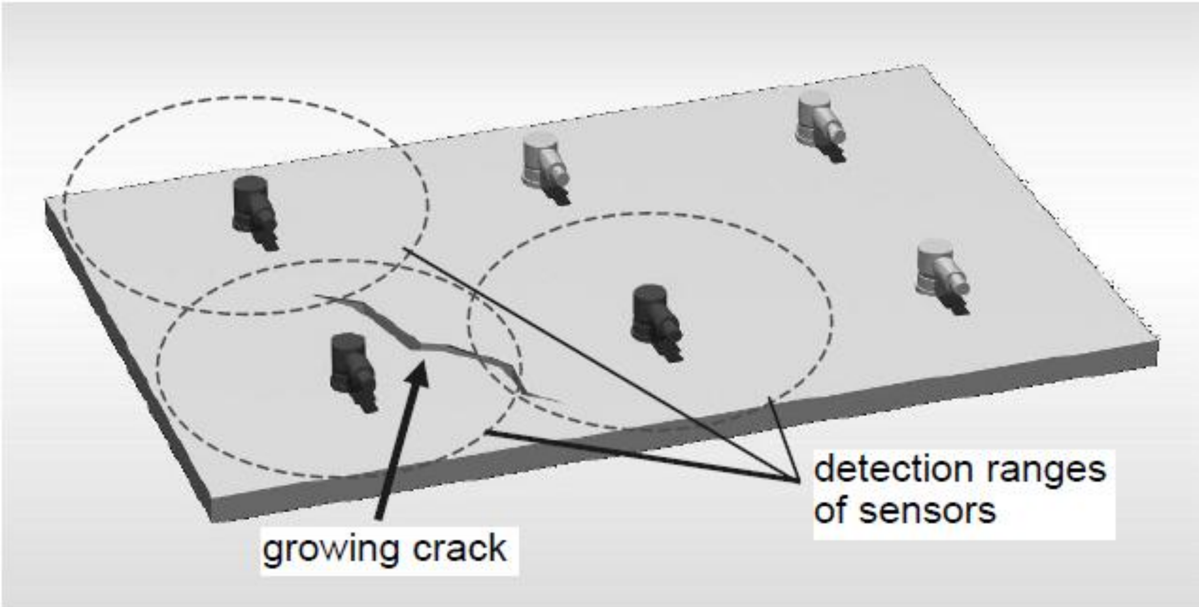

Figure 3.6: Configuration illustrating the principle of planar localization

Source: (Grosse et al. 2006).

In the case of the wavelength shorter than the thickness of structure, plate or Lamb wave to be used and their group velocities need to be considered. The 2D method to locate AE sources is usually applied when the accuracy of zonal technique is inadequate for the application.

3.5 Welding Process

The MIG welding process was easier to conduct for the first user. But, to obtain non-defect welding joint need to calibrate the welding parameter to obtain non-defect welding joint. Table 3.2 show the parameter setup for MIG welding process.

The material used in this test was galvanized iron and the composition of the material can be referring in table below.

Table 3.1: Galvanized iron composition

Work Material Composition (wt.%)						
C	Si	Mn	p	S	Cr	Fe
0.135	0.005	0.23	0.003	0.0031	0.026	99.5

Table 3.2: Setup for welding material

	Volt (V)	Amp (A)	Speed welding	Figure of welding joint
Less Defect welding Joint	20	111	Higher speed welding	
Defect welding Joint	18	90	Slower speed welding	

Figure 3.7: During welding process

3.6 Data Acquisition

Data from the test have been analyzed by using Matlab. From one point there have many hit for example in Figure 3.8 show that the hit of Point 1 at defect welding joint.

Variable Editor - Run_16_1_1_387697

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	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	-6.1035e-04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2	-3.0518e-04	0	0	0	0	0	0	0	0	0	-6.1035e-04	0	0	0.0040	0	0	0	
3	3.0518e-04	0	0.0018	-9.1553e-04	0	-0.0012	0	0	9.1553e-04	0	-6.1035e-04	-3.0518e-04	6.1035e-04	0.0049	0.0031	0.0015	6.1035e-04	-3.0518
4	3.0518e-04	-3.0518e-04	0.0021	-0.0012	6.1035e-04	-6.1035e-04	-6.1035e-04	3.0518e-04	9.1553e-04	0	-3.0518e-04	-3.0518e-04	6.1035e-04	0.0055	0.0027	0.0021	9.1553e-04	-3.0518
5	3.0518e-04	-6.1035e-04	0.0018	-0.0012	6.1035e-04	-3.0518e-04	-0.0012	9.1553e-04	3.0518e-04	3.0518e-04	-3.0518e-04	-3.0518e-04	6.1035e-04	0.0058	0.0021	0.0031	9.1553e-04	-3.0518
6	-3.0518e-04	-3.0518e-04	0.0012	-9.1553e-04	9.1553e-04	-9.1553e-04	-0.0015	0.0012	0	3.0518e-04	-6.1035e-04	0	6.1035e-04	0.0061	0.0021	0.0037	9.1553e-04	
7	-6.1035e-04	0	6.1035e-04	-6.1035e-04	6.1035e-04	-9.1553e-04	-0.0012	9.1553e-04	0	3.0518e-04	-3.0518e-04	3.0518e-04	3.0518e-04	0.0061	0.0021	0.0040	6.1035e-04	
8	-3.0518e-04	0	6.1035e-04	-6.1035e-04	6.1035e-04	-6.1035e-04	-9.1553e-04	3.0518e-04	3.0518e-04	3.0518e-04	0	3.0518e-04	3.0518e-04	0.0061	0.0018	0.0040	3.0518e-04	
9	3.0518e-04	0	6.1035e-04	-9.1553e-04	6.1035e-04	0	-0.0012	0	3.0518e-04	3.0518e-04	-3.0518e-04	0	6.1035e-04	0.0055	0.0015	0.0040	-3.0518e-04	-3.0518
10	6.1035e-04	-3.0518e-04	6.1035e-04	-9.1553e-04	6.1035e-04	3.0518e-04	-6.1035e-04	3.0518e-04	3.0518e-04	3.0518e-04	-6.1035e-04	-3.0518e-04	3.0518e-04	0.0049	0.0015	0.0037	-3.0518e-04	-3.0518
11	3.0518e-04	-6.1035e-04	6.1035e-04	-0.0012	3.0518e-04	9.1553e-04	-6.1035e-04	3.0518e-04	3.0518e-04	3.0518e-04	-6.1035e-04	-6.1035e-04	0	0.0046	0.0012	0.0037	-3.0518e-04	-3.0518
12	0	-6.1035e-04	9.1553e-04	-0.0012	3.0518e-04	0.0015	-3.0518e-04	6.1035e-04	0	3.0518e-04	-3.0518e-04	-3.0518e-04	0	0.0043	0.0012	0.0037	0	-3.0518
13	0	-6.1035e-04	9.1553e-04	-9.1553e-04	6.1035e-04	0.0021	-6.1035e-04	0	-3.0518e-04	3.0518e-04	0	0	6.1035e-04	0.0037	0.0012	0.0040	0	-3.0518
14	0	-6.1035e-04	9.1553e-04	-6.1035e-04	6.1035e-04	0.0024	-9.1553e-04	-3.0518e-04	3.0518e-04	6.1035e-04	3.0518e-04	-3.0518e-04	6.1035e-04	0.0034	0.0012	0.0037	-3.0518e-04	-3.0518
15	0	-3.0518e-04	0.0012	-6.1035e-04	6.1035e-04	0.0031	-9.1553e-04	-3.0518e-04	3.0518e-04	6.1035e-04	0	-3.0518e-04	0.0012	0.0034	0.0012	0.0031	-3.0518e-04	
16	-6.1035e-04	0	0.0015	-6.1035e-04	3.0518e-04	0.0037	-6.1035e-04	0	3.0518e-04	6.1035e-04	-6.1035e-04	-3.0518e-04	0.0015	0.0034	0.0012	0.0024	-6.1035e-04	-6.1035
17	-9.1553e-04	3.0518e-04	0.0015	-6.1035e-04	3.0518e-04	0.0040	-3.0518e-04	0	0	6.1035e-04	-9.1553e-04	-3.0518e-04	0.0018	0.0034	0.0012	0.0018	-6.1035e-04	-6.1035
18	-6.1035e-04	0	0.0015	-3.0518e-04	3.0518e-04	0.0040	-3.0518e-04	3.0518e-04	-3.0518e-04	3.0518e-04	-6.1035e-04	-3.0518e-04	0.0021	0.0037	0.0012	0.0015	-3.0518e-04	-6.1035
19	-3.0518e-04	-6.1035e-04	0.0018	0	3.0518e-04	0.0037	-6.1035e-04	3.0518e-04	0	3.0518e-04	-3.0518e-04	-3.0518e-04	0.0021	0.0040	0.0012	0.0012	0	-3.0518
20	-3.0518e-04	-9.1553e-04	0.0024	0	3.0518e-04	0.0040	-6.1035e-04	3.0518e-04	0	6.1035e-04	-3.0518e-04	-9.1553e-04	0.0018	0.0049	9.1553e-04	9.1553e-04	0	-3.0518
21	-6.1035e-04	-9.1553e-04	0.0021	-3.0518e-04	0	0.0043	-9.1553e-04	3.0518e-04	0	9.1553e-04	-3.0518e-04	-9.1553e-04	0.0012	0.0055	9.1553e-04	3.0518e-04	-3.0518e-04	-6.1035
22	-6.1035e-04	-6.1035e-04	0.0021	-3.0518e-04	0	0.0049	-6.1035e-04	0	-3.0518e-04	6.1035e-04	-3.0518e-04	-9.1553e-04	3.0518e-04	0.0061	6.1035e-04	-3.0518e-04	-3.0518e-04	-9.1553
23	-9.1553e-04	-6.1035e-04	0.0018	-3.0518e-04	0	0.0049	-3.0518e-04	0	3.0518e-04	3.0518e-04	-3.0518e-04	-9.1553e-04	-6.1035e-04	0.0067	3.0518e-04	-9.1553e-04	-3.0518e-04	-0
24	-9.1553e-04	-9.1553e-04	0.0018	0	0	0.0046	-3.0518e-04	3.0518e-04	6.1035e-04	-3.0518e-04	-3.0518e-04	-9.1553e-04	-0.0012	0.0067	-3.0518e-04	-0.0012	0	-0

