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Swaying Phenomenon of Express Railway Train in Malaysia

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ABSTRACT – Currently, only one type of train in Malaysia operated for express transport, which is the Express Rail Link (ERL). Due to high speed operation, 145 km/h, the trains suffers from swaying phenomenon and ride comfort lessening. This paper discusses the swaying phenomenon at several locations of the track. The dynamic performance of the train is also studied.

1. INTRODUCTION

Currently, only one type of train runs at high speed operation in Malaysia which is the express rail link (ERL) train. The train is operated at average speed of 145 km/h at a roughly 57 km track from Kuala Lumpur Sentral (KLS) station to Kuala Lumpur International Airport (KLIA) station (Figure 1). In between these stations, there are another three transit stations, Bandar Tasik Selatan (BTS), Putrajaya Sentral (PTJ) and Salak Tinggi Station (STS). The train operated non-stop from KLS to KLIA and vice versa.

Due to high speed operation, the train suffers from swaying phenomenon [1][2]. This phenomenon affects the ride comfort of the passengers and deteriorating the quality service of the company. The significant swaying effect can be observed at several locations throughout the track. This paper discusses the swaying analysis of the high speed train on actual field. The dynamic performance of the train is also studied for future improvement and ride comfort enhancement.

2. METHODOLOGY

The swaying data is recorded from the actual operational train bounding from KLS station to the KLIA station (Figure 1). The exact locations to monitor swaying are labelled as point A at kilometre 26.5 (Km 26.5), B (Km 33), C (Km 36), D (Km 37.7), E (Km 40.7), F (Km 49) and G (Km 52.5). A standard Lego Mindstorms EV3 data logging device with accelerometer & gyro sensor (Figure 2) are used to measure and record the lateral vibration and yaw motion [3][4] together with portable navigation device to record the latitude, longitude, speed and distance travel of the train. The data logging device is located at the rear driver cab of the train (Figure 3) where the forward direction of the train is on the longitudinal x axis. The orientation of the sensors shows the positive values of the data.

Figure 1 High speed train map from KLS to KLIA

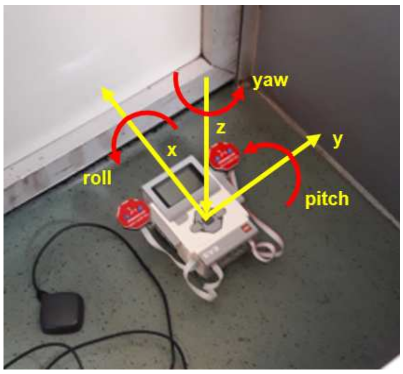

Figure 2 Orientation of the sensor on the train floor

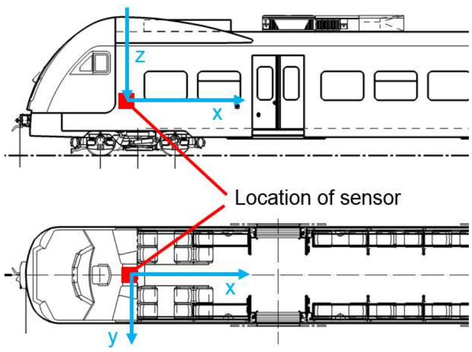

Figure 3 Location of sensor

3. RESULTS AND DISCUSSION

The obvious train dynamics that produce swaying are lateral vibration and yaw moment of the train [5]. Figure 4 and 5 show the lateral vibration and yaw moment of the train respectively. From Figure 4, it can be seen that the speed of the train at the specific locations (A to G) is at the maximum. High lateral vibrations are observed at locations B and E as shown by Table 1. From Figure 5, most of the locations with continuous yaw are at A, C and F. The continuous yaw value shows that the train continuously having swaying effect.

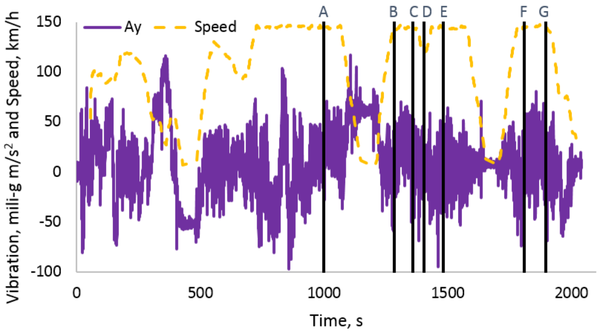

Figure 4 Train lateral vibration

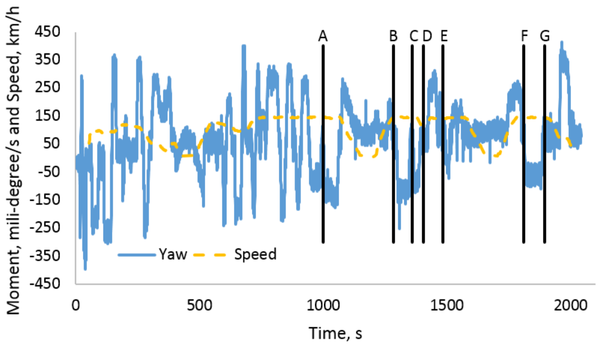

Figure 5 Yaw motion of the train

4. CONCLUSION

The swaying phenomenon of the high speed train is due to lateral vibration and yaw moment of the train. The higher the value of lateral vibration and yaw moment, the higher the swaying effect. Comparing those two dynamic effects, the most ride comfort influential is yaw moment which are at location A, C and F. This swaying data can be used for future improvement in term of rail track work as well as train damping systems.

Table 1 Specific results at the location

Location	Ay, mili-g m/s^2	Yaw, mili-deg/s	Speed, km/h
A	-7	67	144.86
B	-30	52	145.33
C	-12	76	145.76
D	-2	72	120.42
E	24	88	143.96
F	-17	50	144.90
G	19	85	145.44

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