

Condition Assessment and Remaining Service Life Evaluation of a Steel–Concrete Composite Bridge Using BMS and BCI WSDOT Methods

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Cikondang Bridge is a steel–concrete composite girder bridge located on the Cibeber–Sukanagara road section in Cianjur Regency, West Java. The bridge was constructed in 1984 and has been in service for approximately 42 years. This study aims to assess the existing condition and remaining service life of Cikondang Bridge using the Bridge Management System (BMS) and Bridge Condition Index (BCI) WSDOT methods. Primary data were collected through field visual inspection and documentation of bridge components, including the deck, steel girders, drainage system, pier, and railing. The inspection identified several defects, including corrosion on steel girders, poor drainage performance, scouring around the pier, and damage to railing elements. The BMS assessment produced a condition value of $NK = 3$, indicating moderate damage and the need for rehabilitation. The BCI WSDOT assessment produced a BCI value of 45, which also classified the bridge as moderately damaged. The remaining service life analysis showed an equivalent bridge age of approximately 42 years, leaving an estimated remaining service life of about 8 years from the 50-year design service life. The consistency between the BMS and BCI WSDOT results indicates that Cikondang Bridge remains serviceable but requires planned rehabilitation, especially for drainage improvement, corrosion protection, and scour monitoring.

Keywords: bridge condition assessment; Bridge Management System; BCI WSDOT; steel–concrete composite bridge; remaining service life.

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Introduction

Bridges are important elements of road infrastructure because they connect areas separated by rivers, valleys, or other physical barriers. In Indonesia, many regions depend on bridges to support daily mobility, goods distribution, and local economic activities. Therefore, the serviceability and safety of bridges need to be maintained through regular inspection and condition assessment.

Bridge performance may decrease over time due to aging, traffic loads, environmental exposure, and hydraulic effects. Common forms of deterioration include corrosion of steel members, damage to drainage systems, scouring around piers, and defects in safety elements such as railings or parapets. If these defects are not identified and treated properly, they may reduce structural performance and shorten the remaining service life of the bridge. Visual inspection and condition rating are commonly used as the basis for bridge preservation planning and maintenance prioritization (Hearn, 2017; Pratiwi et al., 2023). However, bridge condition evaluation may become less accurate when only element deterioration is considered

without assessing its influence on overall structural performance (Bertola & Brühwiler, 2023). Recent reviews also show that bridge condition rating still relies heavily on visual inspection, while deterioration modeling depends strongly on the quality of historical condition data (Faris et al., 2025).

One approach commonly used in Indonesia is the Bridge Management System (BMS), which provides a systematic procedure for bridge inspection, condition rating, and maintenance decision-making (Bridge Management System, 1993; Harywijaya et al., 2020). In addition to BMS, the Bridge Condition Index (BCI) can be used to express bridge condition in a numerical form based on component condition and weighting. The use of condition indices is useful because it helps bridge managers compare bridge conditions and determine maintenance priorities more objectively (Agredo Chávez et al., 2024; Rizki et al., 2024). Recent studies also emphasize that bridge management systems should support diagnosis, prognosis, and decision-making in maintenance planning (Brighenti et al., 2024).

Jembatan Cikondang, located on the Cibeber–Sukanagara road section in Cianjur Regency, was constructed in 1984 and has been in service for

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approximately 42 years. Based on preliminary visual observation, several defects were found, including corrosion on steel girders, poor drainage performance, scouring around the pier, and damage to railing elements. These conditions indicate that the bridge requires a more systematic evaluation to determine its current condition and maintenance needs.

This study aims to evaluate the condition of Jembatan Cikondang using BMS and BCI WSDOT. The assessment is based on visual inspection of bridge components and condition scoring. The results are expected to provide a clear description of the bridge condition, the consistency between BMS and BCI assessment, and the required maintenance action. In this study, the BMS assessment produced a condition value of 3, while the BCI WSDOT assessment produced a BCI value of 45. Both results indicate that the bridge is in moderate damage condition and requires rehabilitation and planned maintenance.

Research Method

This study was conducted on Cikondang Bridge, located on Jl. Raya Cibeber, Cibeber District, Cianjur Regency, West Java. The bridge was selected because it is still in operation and shows several visible defects on structural and nonstructural elements. The location and existing condition of the bridge are shown in Figure 1.