Figure 3.8: Hit at Point 1 defect welding joint

After that, click plot graph to obtain graph at no of hits. Then it easier to chose the best graph at that point. By using FFT, there a need a code to convert the data from graph amplitude vs time to magnitude vs frequency. The coding can refer in **Appendix A**.

CHAPTER 4

RESULT AND DISSCUSSION

4.1 INTRODUCTION

The experiment was conduct in order to get the signal characteristic of AE from the welding joint of galvanized iron. The material of galvanized iron was weld by using MIG welding technique. There are two experiments were test which is the welding joint with no defect and welding joint with defect. Some result of this experiment shows the same pattern, this is due to some errors occurs during the test been held. The factor that affected the data will be discus in this chapter.

To detect discontinuities and damage in equipment, the technique must be applied when the equipment being stress. It cannot detect problems in area where there is no loading of the structure. To get a successfully of AE testing, carefully attention must be paid to loading schedule.

In order to get the signal in stable condition, there were a few procedures that must be followed. The signal of AE clarified when the amplitude rise above the threshold line. The threshold value needs to be set before the test begins and to ensure burst signal for better recognized the AE signal pattern.

4.2 LOCALIZATION AE SOURCES

It is important to locate the sensor in a suitable position on the plate that has been welded. In this test, the sensor located at four different points. The plate was clamp at the edge of table horizontally and the load placed at the centre on the other welding joint. To enhance the signal of AE, the load applied. The location of the sensor was placed at 4 point.

Noticed that, the signal characteristics like peak amplitude, duration, rise time, and emission count was recorded to see the differences between welding joint defect and less welding joint defect. Also have to ensure that the sensor must place a couplant to enhance the signal from the surface.

4.3 RESULT AND DISCUSSION

This is result from the non-defected and defected welding joints of galvanized iron. The result from the point one to point four was selected by the burst signal characteristic for easier to analyze. From one point of sensor location, there is two signal or graph selected to describe the signal characteristic of AE.

The setup parameter used threshold value of 25 dB was used to eliminate background noise produced by specimen vibration. Threshold used 0.02 mV and block size used is 4098.

The location of point 1 is 50mm from right side of the specimen, the point 2 location 50mm from point 1, the point 3 locations next to the left of point 2 in 50mm and the last point to the left of point 3 in 50mm. It is same position on less defect welding joint and also defect welding joint specimen. The size of the each plate before welding process is 50x250 mm. The load applied to excite the fracture is 20N.

4.3.1 Amplitude, Hit and Count Signal AE analysis

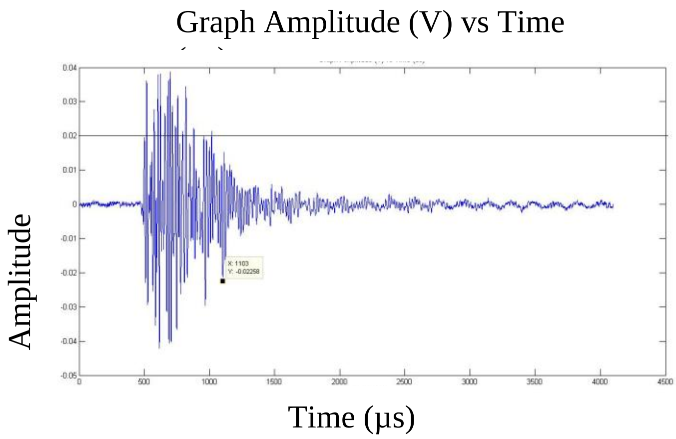


Figure 4.1: Signal AE at Point 1 non-defect welding joint.

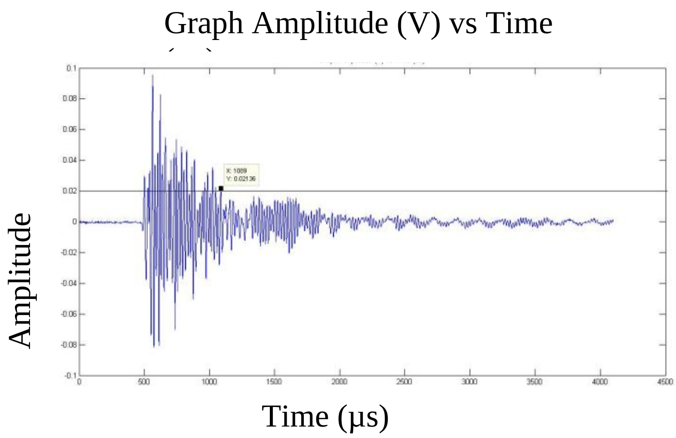


Figure 4.2: Signal AE at Point 1 defect welding joint.

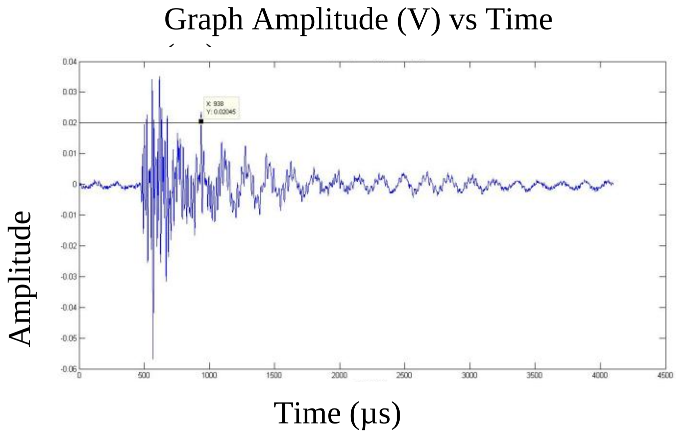


Figure 4.3: Signal AE at Point 2 non-defect welding joint.

