

PROPUESTA DE CAMBIOS EN LOS FORMATOS DE INSPECCIÓN DE PUENTES DE BOGOTÁ

PROPOSAL CHANGES BRIDGES INSPECTION FORMATS OF BOGOTÁ

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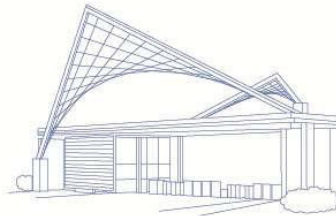
Abstract

This paper presents a proposal to modify the bridges inspection format of Bogotá. As result of the inspection of 36 rural bridges in El Sumapaz, a locality of Bogotá. Some problems in the data taken with these formats are identified. These problems can confuse the decision makers when they assign inversion Budget, for this reason is important to review and modify the current bridges inspection formats. The author proposes include typology that are not consider actually and modify other aspects that can induce a mistake in the data taking. Aspects as buckling, composite section, suspension bridges, anchorage in stayed cable bridges are not involved adequately in these formats and they must be improved.

Key words: bridges inspection, inspection guides, bridges typology, steel bridges, stay cable bridges

Introduction

Actually, the bridges inspection in Bogotá, is done with the following guides **[1] [2] [3]**, in this paper the author presents some aspects that must be reconsidered in the inspection formats. This proposal has evaluated in field. During the development of one inspection bridges contract in the rural zone of Bogotá (Locality of El Sumapaz). El Sumapaz has an area of 780 square kilometers, some approaches of the rural bridges lack a defined way. In this rural zone is necessary to realize strong trekking to Access the bridge site. The minimal work equipment for this inspection must consist in 3 people, (auxiliar personal, junior engineer and senior engineer). The zone is particular with public order problems; the presence of armed groups and Colombian militaries is normal. For



this reason, the option with drones is not possible, both groups can interpret a drone flight like a hostile attack and the security of the work equipment can be comprised.

The bridge inspection must be with traditional methods, manual distance meters, paper formats, pencil, rubber, umbrella, measure tape, wider blade, lantern, video camera, camera.

In El Sumapaz all the time the work group is in heights between 2800 to 3400 MASL, for the bridges inspection in some cases is necessary trekking 3 hours to access to approach and 3 hours more trekking to exit of the bridge. The health of work group is important in the planning. The localization with GPS is important, however, sometimes the cloudy sky difficult the ubication. The demographic density in El Sumapaz is 4people/km², it is a big challenge, where, a good planning of the route before to begin the travel to bridge inspection, is necessary to prevent accidents.

The inspection documents are available in ARCGIS, however in El Sumapaz, the lack of Internet is permanent, this method with wireless connection is not possible. The cell signal is off constantly. There are not phones or mobile communication. The nature grows all around and the plants grow in all the structure of the bridges.

Before to exit of the bridge is necessary to review that all formats of bridge inspection are complete, to verify all the measures are been taken, and review the drawing is complete with measure. The detailed review is necessary for to guaranty the long working day will be successful.

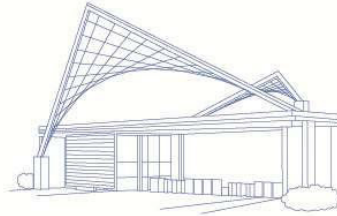
All the time, the work group is in the paramo weather, where, raining permanently and the dense fog appears without previous warning. The presence of this dense fog determines that all bridge inspections must be to realize before 15hour, at that time, the fog obstacles to do more work for its density.

With this context, in this paper, it abord some problem the bridges inspection formats of **[1]** **[2]** **[3]**.

Some problems with the bridge's inspection formats

In **[4]**, the bridge is localized and measures of curbs, railings, sidewalks, joints, road Surface, pedestrian Surface, spans, beams, stringers, deck, bearings and bridge clearances are recorded in the format. A complete drawing must be included and measures of ramps, stairs if these exist.

In **[5]**, the bridge is classified using the typology included in **[1]** and begin the problems. In El Sumapaz, there are suspension bridges but the IDU guides have not this typology. The work group must classify it like cable stayed bridge and to include a note where clarify that the inspected bridge is suspension bridge.



Conexiones entre superestructura y subestructura	Condición superestructura	Tipo de apoyos intermedios	Código puente vehicular	Código puente peatonal
Monolítico	Hiperestático (Luces continuas)	Una columna	VMH_1	PMH_1
		Varias columnas	VMH_2	-
		Pórtico	VMH_3	PMH_3
		Pantalla	VMH_4	PMH_4
No monolítico	Isostático (Luces simples)	Una columna	VNI_1	PNI_1
		Varias columnas	VNI_2	-
		Pórtico	VNI_3	PNI_3
		Pantalla	VNI_4	-
	Hiperestático (Luces continuas)	Una columna	VNH_1	PNH_1
		Varias columnas	VNH_2	PNH_2
		Pórtico	VNH_3	PNH_3
		Pantalla	VNH_4	PNH_4
Box Culvert			VBC_1	PBC_1
Una Luz – Simple			VLS_1	PLS_1
Puente prototipo para Bogotá			-	PPB_1
Atirantado			-	PAT_1
Aro en acero			VAA_1	PAA_1
Aro en concreto			VAC_1	PAC_1
Artesanal - Vernacular			VVA_1	PVA_1

Source: bridge inspection guide [2]

Bridges that are not included in these categories have problems with its classification.

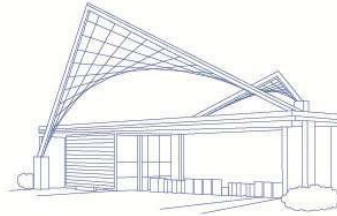
TIPOLOGÍA ESTRUCTURAL DEL PUENTE	
Conexión entre superestructura y subestructura:	
Condición de superestructura:	
Tipo de apoyo intermedio:	
Código de tipología estructural del puente:	
Tipología estructural del puente:	

Source: bridge inspection format [5]

If the deck has composite section, as occur in some cases in El Sumapaz, it is not possible report it because the bridge inspection format has not this possibility.

