

Implementing quality management and EN 13508-2 for CCTV sewer inspection in Austria

Implémentation de la gestion de qualité et de la norme EN 13508-2 sur le codage d'inspection visuelle des réseaux en Autriche

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RESUME

En Autriche, l'âge moyen des réseaux d'égout impose des travaux de restauration. Sachant que les résultats des inspections définissent la planification de la restauration, l'amélioration des résultats d'inspection par TVCF était l'objectif principal d'une étude financée par le ministère de l'environnement et le gouvernement régional de Styrie. Plusieurs ateliers théoriques et pratiques ont permis de concevoir une approche de gestion qualité pour les inspections par TVCF.

Cet article décrit la formation des personnels et ingénieurs d'inspection, les bases des critères de qualité, de l'approche de gestion qualité et de propositions pour une procédure d'appel d'offre de haute qualité, y compris les gabarits standardisés et des recommandations pour l'évaluation. On constate que l'amélioration des résultats d'inspection dépend du personnel d'inspection sur site et des ingénieurs qui décrivent les résultats et évaluent les offres sur une base du mieux disant.

ABSTRACT

Regarding the average age of sewers in Austria, rehabilitation becomes more and more important. As the inspection results build the structural basis for rehabilitation planning, raising the quality of CCTV-inspection results had been one main goal of a pilot-study financed by the ministry of environment and the regional government of Styria. In several theoretical workshops and by practical implementations with 4 operators and 3 inspection companies a quality management approach for CCTV sewer inspection has been designed.

Main issues of the paper are the training and retraining of inspection personnel and of engineers, the underlying basics for a quality mark, the Quality Management (QM) approach and the suggestions for a high quality tendering procedure including standardised templates and evaluation guidelines. It can be seen that the responsibility for an improvement in inspection results has to be taken on the one hand by the inspection personnel onsite and on the other hand by the engineers when describing the deliveries as well as evaluating the tenders not only by costs but by quality.

KEYWORDS

CCTV inspection, operation, quality management, rehabilitation, tendering, training.

1 INTRODUCTION

The inspection of sewer systems and their components serves for the examination and assessment of the condition. As state of the art for the description of the condition of non-man-accessible drains CCTV cameras are used, almost exclusively, for optical inspection. The results of an assessment of condition must be of high quality as all further activities are based on these results. The reliability and correctness of the TV inspection is the foundation for decisions on rehabilitation and the huge financial investments depending on it.

Korving and Clemens (2004) report about *“the measuring accuracy of visual inspections that has been estimated from entrance exams for inspection personnel in The Netherlands. It has been described in terms of entropy of classifications, probability of incorrect classifications and probability of incorrect decision-making on maintenance and rehabilitation. The statistical uncertainty of calculated probabilities has been assessed using Bayesian analysis. The results demonstrate that the accuracy of classifications is less reliable for eight (out of 18) condition types. The majority of these aspects is related to blockage, leakage and subsidence.”*

As Fischer et al. (2006) describe *“the quality of the inspection depends essentially on the qualification and the momentary motivation of the camera operator. In this conjunction, the following basic sources of error are inevitable :*

- *Condition-related defects or other conspicuous points that affect the proper functioning of the sewer are overlooked.*
- *The sewer section is not completely scanned.*
- *Defects or their dimensions are described in inconsistent or non-standard terms.*

The great frequency with which these types of errors occur has been demonstrated by extensive studies comparing the results of parallel inspections of the same sewers by different operators (Hüben, 2002; Müller, 2006 cit. by Fischer et al.2006).

This showed that it was only in 16 % of the 307 inspected reaches that an identical number of defects were detected and a defect description was made with an identical condition classification (ZK) and condition report.

Fig. 1 shows the spread of differences in the condition classifications of each sewer reach according to the first and second inspection or report respectively, which ideally should be near to zero. All in all, this clearly shows that conventional inspections depend considerably on the operating personnel, and as a general rule, it can be assumed that the condition of sewers is not established objectively and therefore not clearly and reliably enough.” Fischer et al. (2006).

