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EVALUATION OF BRIDGE STRUCTURES USING ASSET SURVEY TECHNOLOGY TO BE USED AS MONITORING DATA (CASE STUDY: KAMOJANG HILL BRIDGE)

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Abstract

In the Bridge Management System (BMS92), monitoring is required to obtain information on the detection of early damage before the occurrence of more severe damage. Monitoring data requires a complete, accurate, and validated bridge structure evaluation data in the field. This study was conducted to evaluate the existing structure of the bridge using asset Survey technology (spesifically technology of Terrestrial Laser Scanning and aerial photogrammetry by UAV/Drone) to meet the needs of monitoring the factual condition of the bridge. This study was conducted in 4 stages, namely: preparation, 3d laser scanning onsite, 3d and 2d modeling, and data collection to evaluate the bridge structure. Method to evaluate the bridge structure by comparing the modeling data and existing data available (shop drawing). The monitoring are categorized into 4, namely: dimensions of the bridge elements, physical damage of the bridge elements, position changes of the bridge elements (deformation), and geometrical of the bridge. This study shows that (1) in some elements of the bridge there is mismatchs between dimensions of actual bridge with the dimensions in the shop drawing (2) There are three , physical damage of the elements (puddles in the connection that can lead to the corrotion, 80% of the bolts on the tied rod are rusty, and there are fragments of concrete on the abutment), (3) some elements/profiles are deformed even some elements/profiles exceed the deformation permit, and (4) the geometry of the bridge has a coordinate correction value with shop drawing.

Keywords: Asset Survey Technology, Terrestrial Laser Scanning, Drone and Bridge Monitoring

Introduction

Around the world, investment in road, bridge and tunnel networks is a vulnerable and costly part of infrastructure per kilometre. Bridges play a key role in the backbone of the economy but are often overlooked. If the bridge collapses the entire system will be paralyzed, because the bridge is a controller of the volume and weight of traffic that can be served by the transportation system (Figueiredo et al., 2013; Supriyadi & Muntohar, 2007).

Bridge Management Information System is a system that regulates several components of bridge management, these components are, the bridge inspection system, Bridge data Management System and bridge handling system as a guide in decision-making for planning and programming (Putra Pratama et al., 2015; Subagio et al., 2008).

The system used in the maintenance of bridge conditions in Indonesia is the bridge management system (BMS92). With this BMS92, the condition of the bridge can be monitored to detect early damage before the occurrence of more severe damage and determined the necessary actions to ensure that the bridge is in a safe and serviceable state, using optimal funds for bridge maintenance work. This monitoring requires complete, accurate, and valid evaluation data of the bridge structure in the field (Direktorat Jendral Bina Marga, 1993, 2011; Rahmat et al., 2019; Saputra, 2019).

The system developed in the 1990s is very old and has never been updated to meet the development of progress and the field of Information Technology and the advancement of bridge structure technology, one of the systems that need to be updated is the damage data collection system collected based on visual observations of bridge inspectors who have a high level of subjectivity (Herry et al., 2017).

The data available in many Bridge Management Systems (BMS) does not meet the standard of information needed for subsequent bridge repair, retrofit and rebuild work (Sacks et al., 2018). While, bridge maintenance needs high accuracy of the graphic information that has structural related information. This means that the model must be rich in information that can be verified in the field for the condition of the bridge (Shim et al., 2019).

Various advanced remote sensing technologies are used to rapidly and accurately capture the state of a bridge. But the direct measurement in the field using Total Station, Theodolite and Waterpass still have many shortcomings, that is, the acquisition time in the field is quite long, requires a lot of personnel in the field, the accuracy of the data is not good because the points obtained are few, the data obtained is not in 3D. The spatial Data obtained from this conventional method has the potential to contain errors that can lead to errors in the technical analysis of roads and bridges (Sacks et al., 2018; Samsul Rijalul Hadi, 2020).

The mapping technology is rapidly progressive, which is characterized by the emergence of various types of technology to facilitate work. Even some types of technology can be used for various fields of work, one of which is called *Asset Survey Technology* which able to record the actual geometrical shape of an object and can produce structural-related information that can be verified in the field for the condition of the bridge. The data is generated in the form of 3D models and 2D models, so that it can have a model similar to the original object digitally (twin model).