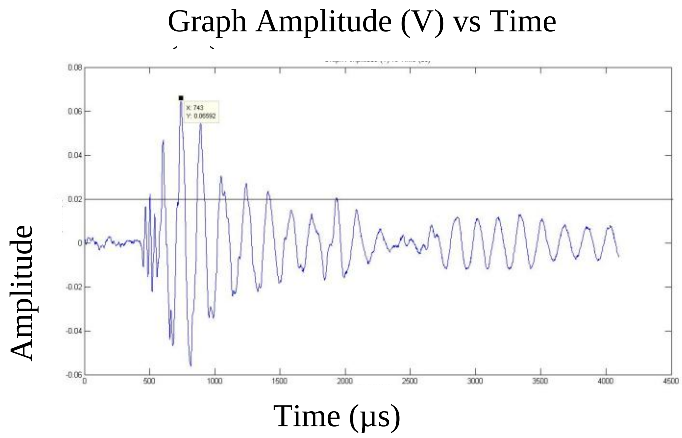


Figure 4.4: Signal AE at Point 2 defect welding joint.

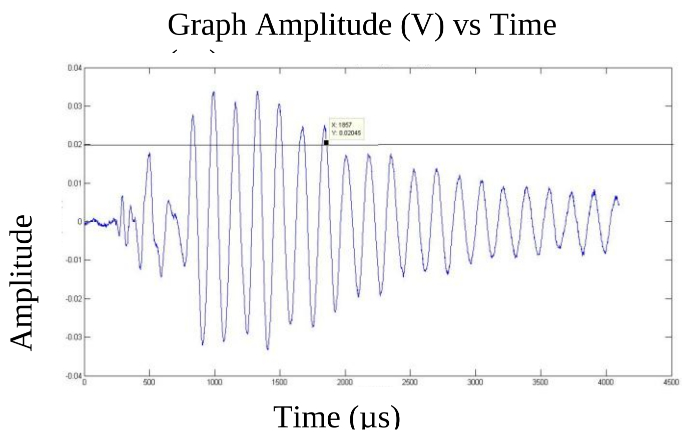


Figure 4.5: Signal AE at Point 3 non-defect welding joint.

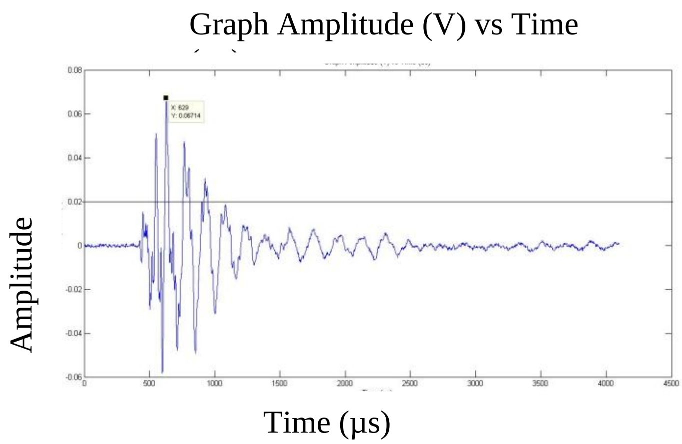


Figure 4.6: Signal AE at Point 3 defect welding joint.

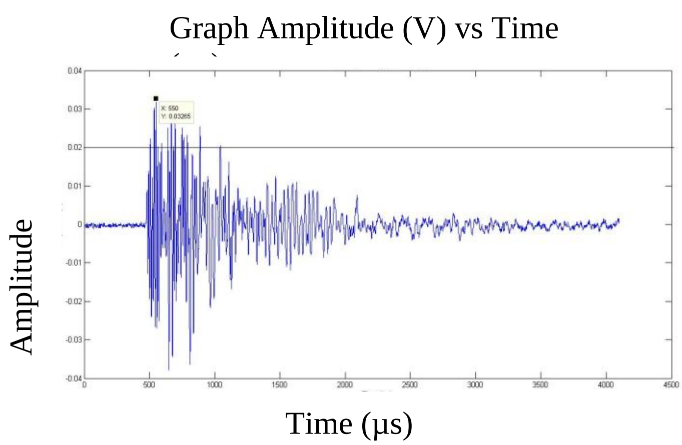


Figure 4.7: Signal AE at Point 4 non-defect welding joint.

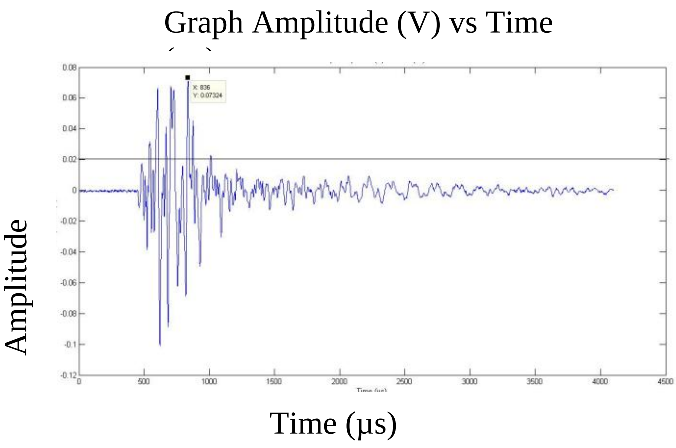


Figure 4.8: Signal AE at Point 4 defect welding joint.