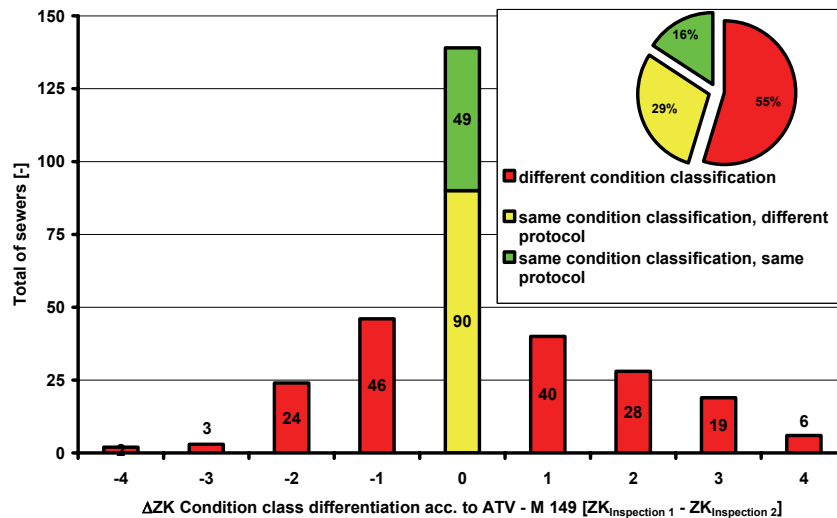


Fig.1 : Differences in condition classification of 307 sewer reaches after parallel inspections (Müller, 2006 cit. by Fischer et al.)

In the authors' opinion automatic digital image processing of fish-eye-lens photographs mathematically transformed to a 3D sewer model as described by Fischer et al. (2006) is one high-end approach of improving the inspection results, if the survey technology will be good enough as the conventional one, but this is not proved until today for any diameter and type of defect.

The other way as described in this paper is to improve the quality of the human inspection results by new forms of accompanying quality measures to prove that the operating personnel delivers an objectively described structural and operational status of the sewers by using high quality equipment in a well trained way.

2 METHODS

2.1 Preparations for and side effects of QM for CCTV inspections

2.1.1 Implementation of standardised tender documents

The definition of standard documents for invitation to tender is a significant step towards quality assurance. Only a clear definition of the requirements from the client requires a correspondingly high quality offer by the contractor. The documents elaborated in the project will be checked by a national working group in order to be published as a template for operators and their civil engineers.

2.1.2 Implementation of EN 13508-2 (2003)

The project team decided to carry out the inspections according to the New European Standard for visual inspection coding for the first time in Austria because of its inherent advantages over the former used systems. The inspection personnel and the civil engineers have been trained in a special course and fulfilled the expectations in the implementation phase. The software applications were hardly to get, but finally after more than 1 year of waiting the inspections were made. Until the end of 2006 there was no assessment software available to transform the codings automatically to condition classes, because the assessment algorithms of ISYBAU (2006) which has been used in the project, has been published very late in October 2006.

2.1.3 Implementation of a checklist for occupational health and safety

The protection and safety of work in Austria is defined by the General Employee Protection Ordinance, by the Employee Protection Law (1994). The risks of working in a sewer can be very high, so the use of the protection and safety equipment should be the basis for every work in the sewer. Therefore, the project team developed together with the ÖWAV committee "operational staff of sewer systems" a check-list for the necessary equipment.

The experiences of the project have shown that none of the project's inspection companies fulfilled all demands given by law at the prequalification. A second check at the education course and a third check at the test inspection has shown that then every company fulfil the requirements and could also use the equipment correct.

2.2 Improving CCTV results by QM and training

Experiences in Austria and other European countries (Bölke, 2004; DTVK, 1986; Gangl et. al., 2005; Müller, 2006; Korving and Clemens, 2004) have shown that the realization of a quality management for CCTV inspection is necessary.