Asset Survey technology consists of several technologies used, namely: (1) *Terrestrial Laser Scanning* (TLS) and (2) *Aerial Photogrammetry by UAV / drone.*

Literature Review

Terrestrial Laser Scanning (TLS)

TLS is one type of laser scanning that uses high technology and digital capabilities to record data that includes 3D mapping surveys to obtain spatial information data that can provide very high accuracy data in two-dimensional (2D) and three-dimensional (3D) formats. TLS is a relatively new surveying instrument and is increasingly used in a variety of engineering applications for as-built data needs including land surveys, archaeological studies, architecture, bridge structures, and Highway surveys. TLS can be applied to measuring bridge load tests and detecting displacement caused by different ambient temperatures (Brahmantara, 2016; Hendriatiningsih et al., 2014; Rahmawati et al., 2021; Rizkiana Wirnajaya et al., 2019; Setiawan, 2018; Siburian et al., 2017; Zaky Mudzakir et al., 2017).

Bridge surveys represented some of the first successful transportation applications of high-definition surveying years ago. Today, the technology is used as an almost de facto standard in many areas. Inaccessibility to parts of the bridge, the ability to capture surfaces without lane closures, and the trustworthiness of the data for areas that are hard to reach are advantages. Overall, the cost of doing a bridge survey with suitable scanning solutions is often less than half of the cost of doing these surveys conventionally (Jacobs, 2005a).

TLS is a type of acquisition of topographic objects in the area around the instrument which is placed in a fixed position. This instrument works by measuring the distance tilt, horizontal angle, and vertical angle of an object simultaneously and automatically. Before the scanning process, generally horizontal and vertical angle changes can be set according to the desired sampling in the polar coordinates system. TLS will emit a laser beam and bounce on the object or objects that scan, at a speed close to 1000,000 (one million) dots/second (depending on the brand and type of the TLS). The data is obtained and collected in the form of points called pointclouds, where each point has XYZ coordinates with accuracy +/- 2mm up to 10mm (Duta Basis, 2019; Fauzi & Simanjuntak, 2018; Lucianto et al., 2014; Prasetyo & Bashit, 2018; Sampulu Adijaya, 2020).

Some advantages of Terrestrial Laser Scanners when compared to conventional methods include (WGS Engineering, n.d.):

1. More efficiency in terms of timing, because the acquisition of survey data will be much faster
2. Data quality is more thorough because it has a spatial resolution that is much more detailed than conventional methods
3. Less data ambiguity
4. Higher level of detail and density
5. Way of obtaining or acquisition of data that is more secure because it also uses the principle of the survey with remote sensing/remote sensing (without touching the object of observation)
6. The process of acquisition and receipt of data that do relatively not interfere with industrial processes
7. The results are in the form of a pointcloud that can be used and reviewed by other parties to significantly improve the efficiency of work, especially in the field of engineering

Aerial Photogrammetry / Drone

Drone is a process of taking pictures from the height. Photos or images taken are very useful for both research and artistic photography. By utilizing the technology of camera, UAV, software, mapping work can be done with a relatively fast time and relatively medium accuracy (Balai Sabo, 2022; Duta Basis, 2019; Utomo, 2017; Wijaya et al., 2020).

Photogrammetry technology continues to evolve, both in terms of data collection and processing. It is characterized by the existence of data collection techniques with unmanned aerial vehicles as a vehicle carrying photogrammetry sensors. The advantage of using this technology is effective and efficient both in terms of time and cost for mapping in areas that are not too large. Another advantage can produce clearer photos because a flying height of about 50-200 meters above the ground produces photos with a resolution of 0.5

cm. Currently, photogrammetry software has developed rapidly, initially, photogrammetry data processing is done manually but currently, the data processing can be done automatically, of them by using Agisoft PhotoScan software. This software can identify the pixel between photos, and mosaics and build DSM automatically. Camera calibration and off-camera orientation can also be done automatically (Gularso et al., 2015; Stefano, 2020).

3D object data collection can be done using photogrammetry techniques using aerial photography as the main data source. Aerial photography provides an alternative to providing 3D information that will be used in determining the height value of a topographic object such as a building. The quality of the resulting information is highly dependent on the image quality of the data source (Alnando et al., 2022; Prayogo et al., 2020).

