

STANDARDIZATION OF CONDITION ASSESSMENT METHODOLOGIES FOR STRUCTURES

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ABSTRACT: *Asset management is becoming more and more the leading principle for the way governments dealing with their assets: public space in general and infrastructure in particular as well as their real estate. Basic in asset management is the need for reliable information regarding the assets: to know what you got and in what state it is, is vital.*

It is therefore that in 2011, CEN/TC 319 'Maintenance' created a new working group, WG 11 'Condition assessment methodologies for structures'. The aim of this working group is produce Technical Specification (TS) on methodologies for condition assessment. The TS will describe an objective inspection method, which is usable for the determination of the technical condition of objects in a uniform way. Starting point for WG 11 was the Dutch standard for 'Condition assessment of buildings and infrastructural objects', NEN 2767. This standard is now common practice in building sector and starting to find its way in infrastructure, but for the moment predominantly for bridges, tunnels and viaducts.

By applying this method, the technical state of (parts of) objects can be expressed in a condition-score ranking from 1 (quality 'as built') to 6 (object can no longer fulfil its function, should be replaced). This condition-score is based on three parameters: the severity, extent and intensity of the defect.

Standardization of condition assessment of various type of assets will lead to better and more reliable information about your assets. It will also lead to

- *uniformity in both assessment and results;*
- *greater objectivity;*
- *similarity in definitions.*

As a result of which all parties involved in the process of condition assessments benefit:

- *less communication failures;*
- *improved long term maintenance planning and control;*
- *improved maintenance budget planning.*

Keywords: *condition, inspection, standardization.*

1 INTRODUCTION

The way asset owners, such as (local) governments manage their properties such as public space or real estate is changing rapidly. For infrastructure for instance the focus changes from building new to maintaining and improve the existing. Traditional focus on straight forward maintenance based on technical aspects only by the asset manager is no longer enough to get by. Risk-based maintenance, public awareness, political influences, performance driven approach of improvement of infrastructure are only a small selection of issues that are concerning authorities in their daily struggle. All these and more aspects are addressed in asset management, which for infrastructures is slowly but surely becoming more common. Basic in asset management is the need for reliable information regarding the assets: to know what you got and in what state it is, is vital.

It is therefore that in 2011 CEN/TC 319 'Maintenance' created a new working group, WG 11 'Condition assessment methodologies for structures'. The aim of this working group is to write a Technical Specification (TS) on methodologies for condition assessment. The TS will describe an objective inspection method, which can be used to determine the technical condition of different types of objects (assets) in a uniform way. The Dutch standard for 'Condition assessment of buildings and infrastructural objects', NEN 2767 [1,2,3,4], was used as baseline for WG 11.

The aim of NEN 2767 is:

To clearly and objectively record the technical life span of building and system parts. The technical condition of assets such as buildings, infrastructure and system parts is established by objective recording the defects. The method aims at the prevention

of subjectivity and variation in interpretation by inspectors in the field and increasing the objectivity and uniformity of the various disciplines (architectural engineering, hydraulic engineering, electrical engineering, mechanical engineering, piping, civil engineering, road construction, steel structures, etc.). As a result of which the quality of the information provided is more trustworthy.

NEN 2767 consists of the following components:

- a uniform inspection method;
- a standardised breakdown into parts of types of managed objects (decomposition);
- standardised lists of defects for every part, in which a defect generally is defined as a visually discernible deviation;
- a level of severity linked to every defect (Minor, Serious, Critical): more significant defects have a more prominent influence on the condition score;
- a method used to aggregate the scores for each part to arrive at a score for the entire object or a part of it.

In order to assess the condition measurement of objects ‘in the field’ the inspector has to:

- determine the defects (from the standardised list of defects);
- determine and register the Scale and Intensity of each defect.

These data then is used to calculate (in an automated way) the condition-score of a part in accordance with a standard.

As mentioned above, the NEN 2767 standard consists not just the inspection method, it also contains a standardized list of building parts and defects. The future CEN-TS will only consist of the inspection method and a method for the calculation of the aggregated score. Decomposition and defects will not be included in the TS. However, it will explain how to build a list of building parts / decomposition and a guidance for writing a standard list of defects.