Figure 1 Location and existing condition of Cikondang Bridge

The data used in this study were primary data obtained from field visual inspection. The inspection was carried out by observing the bridge components directly, documenting visible damage, and identifying the type, location, and severity of defects. Visual inspection is commonly used as the initial basis for bridge condition assessment and maintenance planning because it provides direct information on the actual condition of bridge components (Hearn, 2017; Pratiwi et al., 2023). Bridge management practice also relies on inventory data, component condition, and overall bridge condition to support maintenance and rehabilitation decisions.

The bridge condition was evaluated using two methods: the Bridge Management System (BMS) and the Bridge Condition Index (BCI) WSDOT. In the BMS method, the assessment was based on five parameters: structural condition, damage severity, damage extent, element function, and the influence of damage on bridge performance. These parameters were used to determine the condition value of each bridge element and the overall bridge condition. The damage assessment criteria used in the BMS evaluation are presented in Table 1.

Table 1 Damage assessment criteria based on the BMS method (Efendi et al., 2025)

Assessment Parameter	Criteria	Score
Structure (S)	Dangerous	1
	Not dangerous	0
Damage Severity (R)	Severe	1
	Not severe	0
Quantity/Extent (K)	More than 50%	1
	Less than 50%	0
Function (F)	Element does not function properly	1
	Element functions properly	0
Influence (P)	Affects other elements	1
	Does not affect other elements	0
Condition Value (NK)	$NK = S + R + K + F + P$	0–5

The BCI WSDOT method was used to provide a numerical index of the bridge condition. The assessment was carried out through the calculation of Condition State Averaging (CSA), Weighted Component Score (WCS), and the final Bridge Condition Index (BCI). This approach allows bridge components to be assessed based on their condition state and relative component weight. Condition rating systems are useful for describing the global condition of bridge infrastructure and for supporting maintenance prioritization. The component weighting used in the BCI WSDOT assessment is shown in Table 2.

Table 2 Technical screening criteria based on the BMS method (Rizki et al., 2024)

Parameter	Value	Category	Indicative Treatment
Condition	0–2	Good to minor damage	Routine/periodic maintenance
	3	Moderate damage	Rehabilitation
	4–5	Critical or failed	Replacement
Traffic	0	Sufficient width	Routine maintenance
	5	Too narrow	Duplication, replacement, or widening
Load	0	Sufficient capacity	Routine maintenance
	5	Does not meet standard	Strengthening or replacement

The remaining service life of the bridge was then estimated based on the condition value obtained from the evaluation. This analysis was used to relate the current bridge condition to its design service life and to determine the approximate remaining service period. Previous studies indicate that bridge age and condition rating can be combined to estimate remaining service life and support maintenance decisions.

Results and Discussion

Existing Condition of Cikondang Bridge

Cikondang Bridge is an important transportation infrastructure located on the Cibeber–Sukanagara road section in Cianjur Regency, West Java. The bridge functions as a connector between areas separated by a river and supports local mobility and goods distribution. Based on field observations, the bridge is still operational and actively used by local traffic.

Structurally, Cikondang Bridge is classified as a steel–concrete composite girder bridge consisting of three spans with reinforced concrete piers and abutments. Figure 2 shows the operational condition of Cikondang Bridge during the field inspection and the elevation of its three-span steel–concrete composite structure. Composite girder bridges are commonly used for medium-span bridges because they provide adequate stiffness and load-carrying capacity under traffic loading conditions. Similar bridge configurations are widely applied in Indonesian bridge infrastructure due to their structural efficiency and construction practicality (Pratiwi et al., 2023).

The bridge was constructed in 1984 with a planned service life of 50 years. Therefore, at the time of inspection, the bridge had been in service for

approximately 42 years. The increasing bridge age combined with continuous traffic loading has contributed to deterioration in several structural and nonstructural components. Previous studies indicate that aging bridges are highly susceptible to deterioration caused by environmental exposure, moisture, repeated traffic loading, and insufficient maintenance practices (Simanjuntak et al., 2024; Marshando & Sumargo, 2020).

Visual inspection indicated that the bridge is still serviceable for daily traffic operation. However, several defects and deterioration symptoms were identified, indicating the need for a systematic bridge condition assessment using Bridge Management System (BMS) and Bridge Condition Index (BCI) WSDOT methods.