Drones have 4 advantages compared to other technologies, namely (Duta Basis, 2020; frogs, 2021):

1. Image quality and resolution. The quality of images produced using drones will be far better than satellite imagery, or images from manned aircraft.
2. High productivity and low cost.
3. Human risk free and easy operation
4. The drone does not take a long time

Research Methodology

The method used in this study is a quantitative method with direct measurement in Kamojang Bridge or known as Kamojang Hill Bridge is located at coordinates 707'8.10"S, 107046'32.71"E in Kab. Bandung, Indonesia. This study was conducted on May 19, 2022, using asset survey technology (Terrestrial Laser Scanning and drones).

Bridge scanning requires preparation to obtain accurate and optimal data with efficient time, namely by collecting initial information related to span length, bridge width, bridge height, planning a Scanposition for Terrestrial Laser Scanning (TLS), and planning flying missions for drones.

Scanning in the field was use TLS Trimble TX8 with medium-level settings that have a scanning range of 100 meters with a duration of 6 minutes for each scan position. As for drones was use the DJI Phantom 3 type with a height of 100 meters from the ground and an aerial mapping area of 12 Ha.

Upon completing the scanning onsite, the scanning raw data (pointclouds) of all scan position were further processed in office, to merge one another become a single coordinate system.

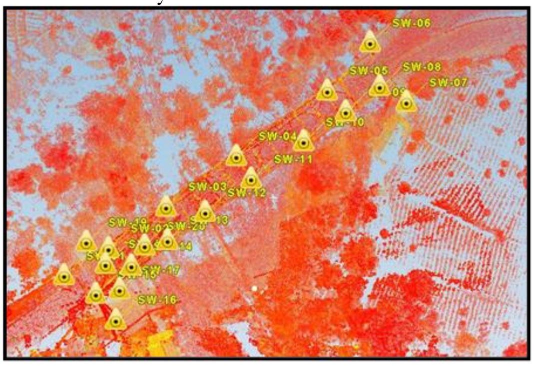

Figure 1. Registration results

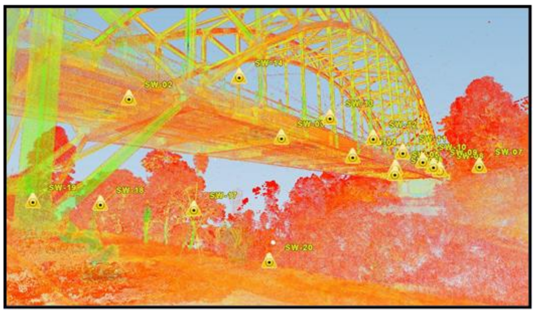

Figure 2. View scanposition 16

Geo-referencing needs to be done because the TLS result data does not yet have a global coordinate value (UTM). This process requires global coordinate data in the form of direct observation in the field (DGPS) or other source such as GPS hanheld or public information from BIG. In this study, the geo-reference process uses data from drones that already have global coordinates.

After the data is processed into one system pointclouds data, visualization modeling of bridge and ground (surface) elements is performed, by converting Pointclouds into 3D solid / mesh/surface objects, to clarify the shape and dimensions of the elements on the bridge. To easily obtain data or information for the needs of evaluating bridge structures.