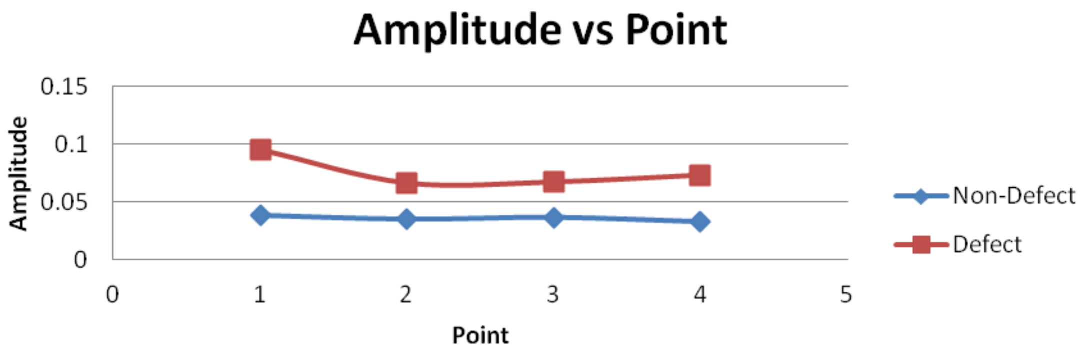


Figure 4.9: Graph Amplitude vs Point of location

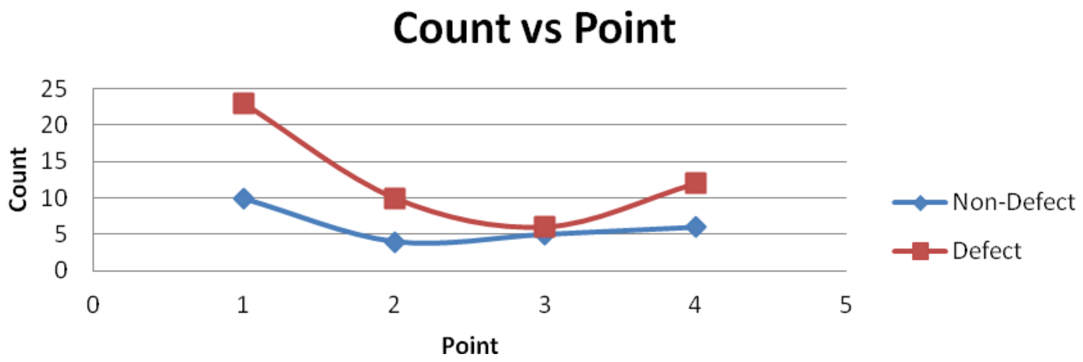


Figure 4.10: Graph Count vs Point of location

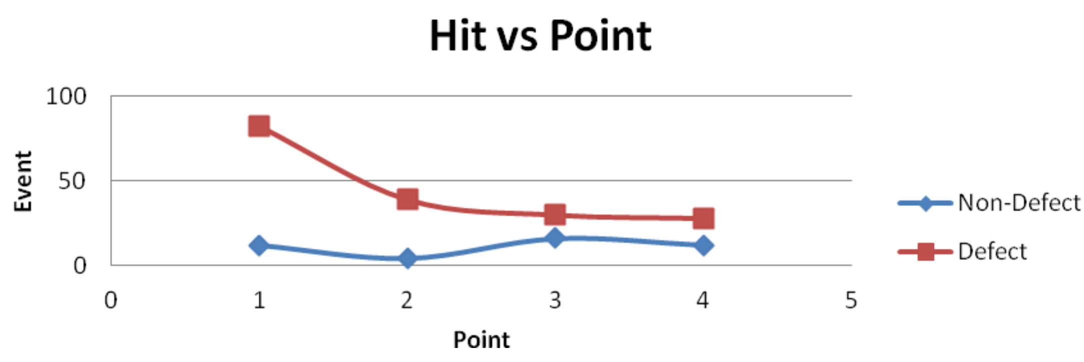


Figure 4.12: Graph Hit vs Point of location

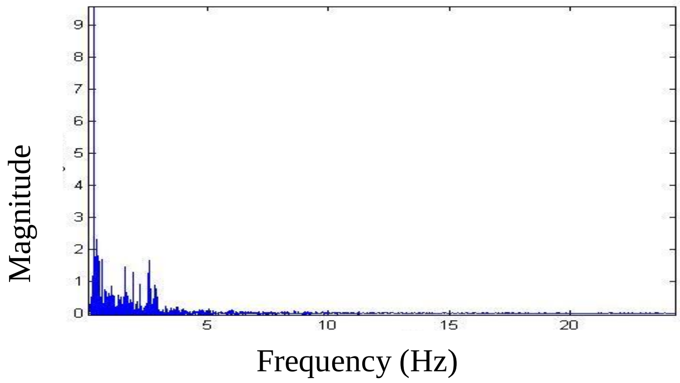
As show on Figure 4.4 on defect welding joint, the signal shows that it not burst and hard to analyze. Same goes to Figure 4.5 on defect welding joint at Point 3, the burst signal not occur. This happens due to the noise disturbances that exist during the test.

Based on the Figure 4.9 show that the defect welding joint has higher value of amplitude due to the load that applied has excited the crack to propagate. The crack activity during the load or stress applied on it show defect welding joint has more than non-defect welding joint.

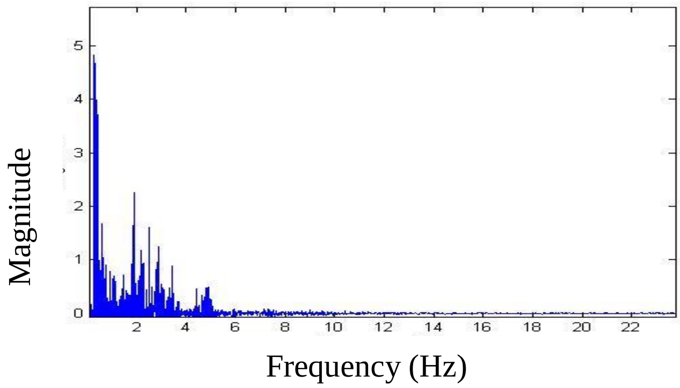
Count is the amplitude counts during the signal exceed the threshold line. As show on Figure 4.10, Point 3 has higher count compare others Point on non-defect welding joint. It shows that at Point 3 on non-defect welding joint there are much activity compare others on non-defect welding joint.

Hit is signals that exceed the threshold and causes a system channel to accumulate data. As show on Figure 4.11, Point 1 on defect welding joint has highest than others. This shows that at this Point on defect welding joint the crack has higher activity to accumulate the data. Same goes to Point 3 on non-defect welding joint.

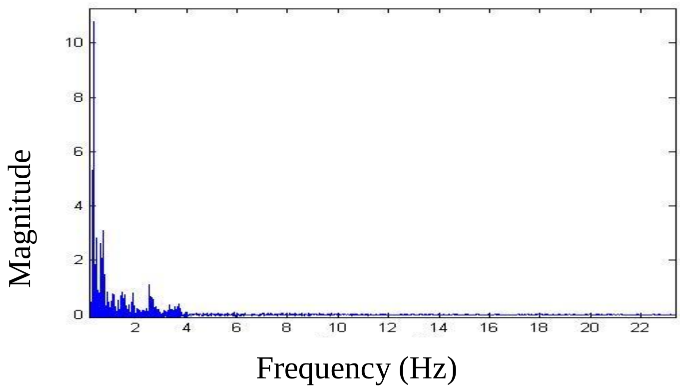
4.3.2 Fast Fourier Transform (FFT) Analysis



(a)



(b)



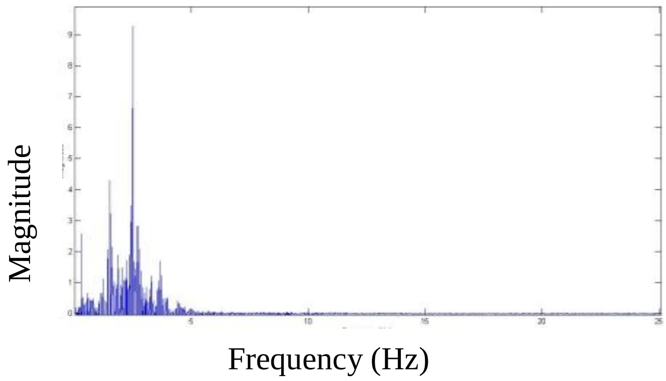
(c)

Figure 4.13: (a), (b), and **(c)** shows FFT on Point 1 at non-defect welding joint.

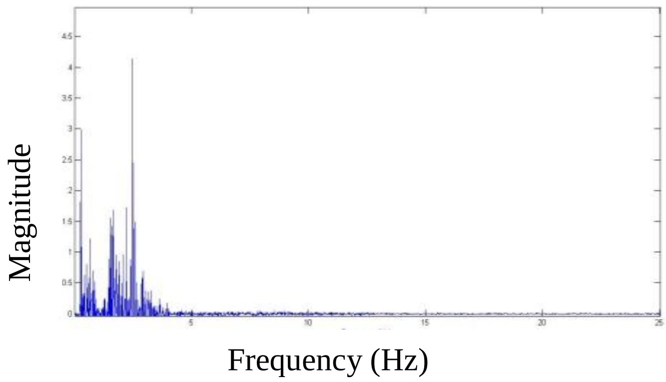
Table 4.1: Dominant frequency at Point 1 non-defect welding joint

Hit	Dominant Frequency	Amplitude
(a)	0.28 Hz	9.98 mV
(b)	0.27 Hz	4.82 mV
(c)	0.29 Hz	10.76 mV

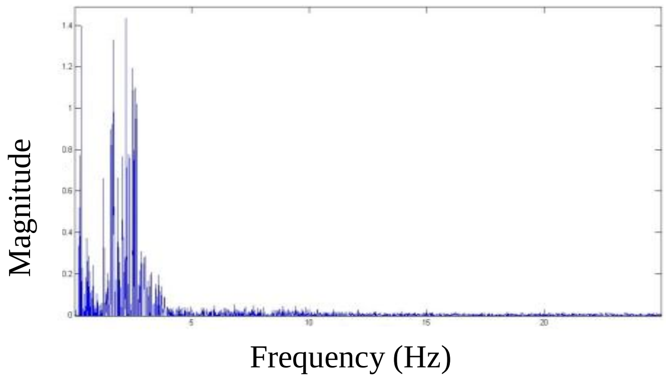
The signal pattern shows that at Point 1 on non-defect welding joint almost the same but different value in amplitude. The range dominant frequency at this point is 0.27 Hz-0.29 Hz. The amplitude of dominant frequency show that variable value due to the magnitude of source hit. Some hit that accumulate by data acquisition of AE show the existence of noise disturbance that is hard to analyze and to obtain the signal pattern.