Visual Damage Identification on Bridge Elements

The visual inspection identified several deterioration forms on both structural and nonstructural bridge elements. The observed defects included steel girder corrosion, drainage malfunction, pier scouring, and railing deterioration. These damages indicate progressive deterioration caused by long-term environmental exposure and aging effects.

Corrosion on Steel Girders

Corrosion was observed on several steel girder surfaces beneath the bridge deck. The affected areas showed brownish oxidation products and moisture accumulation around the lower structure. This condition indicates ongoing steel deterioration due to prolonged exposure to water and humid environmental conditions.

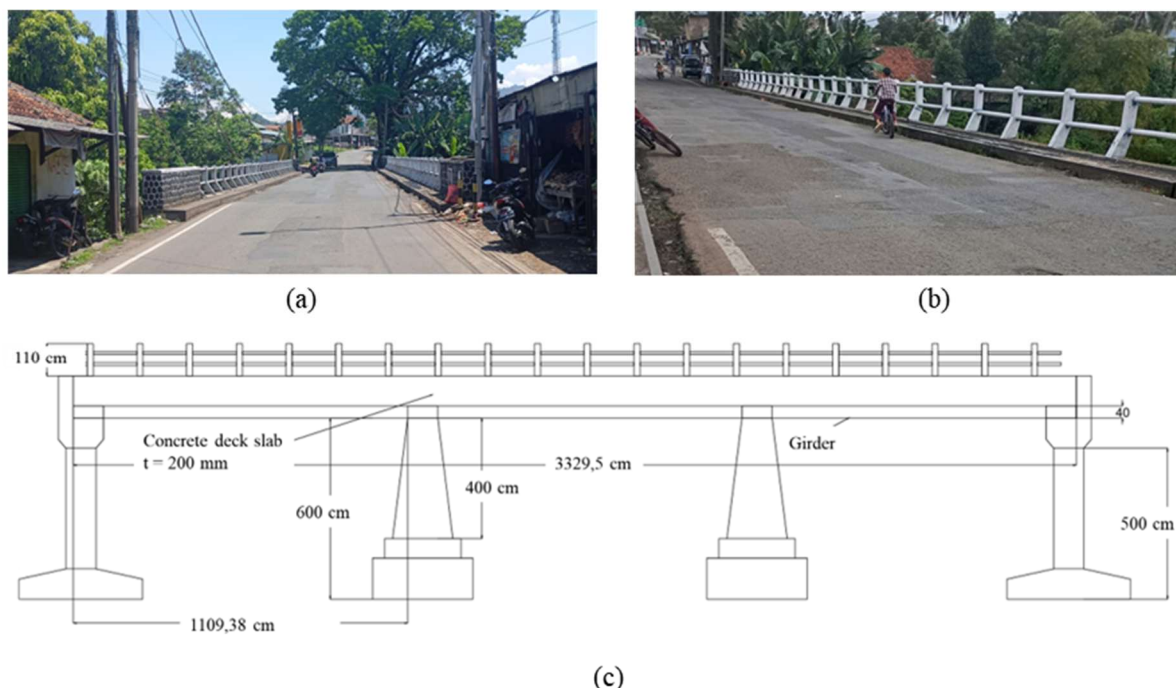


Figure 2 Existing condition and structural elevation of Cikondang Bridge: (a) view from east to west; (b) view from west to east; and (c) elevation of the three-span steel–concrete composite bridge structure.

The corrosion mechanism is strongly associated with ineffective drainage and water retention on bridge surfaces. According to Main Roads Western Australia (2012), inadequate drainage systems significantly accelerate corrosion propagation in steel bridge elements because trapped water increases humidity and prolongs the wet-dry cycle on steel surfaces. Corrosion in steel bridge girders is critical because it may reduce section thickness and eventually decrease load-carrying capacity if left untreated.

The observed corrosion was still categorized as moderate because no major deformation or excessive section loss was visually detected. However, studies on bridge deterioration modeling indicate that corrosion propagation tends to increase exponentially after the protective coating system fails, particularly in humid environments (Hasan et al., 2015). Therefore, preventive rehabilitation is necessary to control further deterioration. Corrosion observed on the lower steel girders is shown in Figure 3.