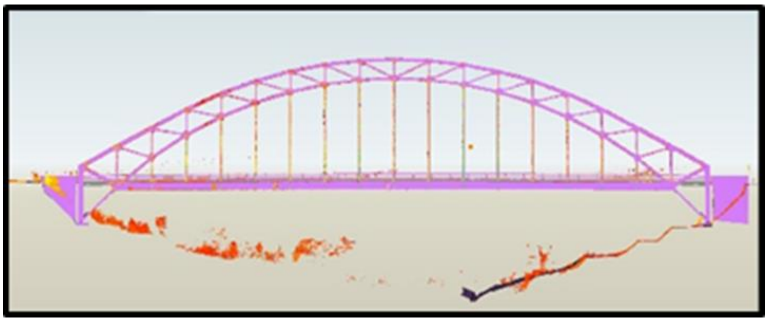

Figure 3. Modeling of bridge elements

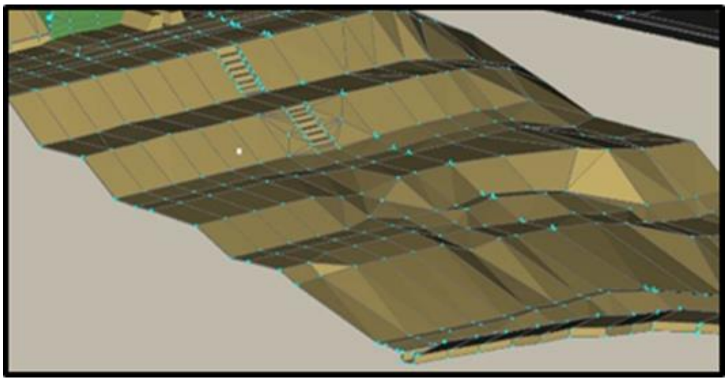

Figure 4. Soil modeling (surface)

The methods to obtain data evaluation of bridge structures is by comparing the modeling data and existing data available (shop drawing).

The results of the structural evaluation are categorized into 4 monitoring data, namely: monitoring dimensions of bridge elements, Monitoring physical damage of bridge elements, Monitoring the position of bridge elements (deformation), and monitoring the geometry of the bridge.

Monitoring Data to assist inspectors in making long-term strategies for bridge operation and management in preventive maintenance. By holding this evaluation data, inspection process can be done in a short time with high data accuracy, inspectors quickly assess the behavior of the structure and provide the basic / temporary conclusion for the decision-making team, with minimize the need of site visit in person, because the data can be presented as complete as possible digitally.

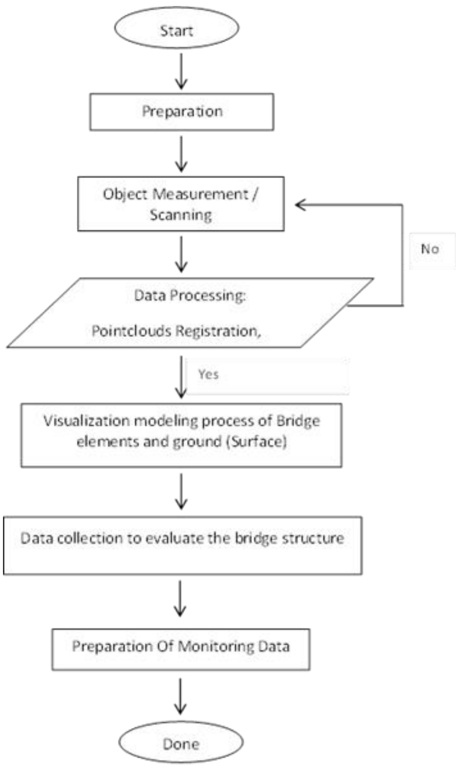

Figure 5. Flow chart

Results and Discussion

Pointcloud data from asset Survey technology will need a specific and expensive software (and extensive training for the operator) to access it. Therefore, pointclouds are better be converted into 3D and 2D modeling that are way easier to understand and can be opened in more general and common software.

In the process of modeling, the shape of the element, the dimensions of the element, the position of the element (deformation, deflection, etc.), the location of the damage, etc. are obtained. The following are the results of the evaluation of bridge structures that have been categorized based on monitoring data.

Monitoring Dimenstions of Bridge Elements

Collection of information on The Shape of elements and dimensions of existing elements in the field obtained from the results of modeling, and collected in the form of tables.

In addition to getting the shape of the material and the existing dimensions in the field are also compared using the profile dimension table in the Kamojang translucent road construction drawing Shop.