(a)



(b)



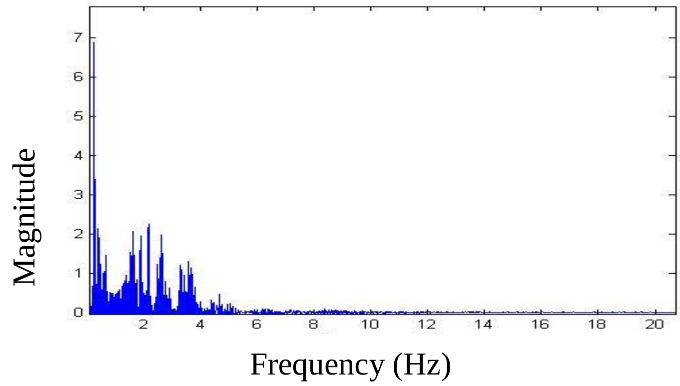
(c)

Figure 4.14: (a), (b), and **(c)** show FFT at Point 1 on defect welding joint.

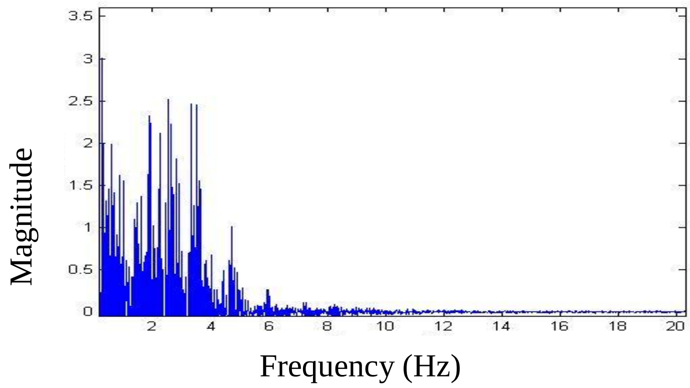
Table 4.2: Dominant frequency at Point 1 defect welding joint

Hit	Dominant Frequency	Amplitude
(a)	2.51 Hz	9.26 mV
(b)	2.49 Hz	4.13 mV
(c)	2.21 Hz	1.43 mV

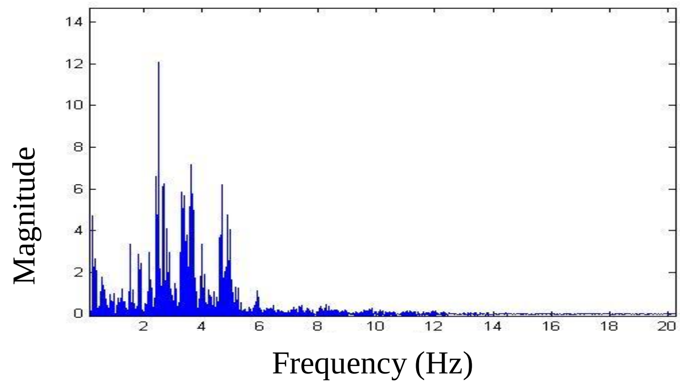
As been compared between non-defect and defect welding joint on FFT, show that the signal pattern on defect welding joint has higher range of dominant frequency. The range of dominant frequency is 2.21 Hz-2.51 Hz. The amplitude value at this point also show variable value due to source of hit magnitude. There also has some disturbance noise occur hence the signal was selected by burst signal to analyze.



(a)



(b)



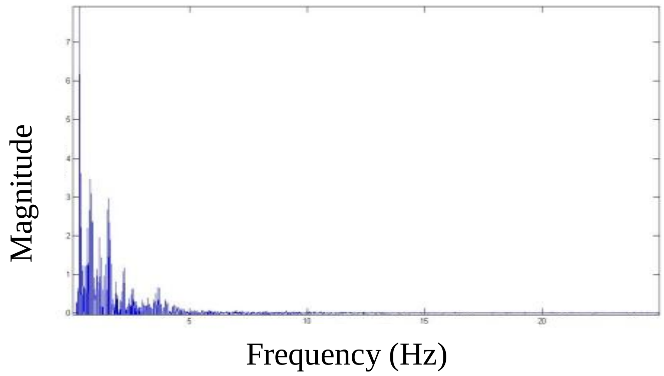
(c)

Figure 4.14: (a), (b), and **(c)** show FFT at Point 2 on non-defect welding joint.

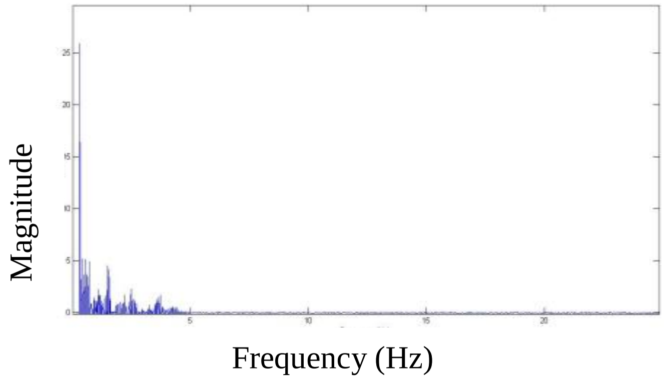
Table 4.3: Dominant frequency at Point 2 non-defect welding joint

Hit	Dominant Frequency	Amplitude
(a)	0.27 Hz	6.90 mV
(b)	0.28 Hz	3.10 mV
(c)	2.52 Hz	12.1 mV

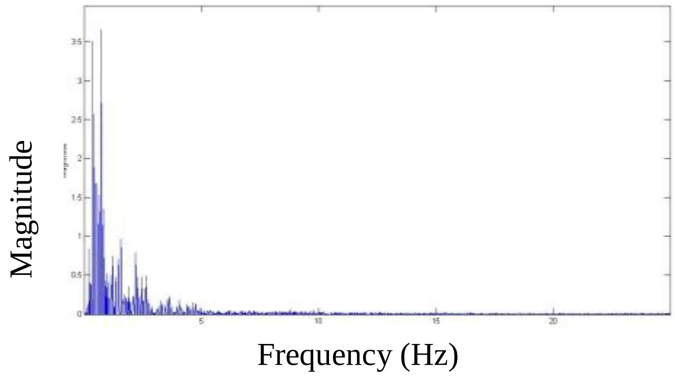
At this point, the signal pattern shows outrange and at this point on non-defect welding there only 4 hit that accumulate by data acquisition AE. For (a) and (b) the dominant frequency is 0.27 Hz and 2.52 Hz. But for (c) the dominant frequency is outranged compare the dominant frequency range of non-defect welding joint. This shows that the disturbance noise occur during the test.