2 METHOD OF CONDITION ASSESMENT

As explained above, the European TS will largely be based on the Dutch standard NEN 2767. In this section, the method as described in NEN 2767 will be explained briefly.

2.1 Defining a condition-score

The condition, expressed in a condition-score, is recorded in accordance with the first part of this standard, NEN 2767-1. This part contains the basic description of the method. The overall condition score of a building part is based on all defects that are detected. For each building part, the most rele-

vant defects are recorded and classified according to the importance of the defect.

According to NEN 2767, the condition score of a building part is determined on the basis of three parameters of a defect:

- severity
- scale
- intensity

2.1.1 Severity

The severity of a defect relates to the degree of influence of the defect on the performance of an object or object part and is determined in one of three classes:

- Minor: A minor defect has a direct influence to the function of the building- or system-part, for example dry rot or a defect ventilator of a air treatment box;
- Serious: A serious defect stands for a degradation of the building- or system-part, without assaulting the direct function of this building- or system-part, for example erosion or a leakage at system-parts;
- Critical: A critical defect has no influence on the function of a building- or system-part, for example graffiti.

2.1.2 Intensity

The intensity-parameter indicates the stage of a defect, also determined in one of three grades:

- Intensity 1: Initial stage: The defect is hardly observable.
- Intensity 2: Advanced stage: The defect is clearly observable.
- Intensity 3: Final stage: The defect is very clearly observable, a increase of the defect is not or hardly possible.

2.1.3 Extent

This is the net proportion of a defect in relation to the total size of the building- or system-part being considered: The extent is determined in one of five classes

- 1: The defect occurs incidentally (< 2%)
- 2: The defect occurs locally (2% to 10%)
- 3: The defect occurs frequently (10% to 30%)
- 4: The defect occurs substantially (30% to 70%)
- 5: The defect is common (> 70%)

The standard, as well as the future CEN-TS consists of clear guidelines for defining the Severity, Intensity and Extent of a defect. In the Dutch standard, the Severity of each defect is included in the standard list of defects. In the field therefore, the inspector only has to determine the Intensity and Extent of the defect. Since the CEN-TS will not include a list of defects, the Severity cannot be standardised at a

European level. The TS will give clear guidelines on how to make a list of defects. In these guidelines, there will also be a clear explanation of the framework for standardising the Severity of the defects. For a particular defect, the severity, scale and intensity scores jointly result in a score on a scale of 1 to 6 (table 1).

So, eventually a condition-score is derived in the range of one to six, where the explanation is as follows (table 2):

Table 2. Description of the condition score

Condition score	Description
1 = Excellent	Occasional minor deficiencies
2 = Good	Occasional signs of early aging
3 = Reasonable	Local aging, without jeopardizing performance or function
4 = Mediocre	Performance or function occasionally in jeopardy
5 = Poor	Ageing is irreversible
6 = Very poor	Technically ready for demolition

Once available the condition-score can be used in the various assetmanagementsystems, for instance in the way as shown in figure 1. This makes it able to analyse the condition of all the assets. Other aspects such as risks, achievements and costs can be related to the condition of these assets.

Table 1. Table of values for the classification score

Critical defects					
Size / Intensity	1) Incidental (< 2 %)	2) Local (2 % to 10 %)	3) Frequent (10 % to 30 %)	4) Substantial (30 % to 70 %)	5) Common (≥ 70 %)
1) Low (Initial stage)	1	1	2	3	4
2) Middle (Advanced stage)	1	2	3	4	5
3) High (Final stage)	2	3	4	5	6

Serious defects					
Size / Intensity	1) Incidental (< 2 %)	2) Local (2 % to 10 %)	3) Frequent (10 % to 30 %)	4) Substantial (30 % to 70 %)	5) Common (≥ 70 %)
1) Low (Initial stage)	1	1	1	2	3
2) Middle (Advanced stage)	1	1	2	3	4
3) High (Final stage)	1	2	3	4	5