Figure 3 Corrosion on steel girder elements of Cikondang Bridge

Drainage System Damage

The bridge drainage system was found to function poorly. Water ponding and sediment accumulation were observed on the bridge surface, indicating insufficient water flow toward the drainage outlet.

Poor drainage performance plays a significant role in bridge deterioration because trapped water accelerates surface degradation and increases moisture exposure to structural elements. Agredo Chávez et al. (2024) emphasized that drainage-related deterioration is one of the dominant factors affecting bridge condition indices in bridge management systems because moisture accelerates corrosion and concrete weathering processes.

For steel–concrete composite bridges, drainage malfunction is particularly critical because continuous moisture exposure may simultaneously affect steel girders and reinforced concrete deck components. The observed drainage condition indicates the need for immediate maintenance to prevent accelerated

deterioration in adjacent bridge components. The condition of the malfunctioning drainage system is presented in Figure 4.

Scouring Around the Bridge Pier

Visual inspection also identified scouring around the pier foundation caused by river flow. Soil erosion was observed near the exposed foundation area, especially at sections directly affected by water current.

Scour is considered one of the most critical hydraulic problems in bridge engineering because it can reduce foundation stability and change the response of the bridge substructure under vertical and lateral loading (Ciancimino et al., 2022).



Figure 4 Malfunctioning bridge drainage system

Although no major structural instability was visually identified during inspection, the observed scour pattern indicates active interaction between the river flow and the bridge foundation. Continuous monitoring is therefore required, especially during high-flow conditions in the rainy season. Scouring around the pier foundation identified during the inspection is shown in Figure 5. Scouring around the pier is critical because it can reduce foundation capacity and change the response of the bridge substructure under vertical and lateral loading (Ciancimino et al., 2022).

Damage on Bridge Railings

Damage was also identified on the bridge railing elements, particularly at the connection and surface areas. Local deterioration and material degradation were observed on several railing components.

Although the damage does not directly affect the primary load-bearing system, railing deterioration reduces user safety and serviceability. Bridge railing systems are important safety components designed to prevent vehicle accidents and improve traffic protection. According to bridge inspection guidelines developed by Main Roads Western Australia (2012), deterioration in safety components should still receive maintenance attention even if the primary structure remains functional.



Figure 5 Scouring around the bridge pier area

The observed deterioration was mainly associated with environmental exposure and long-term weathering effects. Therefore, local rehabilitation and protective maintenance are required to prevent further deterioration. Damage on the bridge railing elements is presented in Figure 6.



Figure 6 Damage on bridge railing elements

The visual inspection results indicate that Cikondang Bridge is experiencing light-to-moderate deterioration in several bridge components. These findings were subsequently used as the basis for bridge condition assessment using the BMS and BCI WSDOT methods.

Bridge Condition Assessment Using BMS

Bridge condition assessment was conducted using the Bridge Management System (BMS) based on visual inspection results for each bridge component. The BMS method evaluates bridge condition systematically through hierarchical inspection levels, ranging from general inspection to detailed element evaluation.

In the BMS approach, each bridge component is assessed using five parameters: structure condition,

damage severity, damage extent, functionality, and influence on the structural system. These parameters are combined to determine the overall bridge condition value.

Level 1 and Level 2 Inspection

Level 1 inspection was conducted to evaluate the overall bridge condition, while Level 2 inspection focused on major bridge components such as the superstructure, substructure, deck system, and supplementary elements.

The inspection results showed that several bridge components experienced deterioration. Corrosion was identified on steel girders in the superstructure, while scouring was observed around the pier foundation in the substructure. Drainage and railing components also showed localized deterioration.

The bridge remained operational despite the observed deterioration. However, the inspection results indicate that preventive rehabilitation and periodic maintenance are required to prevent more severe structural degradation. Similar findings were reported by Efendi et al. (2025), where moderate bridge deterioration was mainly associated with environmental exposure and insufficient maintenance. In the assessment tables, S represents structure condition, R represents damage severity, K represents damage quantity or extent, F represents functionality, P represents influence on other elements, and NK represents the total condition value. The results of the Level 1 and Level 2 inspections are summarized in Table 3.