(a)



(b)



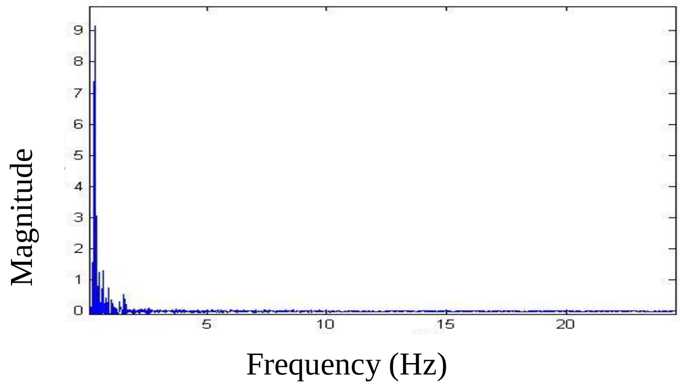
(c)

Figure 4.15: (a), (b), and **(c)** show FFT at Point 2 defect welding joint.

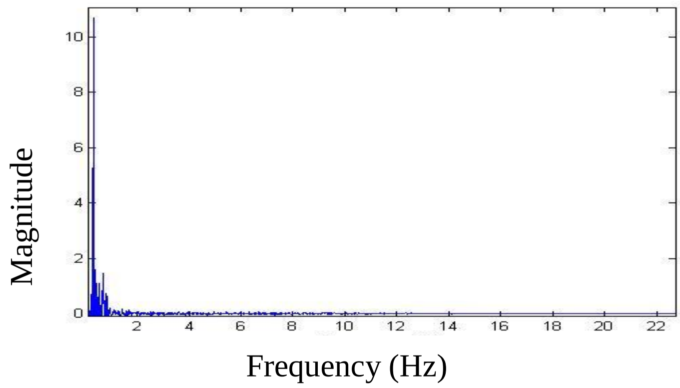
Table 4.4: Dominant frequency at Point 2 defect welding joint

Hit	Dominant frequency	Amplitude
(a)	0.32 Hz	7.89 mV
(b)	0.32 Hz	25.90 mV
(c)	0.74 Hz	3.66 mV

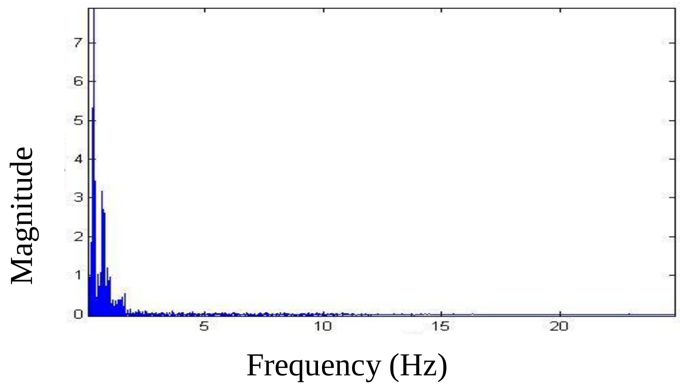
At this point, the dominant frequency range is a little bit higher compare to non-defect welding joint. The dominant frequency range at this point is 0.32 Hz-0.74 Hz. By this signal pattern can show us that the crack activity or the propagation of the crack due to load applied is low at this point.



(a)



(b)



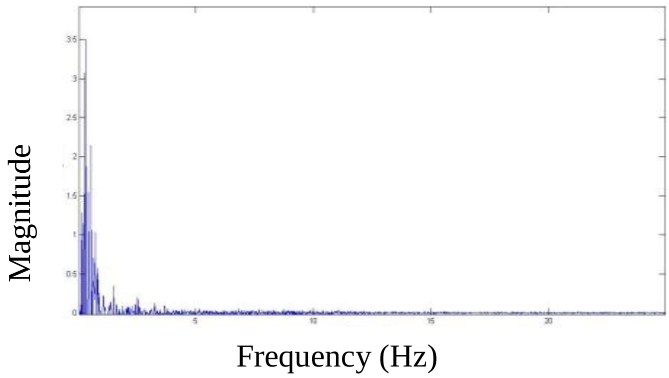
(c)

Figure 4.16: (a), (b), and **(c)** show FFT at Point 3 non-defect welding joint

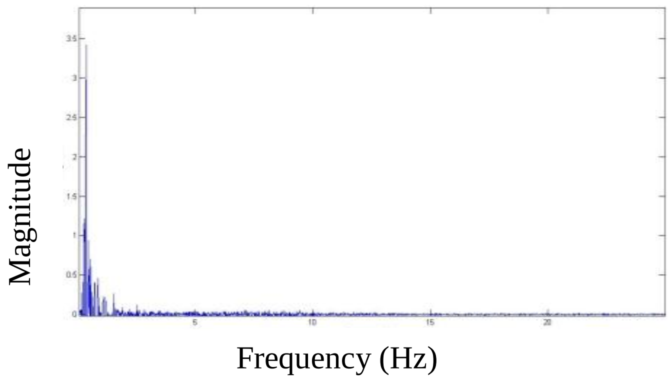
Table 4.5: Dominant frequency at Point 3 non-defect welding joint

Hit	Dominant frequency	Amplitude
(a)	0.31 Hz	9.15 mV
(b)	0.32 Hz	10.7 mV
(c)	0.32 Hz	7.89 mV

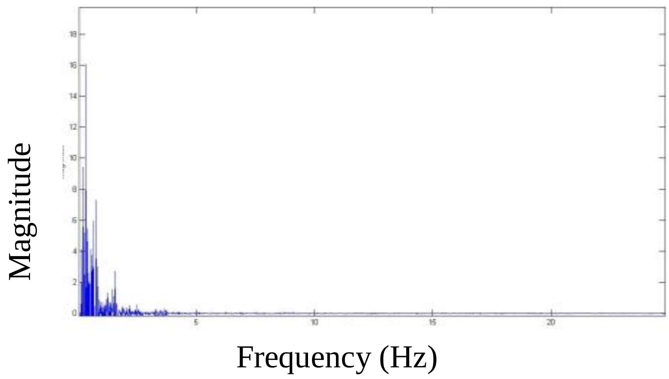
At this point, the signal pattern easily recognized due to the dominant frequency range a little bit low and same as signal pattern at Point 1. The dominant frequency range at this point is 0.31 Hz- 0.32 Hz. The cracks occur at this point much less than others point on the same non-defect welding joint.



(a)



(b)



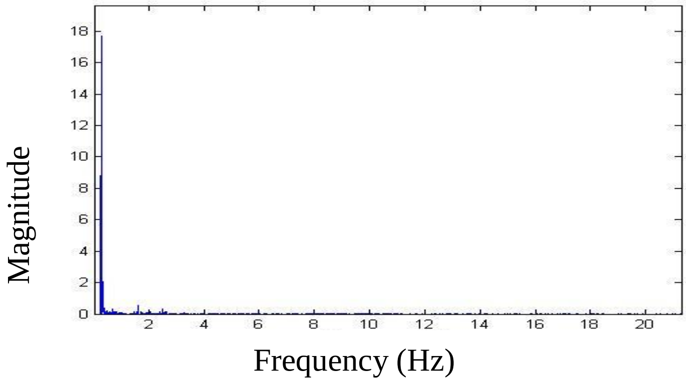
(c)

Figure 4.18: (a), (b), and **(c)** show FFT at Point 3 defect welding joint

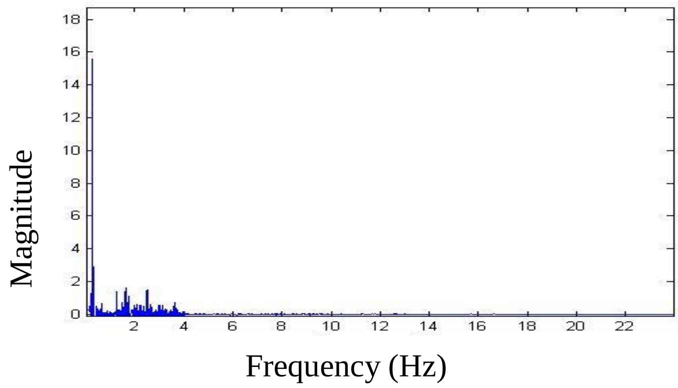
Table 4.6: Dominant frequency at Point 3 defect welding joint

