Available online at www.sciencedirect.com

ScienceDirect

Procedia - Social and Behavioral Sciences 160 (2014) 597 – 606

Procedia
Social and Behavioral Sciences

XI Congreso de Ingenieria del Transporte (CIT 2014)

A Methodology for the Inventory of Road Culverts Pathologies applied to the province of Jaen (Andalusia, Spain)

Fernando Delgado-Ramos[a]*, Maria Soledad Sanchez-Ladron-de-Guevara[a], Ana Diez-Contreras[b], Marcos Perez-Diaz[a]

[a]*Higher Technical School of Civil Engineering. University of Granada, Severo Ochoa Street, Granada 18071, Spain*
[b]*Agency of Public Works of the Andalusian Regional Government, Diego Martinez Barrio Avenue, Seville 41013, Spain*

Abstract

Culverts are essential elements of any road infrastructure. A culvert failure or malfunction may affect not only the culvert itself, but also it could cause serious problems on the road and its surroundings, such as floods, roadway damage, traffic interruption, and even fatal accidents. Although there are extensive bibliography and regulations related to proper design and construction of culverts, very valuable and less accessible information can be obtained from bad experiences. For example, sometimes culverts have a malfunction because of extreme rainfalls, but other times the failure is caused by changes in land use outside the road area with an excessive production of debris. It is therefore very important to gather all the information related to failures in culverts and to process it efficiently, both to reconsider the design criteria, and to prioritize actions for maintenance or improvement.
In this paper a methodology for the collection and processing of information related to culverts pathologies is proposed by the establishment of appropriate categories, the development of a database easy to operate; and the implementation of all this information in a Geographic Information System (GIS) for decision making support. As an example, this methodology has been applied to the Andalusian regional road network in the province of Jaen, (Spain).

Peer-review under responsibility of CIT 2014.

Keywords: Culvert;Road Maintenance;Database;GIS

* Corresponding author. Tel. : +34 958 248954
E-mail address: fdelgado@ugr.es

Peer-review under responsibility of CIT 2014.
doi:10.1016/j.sbspro.2014.12.173

1. Introduction

Culverts are essential elements of any road infrastructure. In Spain, the roads culverts have been designed using the technical regulation "5.2-IC for Surface Drainage", (Ministerio de Obras Públicas y Urbanismo, 1990), nowadays under revision, but there is not enough information or methodologies for culvert management such as in the USA with the "Culvert Repair Practices Manual" (Federal Highway Administration, 1995), or the "Culvert Management Manual" (Ohio Department of Transportation, 2012).

Experience shows that it is very important to get information from the management activities, failures and reparations, (Beaver & Mcgrath, 2005), (Najafi & Bhattachar, 2010). Some failures or deficiencies can produce high economic impacts (Perrin & Jhaveri, 2004), but also an arbitrary oversizing of every culvert can produce even worse economical effects.

In this paper a methodology for the inventory of road culverts pathologies is proposed based on several stages: (i) data collection, (ii) data base implementation with several categories, (iii) Geographical Information System implementation and (iv) analysis of results for decision making support.

As an example, this methodology has been applied to de regional road network in the province of Jaen, (Andalusia, Spain).

2. Data Collection

2.1. Structure

Data collection stage was designed in a sequential way (Najafi & Bhattachar, 2010) with three sources: (i) interviews, (ii) data registration in tables, and (iii) compilation and analysis of reports of emergencies.

First of all, the chief engineers of roads maintenance in the eight provinces of Andalusia and the Central Services were interviewed. In this first stage of data collection the most common problems in the road networks related to culverts and surface drainage were described. From this information it was possible to develop a preliminary classification of pathologies and diagnosis to facilitate the completion of a typified form to be sent in the next phase of data collection. After various meetings, a typified form was sent to the Heads of Road Maintenance Departments in order to let them indicate more precisely the different culvert pathologies, in a standardized way. Once received all the information and after a thorough processing, some changes were made in several categories to fix errors or deficiencies detected. Finally different reports provided by the Agency of Public Works of the Andalusian Regional Government were collected.

Table 1. Analysed culvert pathologies and distribution by province

Province	Number of Culverts with analysed pathologies	Number of associated Roads	Km. of Roads with analysed pathologies	% Km. affected compared to the total
Almeria	37	11	452,11	55,25 %
Cadiz	57	25	746,48	72,06 %
Cordoba	52	21	647,84	39,55 %
Granada	45	20	909,81	57,88 %
Huelva	23	11	280,69	36,42 %
Jaen	40	27	894,44	62,52 %
Malaga	125	19	809,49	63,53 %
Seville	74	28	1391,71	74,21%
TOTAL	**453**	**163**	**6132,57**	**58,88 %**