Table 3 Results of Level 1 and Level 2 bridge inspection using the BMS method

Inspection Level	Code	Element	S	R	K	F	P	NK
Level 1	1,00	Bridge	1	1	1	0	0	3
Level 2	2,20	River Flow / Embankment	0	0	1	0	1	2
Level 2	2,30	Substructure	1	1	0	0	1	3
Level 2	2,40	Superstructure	1	1	1	1	0	3
Level 2	2,70	Bridge Accessories	0	1	0	0	0	2
Level 2	2,80	Drainage System	–	–	–	–	–	2
Level 2	2,90	Wet Crossing Area	–	–	–	–	–	2

Level 3 to Level 5 Inspection

Detailed inspection at Levels 3 to 5 was conducted to identify damage type, location, and its influence on bridge performance. A summary of the Level 3–5 inspection results is presented in Table 4.

The results showed that the dominant deterioration mechanisms included steel girder corrosion, poor drainage performance, pier scouring, and railing deterioration. These defects are associated with long-term environmental exposure, humidity, traffic loading, and aging effects.

Corrosion was identified as the most critical deterioration mechanism because it directly affects the structural capacity of steel girders.

Table 4 Summary of Level 3–5 bridge element inspection results

Element Code	Element	Damage Code	Damage Description	Location	Level 5 Condition Value	Level 3–4 Condition Value	Drawing	Photo	Emergency Action	Special Inspection/ Recommended Action
4.411	Girder	302	Corrosion	X = 2 Y = 2	S=1, R=2, K=1, F=0, P=1, NK=3	S=1, R=2, K=1, F=0, P=1, NK=3	Y	Y	T	Recoating/ protective coating
3.32	Pier Cap/ Pier	503	Scouring	B	–	S=1, R=1, K=1, F=0, P=1, NK=3	Y	Y	T	Structural strengthening using gabion
3.5	Deck System	204	Component deterioration due to wear and weathering (drainage damage and water ponding identified on deck surface)	A	–	S=1, R=1, K=1, F=1, P=0, NK=3	Y	Y	T	Drainage cleaning
3.62	Railing	205	Cracking or partial concrete loss	A	–	S=1, R=1, K=0, F=0, P=0, NK=2	Y	Y	T	Mortar patch repair

Studies on bridge deterioration modeling indicate that corrosion progression significantly influences bridge condition ratings and long-term maintenance costs (Hasan et al., 2015). Similarly, drainage malfunction contributes to continuous moisture accumulation, which accelerates corrosion and surface deterioration.

Pier scouring also requires attention because continuous erosion may gradually reduce foundation stability. Although no immediate structural failure risk was identified, the observed scour condition indicates the need for periodic monitoring and hydraulic protection measures.

Overall Bridge Condition Value

Based on the BMS evaluation, the overall bridge condition value (NK) was 3. The overall bridge condition assessment based on the BMS method is shown in Table 5. According to the BMS classification, this value indicates a moderate damage condition requiring rehabilitation.

Table 5 Overall bridge condition value based on the BMS method

Structural Component	NK	Damage Category
Deck Layer	2	Minor damage
Superstructure	3	Moderate damage
Substructure	3	Moderate damage
Overall Condition Value (NK)	3	Moderate damage

The obtained condition value shows that the bridge is still serviceable but has experienced deterioration in several structural and nonstructural components. If no

corrective action is implemented, deterioration may continue and reduce both structural safety and remaining service life.

The rehabilitation priority should focus on drainage improvement, corrosion treatment on steel girders, scour monitoring around piers, and repair of deteriorated supplementary components.

Bridge Condition Assessment Using the BCI WSDOT

Method

The condition of Cikondang Bridge was also evaluated using the Bridge Condition Index (BCI) WSDOT method. This method was applied to obtain a quantitative index of bridge condition based on component-level assessment. In this study, the BCI evaluation consisted of three main steps: Condition State Averaging (CSA), Weighted Component Score (WCS), and conversion of the weighted score into the final BCI value.

Condition State Averaging (CSA)

The first step in the BCI WSDOT assessment was to determine the condition state of each bridge component based on the visual inspection results. The condition state represents the observed damage level of each component and is used as the basis for calculating the Condition State Averaging (CSA).

As shown in Table 6, the condition state values for the deck, steel girder, abutment/pier, railing, and drainage system were 3, 3, 3, 2, and 2, respectively. These values resulted in an average condition state, or CSA, of 2.6, indicating that the overall component condition of Cikondang Bridge falls within the moderate category.