Minor defects					
Size/ Intensity	1) Incidental (< 2 %)	2) Local (2 % to 10 %)	3) Frequent (10 % to 30 %)	4) Substantial (30 % to 70 %)	5) Common (≥ 70 %)
1) Low (Initial stage)	1	1	1	1	2
2) Middle (Advanced stage)	1	1	1	2	3
3) High (Final stage)	1	1	2	3	4

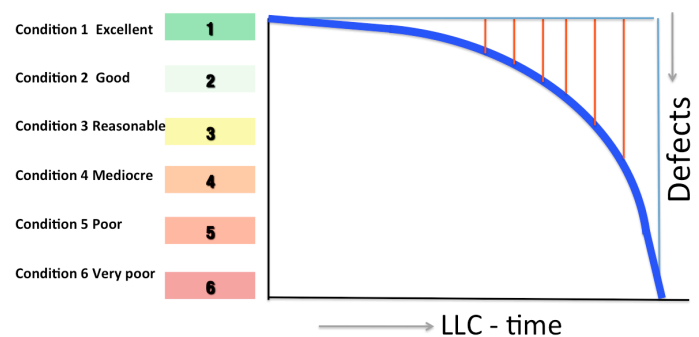


Figure 1. Condition rating based on defects assessment

2.2 Aggregation from building part to element and from element to object

Needless to say, several defects can occur in several building- or system-parts of an element. Taken together, these defects give an accurate impression of the technical condition of the element. NEN 2767 uses a calculation model based on the individual defects, to arrive at the condition-score for a building part. This in its turn can lead by an aggregation method to an overall score for an element and even for an object.

3 APPLICATION OF THE STANDARD

Many national, regional and local government organisations draw up long-term investment programmes for the management of assets such as infrastructure or government buildings.

Although the effects of economic crisis of the past few years are slowly diminishing, still many countries are cutting back on government expenditure in response to the economic downturn. Far-reaching short-term measures are therefore unavoidable. The control and justification of government expenditure are important spearheads. It is important to examine in-depth how the government is spending money, not in the least because cutbacks on services to citizens are prompting the same citizens to ask how the government is cutting back on its own expenses. Therefore new ways for managing the public domain (infrastructure and real estate) are needed, asset management in conformity with ISO 55000 being one of them. In asset management reliable information about the asset-portfolio is essential to draw up maintenance and investment plans and for instance prioritize expenditure on maintenance and management. When using the method for condition assessment as laid down in NEN 2767 it is possible to gather more reliable data towards the condition of objects in particular and the asset portfolio in general. As a result maintenance and management budgets (reduced due to the cutbacks that have been imposed) can be deployed more effectively. Particularly the combination of estimated risks and the current condition of the relevant asset lead to the implementation of controlled cutbacks [5].

3.1 NEN 2767 in asset management

The new international standard for asset management ISO 55000 addresses the importance of trustworthy data about one's assets: knowing what and where they are and what the condition is. Information derived from this data is used in every step of the processes that can be distinguished in asset management. The Dutch knowledgebase "iAMPro" for instance is based on the Deming-circle and consists of six process steps (figure 2). This platform can be seen as a knowledge platform for asset management and the rose itself can be considered as a mark for asset management principles. This is deployed as a connector in this knowledge platform to exchange information between several organizations about asset management.

The aim of NEN 2767 is to unambiguously and objectively determine the condition of systems by clearly recording their defects and technical status. When the condition of systems is recorded in this way, it is possible to assess their status and therefore the condition of the object. In long-term programming, in addition to performing the inspection a prediction is also made of the best economic and technical moment at which to execute maintenance or renovations. Furthermore the risks for the coming years in terms of performance and safety are also estimated [6].