Table 1. Profile dimensions of shop drawing

UPPER BAR		ROOTSTOCK	
BA01	H 450 x 600 x 22 x 25	BB01	H 450 x 330 x 10 x 14
BA02	H 450 x 610 x 22 x 25	BB02	H 450 x 430 x 14 x 20
BA03	H 450 x 540 x 22 x 25	BB03	H 450 x 450 x 14 x 25
BA04	H 450 x 540 x 22 x 25	BB04	H 450 x 480 x 14 x 20
BA05	H 450 x 530 x 22 x 25	BB05	H 450 x 470 x 14 x 20
BA06	H 450 x 500 x 22 x 25	BB06	H 450 x 450 x 14 x 20
BA07	H 450 x 480 x 22 x 25	BB07	H 450 x 400 x 14 x 20
BA08	H 450 x 460 x 22 x 25	BB08	H 450 x 360 x 14 x 20
BA09	H 450 x 450 x 22 x 25	BB09	H 450 x 350 x 14 x 20
DIAGONAL BAR		UPRIGHT ROD	
DG01	H 450 x 520 x 14 x 22	TG01	H 450 x 730 x 25 x 30
DG02	H 450 x 240 x 8 x 10	TG02	H 450 x 280 x 10 x 12
DG03	H 450 x 240 x 8 x 10	TG03	H 450 x 200 x 8 x 10
DG04	H 450 x 240 x 8 x 10	TG04	H 450 x 200 x 8 x 10
DG05	H 450 x 240 x 8 x 10	TG05	H 450 x 200 x 8 x 10
DG06	H 450 x 240 x 8 x 10	TG06	H 450 x 200 x 8 x 10
DG07	H 450 x 240 x 8 x 10	TG07	H 450 x 200 x 8 x 10
DG08	H 450 x 240 x 8 x 12	TG08	H 450 x 200 x 8 x 10
DG09	H 450 x 270 x 8 x 12	TG09	H 450 x 200 x 8 x 10
BRACING		CROSS GIRDER	
BRU	H 360 x 360 x 10 x16	CG1	H 1000 x 390 x 14 x 25
BR1	P 273 x 8	CG2	H 1000 x 500 x 14 x 25
BR2	P 273 x 9	CG3	H 700 x 300 x 14 x 27
BR3	P 273 x 6	CG4	H 1000 x 430 x 14 x 28
BR4	P 273 x 9	END JACK	H 1350 x 450 x 22 x 25
BR5	P 273 x 6		
BR6	P 273 x 6	STRINGER	
BR7	P 219 x 6	STR1	H 460 x 150 x 8 x 10
BR8	P 219 x 6	STR2	H 460 x 150 x 8 x 10
BR9	P 219 x 6	STR3	H 470 x 170 x 8 x 10
		STR4	H 250 x 130 x 8 x 10
TIED ROD			
TI	H 1300 x 450 x 25 x 32		
HANGER			
H	2L 120 x 120 x 12		

This information collection is grouped based on naming follows the profile dimension table in Shop Drawing, which is described according to the number of existing elements.

Table 2. Evaluation of dimensions on the left upper bar profile

LEFT UPPER BAR					
CODE		SHOP DRAWING	TEKNOLOGI SURVEY ASET	LENGTH	DESC
BA01	1	H 450 x 600 x 22 x 25	H 450 x 610 x 22 x 25	5557	Do Not Correspond
BA02	1	H 450 x 610 x 22 x 25	H 450 x 610 x 22 x 25	6157	Correspond
BA03	1	H 450 x 540 x 22 x 25	H 450 x 540 x 22 x 25	6308	Correspond
BA04	1	H 450 x 540 x 22 x 25	H 450 x 540 x 22 x 25	6032	Correspond
BA05	1	H 450 x 530 x 22 x 25	H 450 x 530 x 22 x 25	5832	Correspond
BA06	1	H 450 x 500 x 22 x 25	H 450 x 500 x 22 x 25	5662	Correspond
BA07	1	H 450 x 480 x 22 x 25	H 450 x 480 x 22 x 25	5574	Correspond
BA08	1	H 450 x 460 x 22 x 25	H 450 x 460 x 22 x 25	5512	Correspond
BA09	1	H 450 x 450 x 22 x 25	H 450 x 450 x 22 x 25	5481	Correspond
BA10	1	H 450 x 450 x 22 x 25	H 450 x 450 x 22 x 25	5476	Correspond
BA11	1	H 450 x 460 x 22 x 25	H 450 x 460 x 22 x 25	5505	Correspond
BA12	1	H 450 x 480 x 22 x 25	H 450 x 480 x 22 x 25	5573	Correspond
BA13	1	H 450 x 500 x 22 x 25	H 450 x 500 x 22 x 25	5680	Correspond
BA14	1	H 450 x 530 x 22 x 25	H 450 x 530 x 22 x 25	5831	Correspond
BA15	1	H 450 x 540 x 22 x 25	H 450 x 540 x 22 x 25	6041	Correspond
BA16	1	H 450 x 540 x 22 x 25	H 450 x 540 x 22 x 25	6302	Correspond
BA17	1	H 450 x 610 x 22 x 25	H 450 x 610 x 22 x 25	6168	Correspond
BA18	1	H 450 x 600 x 22 x 25	H 450 x 610 x 22 x 25	5564	Do Not Correspond