This result shows that deterioration was not limited to secondary or nonstructural elements. The deck, steel girder, and abutment/pier received higher condition

state values than the railing and drainage system, indicating that several primary components had already experienced moderate deterioration. Therefore, the CSA result supports the need for rehabilitation rather than routine maintenance alone. Component-level assessment is important because relying only on the general visual appearance of a bridge may underestimate deterioration in specific structural elements (Agredo Chávez et al., 2024). In addition, visual inspection data can support future deterioration monitoring when condition states are recorded consistently over time (Hasan et al., 2015).

Table 6 Condition state values of Cikondang Bridge components

Component	Damage Type	CS
Deck	Cracking and wear	3
Steel Girder	Corrosion	3
Abutment/Pier	Scouring	3
Railing	Minor corrosion	2
Drainage	Surface damage	2

Weighted Component Score (WCS)

After the condition state values were obtained, the next step was to calculate the Weighted Component Score (WCS). This calculation considers the relative weight of each bridge component. The weighting system is used because structural components do not have the same influence on the overall bridge condition. The component weighting system used in the BCI WSDOT assessment is presented in Table 7.

Table 7 Bridge condition classification based on BCI range (Rizki et al., 2024)

BCI Range	Bridge Condition	Recommended Action
0–20	Good	Routine maintenance
21–40	Minor damage	Periodic maintenance
41–60	Moderate damage	Rehabilitation
61–80	Severe damage	Strengthening or major rehabilitation
81–100	Critical / failed condition	Replacement

Components with a more direct role in load transfer, such as girders, deck elements, piers, and abutments, have a greater effect on the final condition index than complementary elements. This is relevant to the condition of Cikondang Bridge, where the main observed defects were found on steel girders, drainage, and piers. Although railing damage affects safety and serviceability, deterioration on girders and piers has a stronger implication for structural performance.

Based on the calculation, the weighted score obtained for Cikondang Bridge was 550. The recapitulation of the weighted component score is shown in Table 8. This value was then used to calculate the final BCI value. The use of weighted scoring provides a more proportional assessment because damage to

primary structural elements is reflected more strongly in the bridge condition index. This approach is consistent with bridge management principles, where element-level condition assessment is used to support maintenance prioritization and bridge preservation planning (Agredo Chávez et al., 2024; Hearn, 2017). Similar bridge assessment approaches have been developed to prioritize maintenance strategies by considering the relative importance of bridge components and the severity of observed deterioration (Mansour et al., 2019).

Table 8 Weighted Component Score recapitulation of Cikondang Bridge

Component	CS	Wi	GM	WCS
Deck	3	50	1	150
Girder	3	60	1	180
Abutment	3	40	1	120
Railing	2	30	1	60
Drainage	2	20	1	40
Total		200		550

Final BCI Value and Condition Interpretation

The final BCI value was determined from the weighted score obtained in the previous step. Based on the WCS calculation, Cikondang Bridge obtained a weighted score of 550, which corresponds to a BCI value of 45. The BCI classification scale used in this study follows Rizki et al. (2024), as presented in Table 9.

Table 9 Bridge Condition Index conversion scale (Rizki et al., 2024)

BCI Range	Description	Weighted Score Range	Equation Scale
0–19	Very Good	100–160	$BCI = (WS - 100) \div 3$
20–39	Good	161–500	$BCI = (WS + 180) \div 17$
40–55	Moderate	501–660	$BCI = (WS - 100) \div 10$
56–100	Poor	600–2,000	$BCI = (9 \times WS + 9,068) \div 268$
101–200	Severe Damage	2,000–5,000	$BCI = (0.033 \times WS + 35)$

A BCI value of 45 places Cikondang Bridge in the moderate damage category. This result indicates that the bridge remains serviceable for traffic operation, but its condition has decreased to a level that requires rehabilitation. This interpretation is consistent with the BCI WSDOT framework, which uses component condition and weighted scoring to evaluate the overall bridge condition (Rizki et al., 2024).

The BCI result is consistent with the BMS assessment. The BMS method produced a condition value of $NK = 3$, while the BCI WSDOT method produced a BCI value of 45. Both values classify the bridge as moderately damaged and lead to the same recommended action, namely rehabilitation. This consistency strengthens the assessment result because the two methods use different scoring approaches but produce the same condition category.