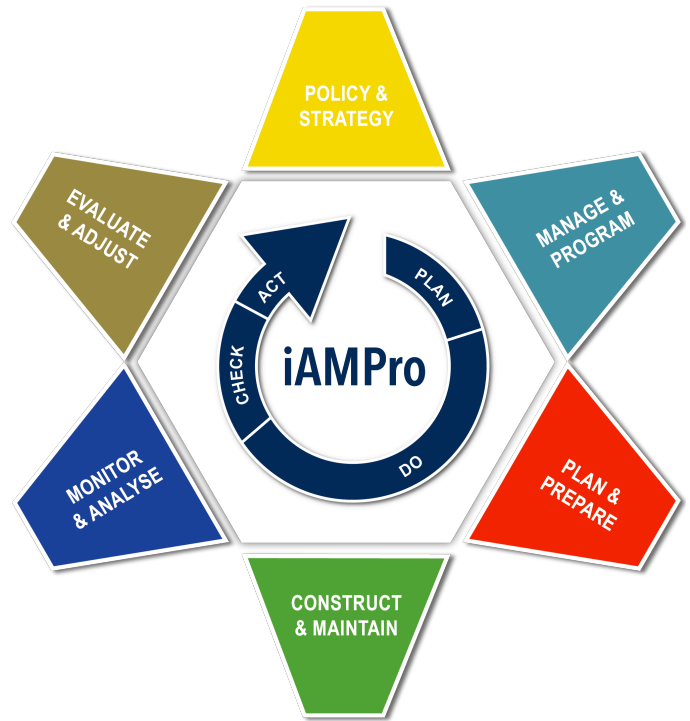


Figure 2. iAMPro rose based on the plan-do-check-act cycle

The distinction that is currently made between a condition inspection and long-term programming is not based on the actual inspection but on the results of the entire process. The condition of the systems is recorded for both short term maintenance planning as well as long-term programming. Desk studies are done to determine the risks and the consequences while drawing up the long-term programming. NEN 2767 is positioned at the level of the condition inspection and provides information for the programming process (figure 3).

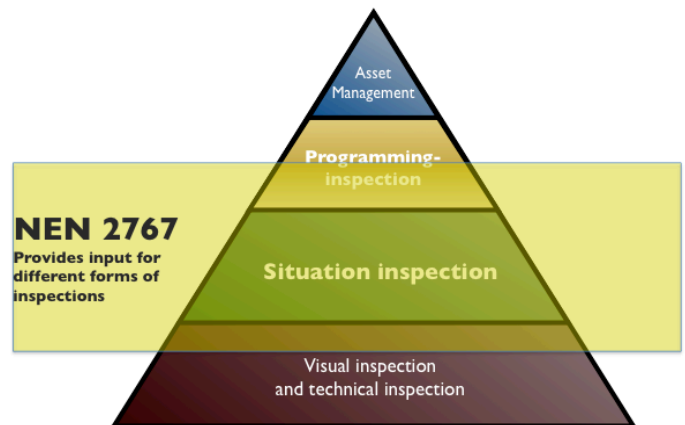


Figure 3. Location of the NEN2767 within the long-term programming process

Therefore it can be concluded that rather than signifying a change in the inspection policy of the government organizations, NEN 2767 is a methodology to ensure that inspections are conducted and reports are compiled in an unambiguous way.

3.2 *Applicability of maintenance management systems (MMS) and geo applications*

Establishing the technical condition of objects in accordance with NEN 2767 is an effective means to draw up maintenance plans. In this respect when used in combination with a Maintenance Management System (MMS) and a Geo application NEN2767 is of great value.

Customers such as road authorities or real estate corporations can obtain a clear picture of the condition of their systems and objects and thus insight in maintenance planning and costs. By performing condition measurement and recording on a regular base the results in the MMS together with the other maintenance information, such as risk analyses, corrective and preventative maintenance an insight can be gained into the various contract parameters.

The use of an MMS, the execution of regular condition measurements in accordance with NEN 2767 or the future CEN-TS, the execution of a risk analysis and the use of this data in a Geo application results in the following advantages for users:

- The data related to objects is safeguarded;
- The maintenance levels of objects and system parts are determined in an objective and uniform way;
- And therefore condition-levels of various types of objects are presented in an in a uniform way;
- NEN 2767 provides a trustworthy tool for drawing up contracts and can therefore be used for to manage contracts, thus reducing conflicts between the client and the contractor.
- Responsibilities can be transferred more easily.