Hit	Dominant frequency	Amplitude
(a)	0.34 Hz	3.50 mV
(b)	0.36 Hz	3.42 mV
(c)	0.34 HZ	16.05 mV

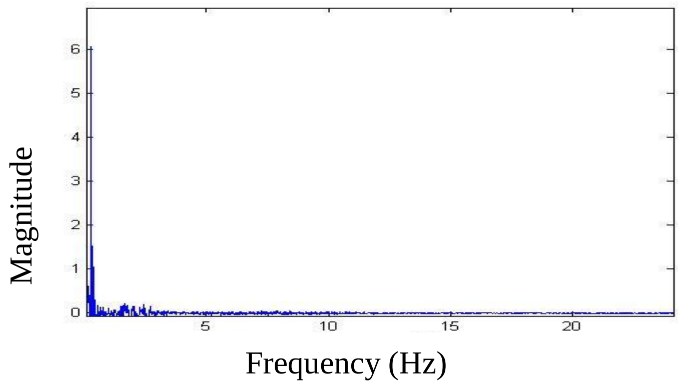
From the signal pattern can assume that at this point the propagation of the crack is equivalence to the signal pattern on non-defect welding joint. The dominant frequency range at this point is 0.34 Hz-0.36 Hz. The range is little bit low and this show that the minor activity of the crack propagation during the test run. This also show that at this point the crack is less than others point on defect welding joint.



(a)



(b)



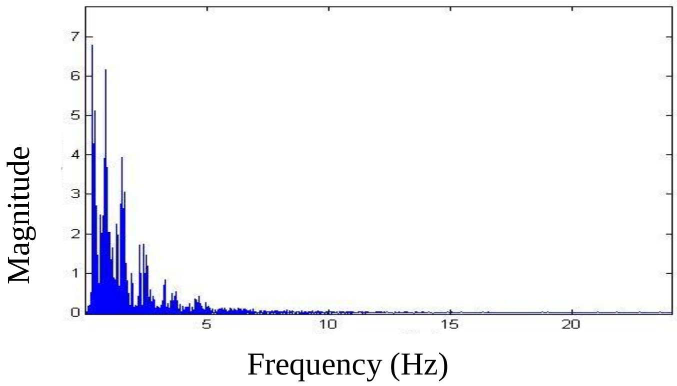
(c)

Figure 4.19: (a), (b), and **(c)** show FFT at Point 4 on non-defect welding joint

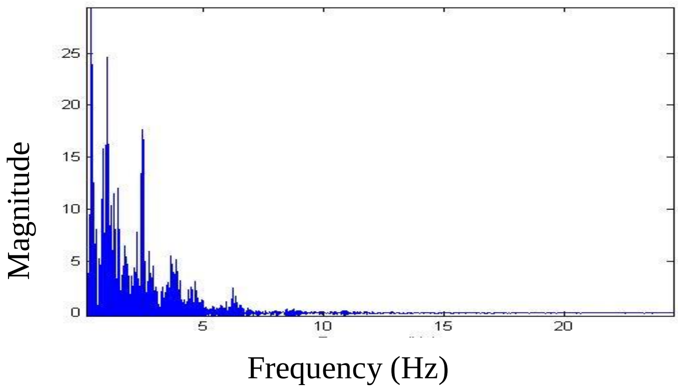
Table 4.7: Dominant frequency at Point 4 non-defect welding joint

Hit	Dominant frequency	Amplitude
(a)	0.28 Hz	17.71 mV
(b)	0.29 Hz	15.59 mV
(c)	0.29 Hz	6.01 mV

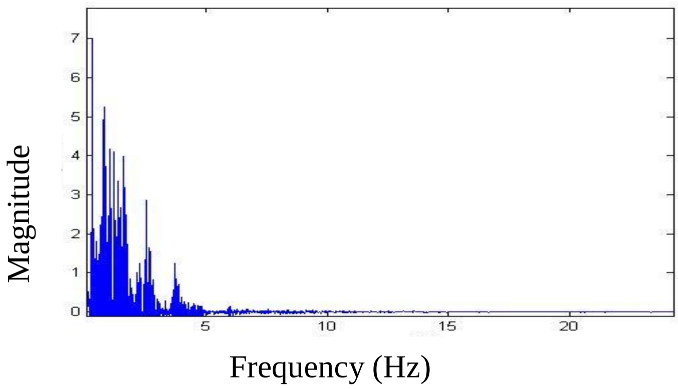
As show on Figure 4.19, the signal pattern not burst to analyze but the dominant frequency range is little bit low compare to others point on non-defect welding joint which is 0.28 Hz-0.29 Hz. The amplitude on dominant frequency is variable one to another. The dominant frequency on this welding show that at this point there are much less cracks appear based on the signal pattern.



(a)



(b)



(c)

Figure 4.20: (a), (b), and **(c)** show FFT at Point 4 on defect welding joint.

Table 4.8: Dominant frequency at Point 4 defect welding joint

Hit	Dominant frequency	Amplitude
(a)	0.30 Hz	6.79 mV
(b)	0.34 Hz	29.85 mV
(c)	0.29 Hz	6.98 mV

The signal pattern on Figure 4.20 shows that it is easily recognized by dominant frequency shows. The dominant frequency range is 0.29 Hz-0.34 Hz. The burst signal pattern show easily to analyze. At this point the hit on (b) show the highest dominant frequency at this point which is 0.34 Hz and also higher amplitude which is 29.85 mV at this point.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

This study has proved that acoustic emission (AE) technique can be used to identify the characteristics of AE parameter of welding joints on less no. of defect and defect welding material welding joint. This technique can offer lower cost and time consuming for a simple welding joint.

For this study, AE signal easily analyze the crack that propagate from the loading applied to the welding joint. From the Chapter 4 have discus about the signal characteristic on each point the sensor located. As predicted, the signal based parameter from the defect welding joint has higher value compare the non- defect welding joint. There also have some disturbance signal from unwanted noise appear on the signal.

For the parameter of amplitude or peak amplitude, it can conclude that the defect welding joint has higher value compare to non-defect welding joint. The amplitude or peak amplitude will excite much higher if there has more fracture or crack on the welding joint after loading is applied.

As mention in previous chapter, emission count reacts to the fracture and if there is fewer cracks or fracture in the welding joint, then less emission count appear on the signal. Hence, it can be conclude that the defect welding joint maybe will produce many emission counts.

For Fast Fourier Transform (FFT) analysis can conclude that there have a different signal pattern for non-defect and defect welding joint. For defect welding joint there is higher range of dominant frequency compare to non-defect welding joint. The burst signal can show the different between the defect and non-defect signal pattern.

For overall conclusion, as mention above all the signal shows higher value in their term of signal characteristics on the defects welding joints. It can conclude that the defect welding joints will catch a higher signal characteristic of AE.

5.2 RECOMMENDATION

There is some recommendation and all of these suggestions are important to ensure better result will be obtained from the experiment:

To get better result should use more point of sensor location near the welding joint. Since the MIG welding produces less crack than others type of welding, the other method of welding should be consider such as arc welding. To identify the type of crack produce, should consider use UT method and to identify the type of crack each location use the localization method.