Table 3. Evaluation of dimensions on the bottom upright bracing profile

BOTTOM UPRIGHT BRACING					
CODE		SHOP DRAWING	TEKNOLOGI SURVEY ASET	LENGTH	DESC
END JACK	1	H 1350 x 450 x 22 x 25	H 1350 x 450 x 22 x 25	7677	Correspond
CG2	2	H 1000 x 500 x 14 x 25	H 1000 x 500 x 14 x 25	10917	Correspond
BR1	4	P 273 x 8	P 273 x 8	9117	Correspond
BR3	5	P 273 x 6	P 219 x 6	8624	Do Not Correspond
BR3	6	P 273 x 6	P 219 x 6	9117	Do Not Correspond
BR3	7	P 273 x 6	P 219 x 6	8600	Do Not Correspond
BR3	8	P 273 x 6	P 219 x 6	9070	Do Not Correspond
BR3	9	P 273 x 6	P 219 x 6	8574	Do Not Correspond
BR3	10	P 273 x 6	P 219 x 6	9145	Do Not Correspond
BR3	11	P 273 x 6	P 219 x 6	8600	Do Not Correspond
BR3	12	P 273 x 6	P 219 x 6	9111	Do Not Correspond
BR3	13	P 273 x 6	P 219 x 6	8623	Do Not Correspond
BR3	14	P 273 x 6	P 219 x 6	9105	Do Not Correspond
BR3	15	P 273 x 6	P 219 x 6	8633	Do Not Correspond
BR1	16	P 273 x 8	P 273 x 8	9103	Correspond
CG2	18	H 1000 x 500 x 14 x 25	H 1000 x 500 x 14 x 25	10912	Correspond
END JACK	19	H 1350 x 450 x 22 x 25	H 1350 x 450 x 22 x 25	7654	Correspond

The results of the evaluation of the dimensions collected there are 23 elements of 491 or 4,68% elements elements that do not correspond to Table 1. Profile dimensions on Shop Drawing. That is, this asset survey technology is able to find discrepancies between the dimensions of the elements in the field with the dimensions of the elements documented. By using this technology, the bridge monitoring team no longer needs to use a measuring tape to measure the elements on the bridge, especially for long-span special category bridges that have complicated construction. This technology can also reduce the risk of accidents in bridge monitoring activities.

Monitoring Physical Damage of Bridge Elements

There are 3 records obtained in the field regarding the existing damage and/or the condition that can lead to the physical damage of the bridge elements, namely:

a) Puddles on 3 of the 4 profiles connections, that can cause corrotion to the affected steel.

Figure 6. Puddle in joint BB18 left and GD18 left

b) On the inside of the Tied Rod profile, there are about 80% of the bolts are already in a state of rust.

Figure 7. Rusty bolt on tied rod

Figure 8. Rusty bolt on tied rod

c) On the Abutment there are fragments of concrete due to impact.

Figure 9. Photo fractional abutment

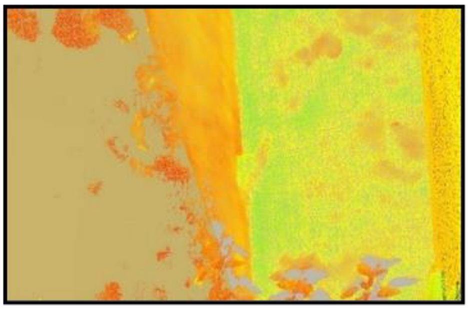

Figure 10. Pointclouds fractional abutment

Physical damage or the potential for physical damage can be easily found and can be directly measured or calculated to the extent to which the damage has occurred, this physical damage monitoring data is used for repair decision-making (handling) of damage to inspectors who have experience in making such repair decisions.

In addition to the size of the damage, the inspectors can find out the point where the damage occurred without the need for direct spaciousness, because the data presented in the form of 3D drawings and 2D drawings by the circumstances in the field, the data can be used as a comparison for monitoring purposes in the future, to determine the development of damage in a certain period.