4 WHY NEN2767?

Due to the standardised character of the method, the condition assessment will result in uniform and objective results for different types of objects (disciplines) in an asset-portfolio. This will improve the reliability of the collected data which in turn will lead to:

- Better and more transparent long-term maintenance plans;
- Better maintenance specifications;
- Improvements in transferring responsibilities;
- Better contract-management.

Also when NEN2767 data is recorded electronically (for example, in a Maintenance Management System - MMS), trend analyses can be conducted, which in turn makes it possible to migrate from a reactive to predictive management. The use of condi-

tion measurement gives clients a clear picture of the condition of the systems and objects before during and after contracts.

4.1 *Current and new inspection strategy*

In an asset portfolio often a wide variety of different types of assets is at hand. It is common practice that current inspection strategies include many different inspection methods, leading to different types of inspection reports, which may be used in different departments in the relevant organisations. Using NEN 2767 the condition assessment of the various disciplines will result in a single unambiguous inspection report that gives an accurate impression of the condition of an object or system. To realize this, the inspections will have to be geared more accurately to each other and the results will have to be processed centrally.

4.2 *Risk analyses*

The condition of assets can be combined with other aspects out of the asset management principle. A relationship also exists with risk analyses, which determine the chance of failure and consequences of failure of a system. These risks can affect the inspection strategy, given the fact that high-risk systems are often subjected to more in-depth and/or more frequent inspections. Ultimately the main objective of the asset-manager is that his asset portfolio performs well and therefore its objects. Their performance can be expressed in indicators such as availability, safety and maintainability. With these insights in risks for assets combined with their condition both parameters can strengthen each other.

5 CONCLUSIONS

For several decades, many different methods for the assessment of the technical state of buildings and infrastructure were performed alongside each other (and still are). With NEN 2767 it is possible to replace these different methods by one single inspection method.

NEN 2767 expresses the technical state of all building and installation parts and objects in condition scores between 1 and 6. These scores represent the stage in the technical life cycle that the part is in. Application of this standard, leads to among others:

- uniformity in both assessment and results;
- objectivity;
- similarity in definitions;
- one common language.

By applying NEN 2767 all parties involved in the process of condition assessments profit:

- less communication failures;
- improved long term maintenance planning and control;
- improved maintenance budget planning.

Currently, NEN 2767 is applied in the Netherlands, where its usefulness and advantages have been proven widely. By evolving this method for condition assessment into a European Technical Standard a much wider range of organisation could profit from this method. It will give international organisations, with properties in different countries, the possibility to gain standardized, comparable information on the technical state of their properties. Furthermore, it will create possibilities for inspection and advisory organisation to widen their market and work more internationally.

To create a Technical Standard which is applicable widely and internationally, it is important that specialists from all different backgrounds and nationality work together. Only in this way, the method can be evaluated widely and can be improved before publication of the CEN-TS.

6 REFERENCES

- CROW – iAMPro , www.iampro-portaal.nl regional governments Noord-Holland, Gelderland
- NEN 2767-1:2011 Condition assessment of building and installation components – Part 1: Methodology, NEN (2011), Delft, Netherlands
- NEN 2767-2:2008 Condition assessment of buildings and installation components – Part 2: List of faults, NEN (2008), Delft Netherlands
- NEN 2767-4-1:2010 Condition assessment – Part 4: Infrastructure – Part 1: Methodology
- NEN 2767-4-2:2010 Condition assessment – Part 4: Infrastructure – Part 2: Web application for the Decomposition and list of defects, NEN (2010), Delft, Netherlands
- Van der Velde, J. 2011. *Asset Management*, Rijkswaterstaat, Utrecht, Netherlands
- Vrouwenvelder, A.C.W.M. 2011. *Onderhoud en beheer in de bouw*, TNO/TU Delft, Delft, Netherlands