From a technical perspective, the BCI value of 45 reflects the combined influence of several deterioration mechanisms, including corrosion on steel girders, poor drainage performance, scouring around the pier, and railing damage. Among these defects, drainage malfunction should receive early attention because poor drainage can prolong moisture exposure and accelerate deterioration of steel and concrete bridge components (Main Roads Western Australia, 2012). Therefore, drainage improvement should be considered one of the first rehabilitation priorities, followed by corrosion treatment on steel girders and monitoring of scour around the pier.

Remaining Service Life Analysis

The remaining service life analysis was conducted to relate the current bridge condition to its design service life. In this study, the interpretation was based on the BMS condition value and supported by the BCI WSDOT result.

The BMS assessment produced a condition value of $NK = 3$, while the BCI WSDOT assessment produced a BCI value of 45. Both values indicate moderate damage. Based on the service life estimation, the equivalent age of Cikondang Bridge was approximately 42 years. With a design service life of 50 years, the estimated remaining service life is therefore about 8 years.

This remaining service life should not be interpreted as a period in which the bridge can be used without intervention. It represents the estimated residual service period under the current condition at the time of inspection. If the observed defects are not treated, especially corrosion on steel girders, poor drainage performance, and scouring around the pier, the deterioration process may accelerate and reduce the actual remaining service life. Visual inspection records can be used to support the prediction of future bridge component conditions, particularly when component-level deterioration data are recorded consistently over time (Hasan et al., 2015).

The combination of $NK = 3$ and $BCI = 45$ indicates that Cikondang Bridge has entered a deterioration development phase. In this phase, the bridge is still operational and no immediate structural failure was observed, but the damage has reached a level that requires rehabilitation. Therefore, the remaining service life of approximately 8 years should be treated as a maintenance warning rather than a safe operating allowance.

Based on the observed defects, rehabilitation should prioritize three actions. First, the drainage system should be cleaned and repaired because poor drainage can prolong moisture exposure and accelerate deterioration of bridge deck and steel components. Second, corroded steel girders should be cleaned, protected, and recoated to reduce further section loss, since corrosion is one of the main deterioration mechanisms affecting steel bridge members. Corrosion control for steel bridges commonly involves cleaning, protective coating, and preservation practices to maintain structural performance over the bridge life cycle (Federal Highway Administration, 2024). Third, scouring around the pier should be monitored and

treated using appropriate hydraulic protection, as foundation scour can reduce the lateral capacity of bridge foundations and may lead to permanent settlement and rotation of bridge piers (Ciancimino et al., 2022). The summary of the condition assessment and remaining service life evaluation of Cikondang Bridge is presented in Table 10.

Table 10 Summary of bridge condition assessment and remaining service life of Cikondang Bridge

Parameter	BMS Method	BCI WSDOT Method
Condition value	$NK = 3$	$BCI = 45$
Condition category	Moderate damage	Moderate damage
Operational condition	Still serviceable	Still serviceable
Recommended treatment	Rehabilitation	Rehabilitation
Design service life	50 years	50 years
Equivalent age	± 42 years	± 42 years
Remaining service life	± 8 years	± 8 years
Deterioration status	Deterioration development phase	Deterioration development phase

Conclusion

Based on the results, the following conclusions can be drawn:

1. Visual inspection of Cikondang Bridge identified several defects, including corrosion on steel girders, drainage malfunction, scouring around the pier, and damage to railing elements. These defects indicate deterioration caused by environmental exposure and long-term bridge operation.
2. The BMS assessment produced a condition value of $NK = 3$, while the BCI WSDOT assessment produced a BCI value of 45. Both values classify the bridge as being in the moderate damage category.
3. Cikondang Bridge remains serviceable for traffic operation; however, rehabilitation is required to prevent further deterioration. The main rehabilitation priorities are drainage improvement, corrosion treatment on steel girders, scour monitoring around the pier, and repair of railing elements.
4. The remaining service life analysis showed that the bridge has an equivalent age of approximately 42 years, with an estimated remaining service life of about 8 years from its 50-year design service life.
5. The consistency between the BMS and BCI WSDOT results shows that both methods can support systematic bridge condition assessment, rehabilitation prioritization, and maintenance planning.

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