Monitoring the Position of Bridge Elements (Deformation)

Position information of bridge elements can be obtained from modeling results. This information aims to monitor the position of the profile or element. If deformation has occurred then the deformation shall be measured and compared to the deformation permit on the profile or element.

These results are used to monitor the deformation of certain structures and the possible movement of entire buildings caused by excavations adjacent to buildings, settlements due to poor soil conditions, or incorrect design (Agustina, 2022; Jacobs, 2005b; Najib Muzaka et al., 2015).

Live load deflection shall be limited to 800 / L for typical bridges and 1000 / L for bridges for pedestrians. Calculate the live load distribution for deflection by taking the number of lanes times the multiple presence factor and dividing by the number of beams. The multiple presence factor used for this calculation shall not be less than 0.85 (Aashto, 2017).

Table 4. Deformation evaluation on left upper bar profile

DEFORMATION ON LEFT UPPER BAR					
CODE		LENGTH	DEFORMATION LIMITED	DEFORMATION	DESC
BA01	1	106525	133.16	-20	Qualified
BA02	1	106525	133.16	-32	Qualified
BA03	1	106525	133.16	-18	Qualified
BA04	1	106525	133.16	-6	Qualified
BA05	1	106525	133.16	4	Qualified
BA06	1	106525	133.16	18	Qualified
BA07	1	106525	133.16	45	Qualified
BA08	1	106525	133.16	82	Qualified
BA09	1	106525	133.16	111	Qualified
BA10	1	106525	133.16	142	Not Qualified
BA11	1	106525	133.16	198	Not Qualified
BA12	1	106525	133.16	139	Not Qualified
BA13	1	106525	133.16	65	Qualified
BA14	1	106525	133.16	12	Qualified
BA15	1	106525	133.16	-13	Qualified
BA16	1	106525	133.16	-7	Qualified
BA17	1	106525	133.16	-18	Qualified
BA18	1	106525	133.16	-15	Qualified

On Left Upper Bar 3 elements exceed δ limited and on BA11 has a high enough deformation value.

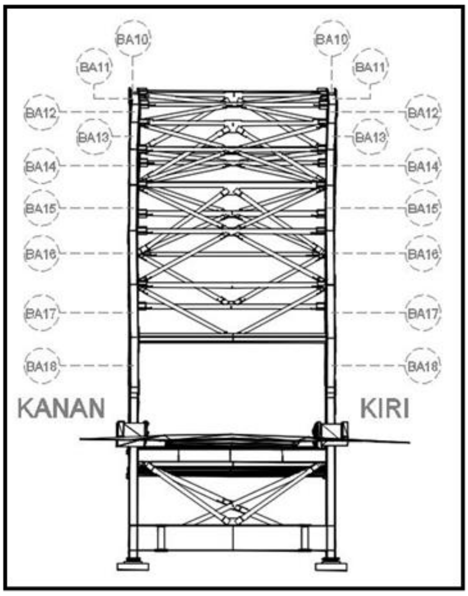

Figure 11. Deformation on left upper bar

Table 5. Deformation evaluation on the bottom upright bracing profile

DEFORMASI THE BOTTOM UPRIGHT BRACING X-AXIS					
CODE		LENGTH	DEFORMATION LIMITED	DEFORMATION	DESC
END JACK	1	7677	9.60	14	Not Qualified
CG2	2	10917	13.65	5	Qualified
BR1	4	9117	11.40	0	Qualified
BR3	5	8624	10.78	0	Qualified
BR3	6	9117	11.40	29	Not Qualified
BR3	7	8600	10.75	0	Qualified
BR3	8	9070	11.34	26	Not Qualified
BR3	9	8574	10.72	1	Qualified
BR3	10	9145	11.43	-40	Not Qualified
BR3	11	8600	10.75	7	Qualified
BR3	12	9111	11.39	-29	Not Qualified
BR3	13	8623	10.78	8	Qualified
BR3	14	9105	11.38	0	Qualified
BR3	15	8633	10.79	0	Qualified
BR1	16	9103	11.38	2	Qualified
CG2	18	10912	13.64	2	Qualified
END JACK	19	7654	9.57	0	Qualified

On Bottom Upright Bracing the direction of X-axis 5 elements exceed δ limited. Deformation evaluation results there are 211 elements of 491 elements that have undergone deformation, 36 elements or 7,33% elements of which have exceeded δ limited.

