6th Asia Pacific Workshop on Structural Health Monitoring, 6th APWSHM

Rail Infrastructure in Port City – Surabaya, Indonesia

Ravi Ravitharan^a, Andrew LaBrooy^a, Hera Widyastutib, Wing Kong Chiua*^* 

^aDepartment of Mechanical Engineering, Monash University, Wellington Rd, Clayton 3800, Australia  
^bCentre Study of Transportation and Logistics, Institut Teknologi Sepuluh Nopember, Jl. Arief Rahman Hakim, Surabaya 60111, Republic of Indonesia

Abstract

1. The aim of this paper is to report on a preliminary study to identify the critical issues in rail infrastructure and assist with the establishment of a firm basis for a large project which will address the asset life extension of the rail infrastructure and the improvement of safety and efficiency of rail transportation in Indonesia. The work is an integral part of a collaborative program within the Infrastructure Research Cluster funded by the Australia-Indonesia Centre (AIC).

© 2016 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Peer-review under responsibility of the organizing committee of the 6th APWSHM

Keywords:

1. Introduction

Rail transportation is an integral part of the logistical network to connect a sea-port to the rest of the city. Rail is often seen as an efficient means of moving freight. The focus of this paper is to present the objective of a collaborative research program that investigates methodologies for the structural health assessment of the rail asset. The aim is to explore continual assessment methodology to assist with asset life assessment, determination of the safe speed and load limits, and the re-activation and management of dormant rail asset.

Tracks are “continuous” linear assets that are distributed over a region [1]. They comprise several components including rails, sleepers, rail clips, ballast and sub-ballast. The maintenance of these assets is expensive given that this asset is expected to cover a large area.

* Corresponding author. 
E-mail address: wing.kong.chiu@monash
A well maintained ballast is crucial for the safe operation of trains [2]. Similarly, the operating conditions of rail tracks cannot be over-emphasized. This has led to the development of on-board monitoring strategies [3-6]. These works lead to a very real practical solution for the monitoring of these continuous structures because they offer the potential of mounting monitoring equipment on board an operating vehicle or wagon [7-8]. The ability to relate the dynamics of the rail vehicle as it travels along a given length of track can facilitate the development of monitoring tools to assess track geometric irregularities [8-9] and the ballast conditions [10-11].

The stability of a rail vehicle when traversing along a track is dependent on the state of the rolling stock, the rail track and the ballast (subgrade). Information about the dynamic response of the rail vehicle can be used to determine the state of the vehicle/rail interaction. This information can be used to establish the wagon speed limits to ensure safe operation of the asset [12-13].

The aim of this project is to outline a framework of collaboration to highlight the importance of the concept of structured health condition monitoring regime including instrumented rail vehicle for systematic identification of maintenance program in Indonesia. It is envisaged that this program of work will be crucial for the future development of the network of rail and road infrastructures. The knowledge base developed can also be extended for the re-activation of rail assets in Indonesia. The objectives of the project include:

1. To identify critical issues that need to be addressed in relation to the rail infrastructure to operate the rollingstock in safe and efficient manner.
2. To outline and prioritize research projects that are essential to address the identified issues.
3. Collaboration between the Indonesian and Australian partners to jointly develop research project and approaches to address common critical issues in the passenger rail network.

2. Solving real world problem

In March 2015 two staff from the Institute of Railway Technology (IRT) at Monash University, conducted a site visit in Surabaya. This marks the initiation of the AIC funded collaborative project between Monash University and the Intitut Teknologi Sepuluh Nopember (ITS) in Surabaya. This collaborative project involves Indonesian state-owned entities that included:

1. East Java Province Department of Transportation (Dinas Perhubungan),
2. The Indonesian Rail (PT KAI) and
3. The Planning and Development team at the recently commissioned port Teluk Lamong (PT Teluk Lemong).

These visits provided opportunities to get an overview of the future plans related to the infrastructure in Surabaya and the challenges faced. The cascading effect that transport efficiency and effectiveness has on the economy of any country is self-evident. Indonesia is not immune to it. As Surabaya is the economic centre of the East Java Province, the effectiveness of its transport infrastructure is crucial to maintaining economic growth. This in turn has a strong flow-on effect on socio-economic situation within the city, the province and the nation in general. Central to this discussion was the new port at Teluk Lamong.

2.1 Port of Surabaya

As shown in Figure 1, the city of Surabaya is serviced by a number of ports, the largest is known as Tanjung Perak. This port is currently operating beyond its designed capacity. Additionally, the infrastructure connecting this port city via a network of road and rail of East Java is also operating beyond its designed capacity. Therefore, getting freight through this port is a slow and expensive exercise. This bottleneck is having a significant negative impact on economic growth within the region.