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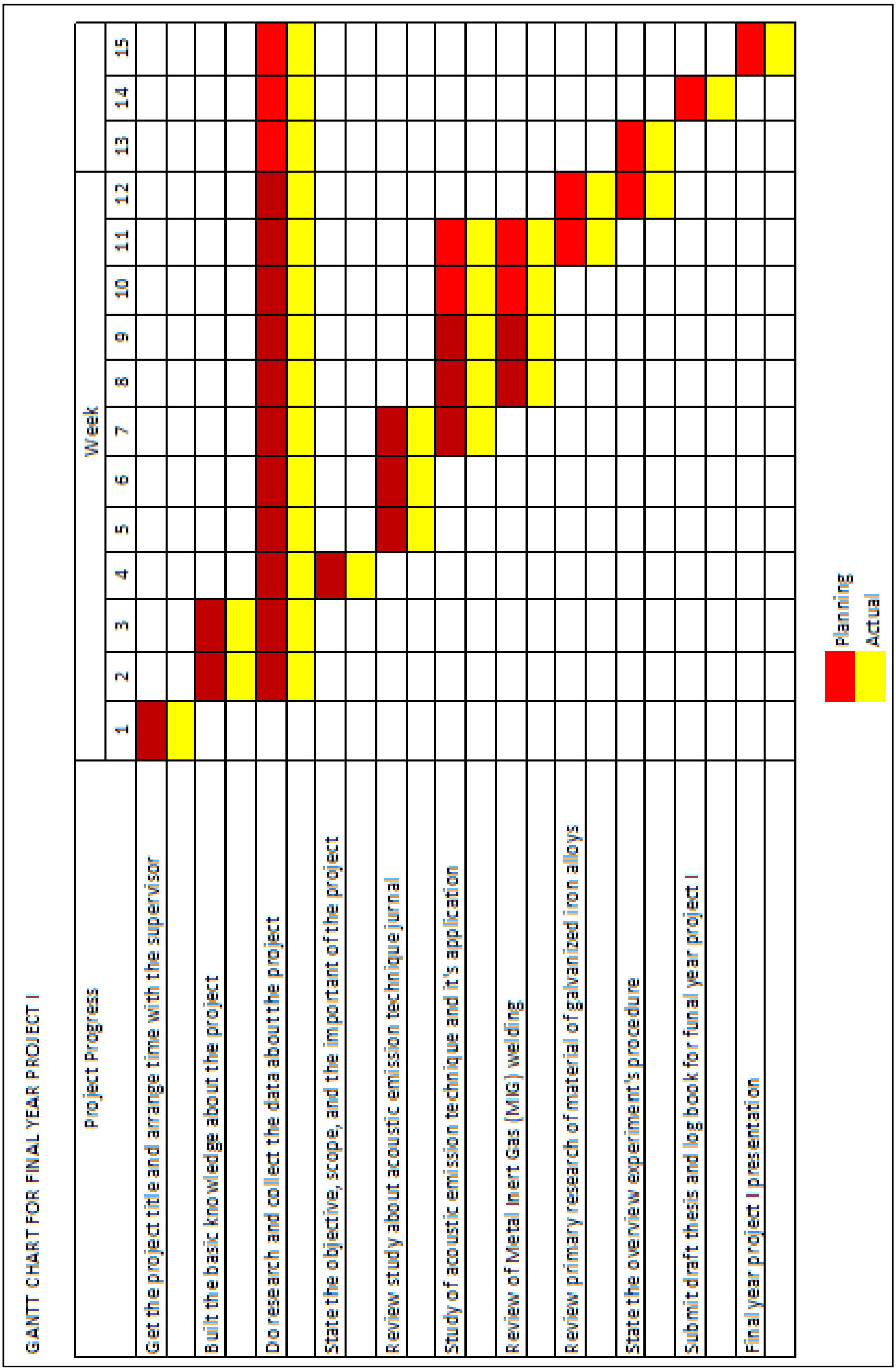
APPENDIX A

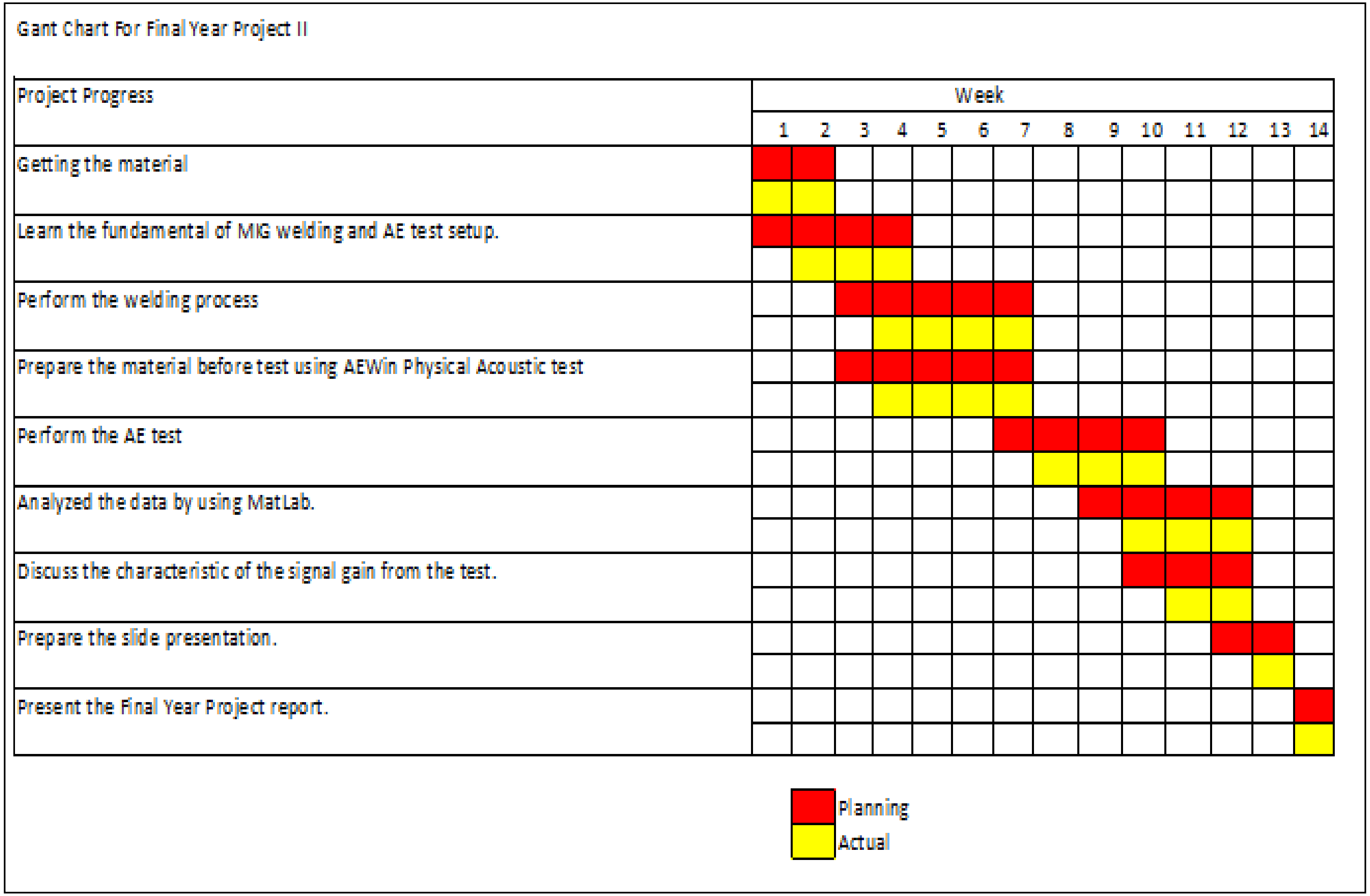
M-file

```
load Test1_1_1.txt;

x=Test1_1_1;
%HFdata=sigHF0;
a0=fft(Test1_1_1);

b0=length(a0)/2;
power0=a0(1:b0);
nyq=1/2;
freq=50*(1:b0)/b0*nyq;

plot(freq,power0,'b');
%set(gcf,'color','white');
xlabel('Frequency (Hz)');
ylabel('Magnitude')
```

APPENDIX B

Gantt chart




Gant Chart For Final Year Project II
Project Progress
Week
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Getting the material
Learn the fundamental of MIG welding and AE test setup.
Perform the welding process
Prepare the material before test using AEWin Physical Acoustic test
Perform the AE test
Analyzed the data by using MatLab.
Discuss the characteristic of the signal gain from the test.
Prepare the slide presentation.
Present the Final Year Project report.
Planning
Actual