This means that asset survey technology can record the deformation/deflection that occurs on the bridge elements, and even the deformation can be measured to determine the extent to which deformation/deflection has occurred. Based on the results of the evaluation for the deformation/deflection category can be used as analysis material, as follows:

1. Analyze the loading capacity according to the condition where the bridge element has deformation/deflection
2. Calculate the remaining life of the bridge without retrofitting.
3. Analyze and apply bridge reinforcement using the external prestressing method. (PD T-03-2004-B, 2004)
4. Calculating the remaining life of the bridge by retrofitting.

Monitoring the Geometry of the Bridge

The geometry information of the bridge is carried out on the bearing holder 1.

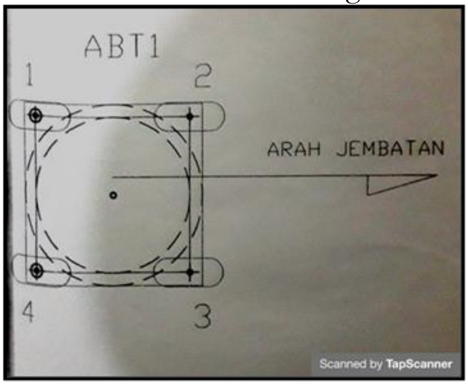

Figure 12. Evaluated coordinate points

Table 6. Comparison of coordinate on the X-axis

Point	Shop Drawing	Survey Asset Technology	Diferential
1	806,609.844	806,609.878	-0.034
2	806,610.162	806,610.195	-0.033
3	806,610.740	806,610.701	0.039
4	806,610.422	806,610.390	0.032

Table 7. Comparison of coordinate on the Y-axis

Point	Shop Drawing	Survey Asset Technology	Diferential
1	9,212,139.231	9,212,139.215	0.016
2	9,212,139.809	9,212,139.790	0.019
3	9,212,139.491	9,212,139.510	-0.019
4	9,212,138.913	9,212,138.939	-0.026

Figure 13. Placement of bridge model modeling results

Geo-reference evaluation shows differential between actual bridge and shop drawing, and need further measurement to make sure whether the bridge is already shifted or our drone data was not accurate enough, since there was no DGPS / Total Station included in the process. The use of DGPS / Total Station is needed to measure the position at the bearing holder bolt as shown on the shop drawing, which tied to the nearest Benchmark (BM). DGPS / Total Station results are used for geo-referencing processes.

The highest diferential value at Point 3 x-axis is 0.039 m or 39mm.

Geometry Monitoring is used to check the location of the bridge, which is influenced by active soil movement in the bridge area.

Conclusion

Asset survey technology is the latest survey instrument that has been popular and increasingly used for as-built data procurement and modeling. This technology can record objects accurately and optimally with efficient time.

In terms of work safety, the use of asset Survey technology can reduce the risk of work accidents, because in data retrieval bridge conditions no longer need to measure each element of the bridge using a measuring tape or other simple tools, especially for bridge elements that are at a height that takes a relatively long time.

The use of asset Survey technology produces data to evaluate the condition of the bridge, several findings have been categorized according to the monitoring category as follows:

In the evaluation of the dimensions of the bridge elements, there are 23 elements of 491 elements or 4,68% elements that do not fit in Table 1. Profile dimensions on Shop Drawing.

3 findings can affect the physical damage of the bridge elements, namely: puddle on 3 of 4 profile connections that can lead to the corrotion of the elements, on the inside of the Tied Rod profile there are about 80% of the Bolts are in a state of rust, on the Abutment there are concrete fragments due to impact.

In the deformation evaluation, there are 211 elements of 491 elements have been deformed, 36 elements or 7,33% elements of which have exceeded δ limited.

Geo-reference evaluation shows differential between actual bridge and shop drawing, and need further measurement to make sure whether the bridge is already shifted or our drone data was not accurate enough. The highest diferential value at Point 3 x-axis is 0.039 m or 39mm.

From these findings, the use of asset Survey technology can be used to help obtain monitoring data on the condition of the bridge to complement the current monitoring limitations, to improve bridge Asset Management. At the same time move the manual data into digital data that can facilitate the search for data if needed for monitoring in the future.

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