To cater for the project increased in demand and expected operating capacity, a new large container port is being constructed at Teluk Lamong. This port is being constructed in five phases over the next fifteen years. Currently phase one has been completed which allows for a small volume of domestic and international freight to be handled. Future development will see the port grow in capacity, connected by dedicated road, rail and mono-rail links. The main rail link to the port will be via the currently inactive Indro Line which runs north to Gresik from Kandangan Station.
2.2 Railway track infrastructure

Figure 2 shows the Kandangan Station which is located to the north-west of Surabaya. Kandangan was chosen as a good site for the inspection as it features a mix of newer, older and deactivated rail infrastructure. The station currently provides passenger services (see Figure 2), but previously was a terminal for livestock transport.
There are three main-line tracks, two of which constitute the double-track Jakarta to Surabaya route (refer Figure 3). The original line was re-railed as part of the infrastructure improvement project in the mid-1980s. The line was duplicated in recent years, doubling its capacity. The original line was not re-railed at that time and still features its original rail. The third main-line, referred to as the ‘Indro line’ originally ran as far as Gresik but now terminates at Indro. It has been inactive since 2010 when it was closed due to a lack of demand. Formerly its primary use was freight transport, mainly cement and petrochemicals.

2.3 Connectivity from port to city

The newly developed and highly efficient terminal at Teluk Lamong will need to be supported by a network of roads and rail infrastructure to allow the efficiency to flow out of the port. Upon completion Terminal Teluk Lamong will be a world class port, amongst the largest of the 16 present and planned ports in the Greater Surabaya area [14]. The port was designed from the outset to be efficient, environmentally friendly and technologically advanced. It will accommodate the import and export of container freight, general cargo and bulk freight from both domestic and international destinations. The port will be built in five phases spread over twenty years. Currently phase one of the project has been completed (refer to Figure 4). It is constructed on reclaimed land, extending four kilometres out into Lamong Bay. The initial wharf, container yard and dry bulk areas have been commissioned and are currently operational.
Presently the only method for moving freight on the land side is via an already congested, undivided road which passes through heavily populated areas (see Figure 4). This road presents a significant bottleneck which must be overcome before the port can operate at maximum efficiency. It is envisaged that the improvement in connectivity between the port and the city can only be achieved with a combination of road and rail network.

The role of rail network to achieve this improvement on the connectivity can be achieved by building new rail infrastructures, using existing infrastructures as well as re-activating unused rail infrastructures. When using existing and re-activating unused infrastructures, one will need to establish the maximum allowable tonnage and the speed limit on the railway network. The tonnage is dependent on the rail infrastructure, the rollingstock, the maintenance and monitoring regimes put in practice by Indonesian Rail (PT KAI). In this respect, continual data access of the performance of the rail asset is essential and this can be achieved with in-situ structural health monitoring concepts. In this respect, we are looking at using instrumented revenue vehicle to acquire data that will facilitate the determination of the state of the rail asset, in determining the load limits and the speed of the rolling stock.

It is important to note that the use of instrumented revenue vehicle for condition assessment should not be restricted existing rail infrastructure. This form of condition assessment is ideal for the “future-proofing” of new rail infrastructure. The capability deliverable from this new monitoring strategy will be useful in determining the safe operation of infrastructure to deliver increased tonnage not just for today, but for the future as well. These infrastructure connections are currently in the planning phase and decisions will be made in the near future to further their development.

3. The way forward

During the above field visit several potential research project was identified related to railway within the infrastructure cluster. The most important and relevant research project was to use instrumented revenue vehicle (i.e. instrumentation of normal vehicle utilised for revenue service) to autonomously monitor the condition of the track entire track infrastructure and provide timely reports to improve safety of the passengers, crews and goods. This would also assist to understand the asset maintenance issues, maintenance planning as well as assess the capacity of the infrastructure. The methodology should be extended to determine:

- Effective method for economic evaluation of deactivated railway infrastructure
Low-cost methods for evaluating inactive infrastructure.
If replacement required, could include recommendations for rail grades, sub track etc.
Development of flood resistant light-rail infrastructure

4. Conclusion

The Port at Teluk Lamong is central to the future economic growth of the region. However, the infrastructure connections to the port are crucial for future development in this port precinct. It has been recognized that the capacity of the rail infrastructure would be the key to enhance the connectivity for the port. Any development of rail infrastructure should consider the use of instrumented revenue vehicle for condition assessment. It should be noted that this must not be restricted existing rail infrastructure. This form of condition assessment is ideal for the “future-proofing” of new rail infrastructure. The capability deliverable from this new monitoring strategy will be useful in determining the safe operation of infrastructure to deliver increased tonnage not just for today, but for the future as well. These infrastructure connections are currently in the planning phase and decisions will be made in the near future to further their development.

Whilst the above focuses mainly on freight transportation, passenger services also should be considered since road traffic is a major issue within Indonesia and rail will be considered as a preferred mode of transportation to overcome congestion. It will be beneficial to cover practical aspects related to rail infrastructure projects, including planning, designing and maintenance to implement current state of the art practices.

The Infrastructure Cluster (Australia Indonesia Centre) activity within rail transportation should include continuous assessment of the rail infrastructure to determine its condition and the capacity to operate mixed traffic. This will minimise risk of the railway operation and increase asset life of the railway infrastructure. Most importantly, it will improve safety of the passengers and freight.

Acknowledgements

Funding from the AIC Small Project Grant is gratefully acknowledged.

References