SISTEMA ESTRUCTURAL	
Superestructura	
Tablero	Material:
	Sistema de piso:
Vigas	Material:
	Parrilla:
	Sección:

Source: bridge inspection format [5]



If the bridge has beams in wooden logs, is not possible to report it, directly.

Vigas	Material:	_____
	Parrilla:	_____
	Sección:	_____
	Sección transversal:	_____
Curvatura:	_____	
Riostras/diagonales:	_____	
Diafragma:	_____	

Viga I
 Viga U
 Rectangular
 Cercha
 Viga Cajón
 Viga en Celosía
 Viga prototipo de Bogotá

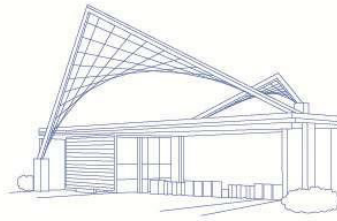
Source: bridge inspection format [5]



Source: ZJ Ingenieros Estructurales SAS. Rock supports a bridge. Beams in different materials

In the Category “Artesanal – vernacular”, are included so many typologies and can produce confusion in the decision makers to assign inversion budget.

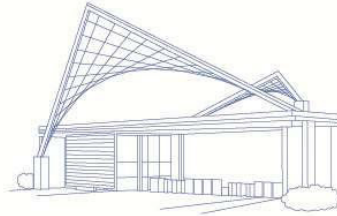
Some bridges in El Sumapaz are difficult to classify with these formats, as the followed in this pictures



Source: ZJ Ingenieros Estructurales SAS.



Source: ZJ Ingenieros Estructurales SAS.



Some problems with the bridges evaluation formats

En [6], with the guide of [3], the bridge assessment is realized and is classified like Good (1), acceptable(2), Regular (3) or Bad (4).

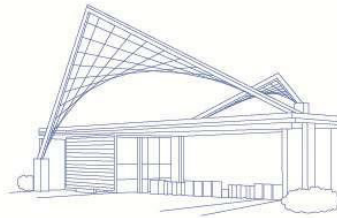
In this format the work group has problems too. When a steel member has buckling, the format [7], confuses distortion with buckling and are different deformations and damages.

If the bridge lacks of abutment and it is supported in a rock, it is not possible to report it, the format lacks this option. [5] y [7]

If the bridge has beams in different materials, the format does not permit evaluated the different materials in the classification. The work group must decide which beam will report, only one material.

INSPECCIÓN VISUAL POR ELEMENTO				
ID Elemento:	5316	Nombre del elemento:	Baranda o barrera en acero estructural	
Unidad de medida:	ml	Cantidad:	8,1	Ejes (Ubicación del elemento): A,B
Condiciones patológicas	Condición del elemento			
	1-Buena	2-Regular	3-Mala	4-Davera
1. Corrosión	100%			
2. Fisuración/ Fractura			40%	60%
3. Conexiones y anclajes			40%	60%
4. Distorsión				100%
5. Alineación				100%
6. Daño por impacto o colisión				100%
7. Altura mínima de seguridad	100%			
Observaciones: La baranda esta fallada debido a impactos las 2 barandas estan en falla estructural por choque en todas las direcciones.				

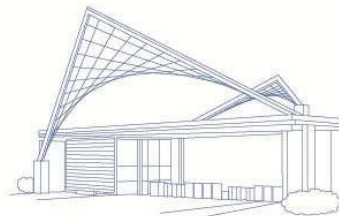
Source: ZJ Ingenieros Estructurales SAS. Distortion vs buckling.



Source: ZJ Ingenieros Estructurales SAS. Rock supports a bridge.

Conclusions

1. The author recommends to modify current bridges inspections formats, where are included more typologies of bridges, decks, beams therefore the work group can identify better the structure and the decision maker can assign inversion budget adequately.
2. It is necessary a total review of the formats, for what it has wrong terms used with distortion and buckling.
3. It is recommendable include more pathologies in the steel structures; therefore, it is possible to evaluate better the bridge.
4. In the contract, where were inspected 36 rural bridges. The public institution considered that the anchorage o massive structure in the suspension bridge was not an element important in the bridge. The author invites to reflexive if this part is the anchorage of the principal cables of the bridge. This should be inspected, included in the formats because a failure in the anchorage would cause a collapse of bridge hence its importance.
5. One option could be to create bridges inspection formats for rural zones and a new version for urban zones, where, be considered the aspects tried in this paper.
6. The author recommends before to use a new version calibrate in field any change that be proposed. For this reason, the change process must involve experienced engineers in field is not enough theoretical engineers to develop a new version of these formats.



Acknowledgments

The author appreciates can use some photos of ZJ Ingenieros Estructurales SAS, and illustrate diverse problems with theses formats and acknowledge the collaboration of this firm.

References

- [1] IDU, *GU-IC-14*, Bogota, 2021.
- [2] IDU, *IN-IC-10*, Bogotá, 2019.
- [3] IDU, *IN-IC-13*, Bogotá, 2019.
- [4] IDU, *FO-IC-27 Levantamiento Geometrico del puentes*, Bogotá, 2019.
- [5] IDU, *FO-IC-28 Caracterizacion estructural de puentes*, Bogotá, 2019.
- [6] IDU, *FO-IC-35 Determinacion de estado estructural y de servicio de puentes*, Enero, 2020.
- [7] IDU, *FO-IC-26 Evaluacion de patologias*, Bogota, 2020.