Adequate equipment, specialist training, and appropriate practice serve as a basis for the achievement of high quality inspection videos. In Austria, the ÖWAV [Austrian Water and Waste Management Association] basic courses and information events in the camera inspection sector are on offer.

2.2.1 Quality Management

The costs for the quality assurance measures are, compared to the total costs of sewer rehabilitation, very low. In return, one obtains a qualitatively secured basis for rehabilitation tasks. Costs due to a possible subsequent correction or a repeated run by the inspection firm are also dispensed with, through which the small additional expense for the inspection firm in turn, should be worthwhile.

When studying the various forms of Quality Management Standards the authors have chosen the FOCUS - PDCA Methodology (MRMA [1999] derived from the ISO 9001 [2000] Plan-Do-Change-Act Cycle) for the project development. The PDCA cycle has been expanded to a nine-step process that incorporates a FOCUS stage before the PDCA cycle. These nine steps are described as follows. Signed with an arrow (→) *the according issues of the project are added in italic letters* :

1. Find a process that needs improvement.
→ *CCTV inspection needs improvement because of unsatisfying results as described above. The inspection process handled by the operators at the beginning of the project contained the following steps:*
 - * *Tendering;*
 - * *Contract assignment (often without written contract and no safety instructions)*
 - * *Delivery of inspection tasks with very old maps or oral instructions only*
 - * *Main inspection without accompanying measures by client*
 - * *Delivery of inspection results (-> archive)*
 - * *Accounting (by inspection length only)*
2. Organize a team that knows the process.
→ *all concerned parties (inspection companies, sewer operators, engineers, government & scientists) are involved in the project team*
3. Clarify knowledge of the process by flowcharting or data collection.
→ *The project managers have discussed the situation of CCTV inspection in Austria together with one of the well-established experts of sewer inspection in Europe. He has been contracted for detailed analyses of all inspection results and for (re-)training of the personnel*

4. Uncover the underlying causes of variation or poor quality.
→ *Workshops have been carried out within the project team and together with the contractors.*
5. Start the P-D-C-A cycle by choosing a single modification to the process.
→ *Evaluation of the company incl. equipment and personnel by using the evaluation matrices*
6. Plan a pilot to test the improvement.
→ *4 sewer operators have joined the project for testing the new steps of the process*
7. Do the improvement.
→ *Beginning with 7 contractors who tried to reach the project level of quality, 3 service companies remained at the end for implementation of the new process*
8. Check that the process actually improved.
→ *the inspection results have been analysed by the inspection expert and the feedback was the basis for discussion in the workshop meetings*
9. Act to adopt, adjust or abandon the change.
→ *additional training courses and quality improvement of the equipment emerged necessary, several new steps in the process have been added or adopted to the new quality management strategy (see below)*

In detail three main steps have been carried out in the project to uncover the underlying causes of poor quality of the inspection results:

- A preliminarily theoretical workshop, where former inspection videos from the operators were discussed.
- A prequalification, where companies were invited for the same sewer section to deliver videos with prescribed inspection quality with coding according to the German standard ATV M 143-2 (1999). The examination of the inspection videos took place through a publicly appointed and sworn expert. To define "high quality", the inspection companies had to reach a preset 80% level of the former published evaluation matrix. This limit was defined by the project partners in a preliminarily workshop.
- A subsequent workshop, where the delivered videos of the prequalification were discussed and the output of the evaluation matrix was presented.

The performance results of the prequalification to which the inspection companies have been invited for inspecting the same sewer section (figure 2) demonstrated the need for an implementation of a quality control for CCTV inspection. Some results in detail included that conditions often have been described in an insufficient or even wrong way, the lens of the CCTV camera was dirty during inspection, for some conditions the pictures were overlightened or the position of the camera was not placed in the middle of the cross section.

None of the inspection companies could reach the former defined level of 80% of the evaluation matrix, which was part of the standardised tender documents, as one can see in figure 2.

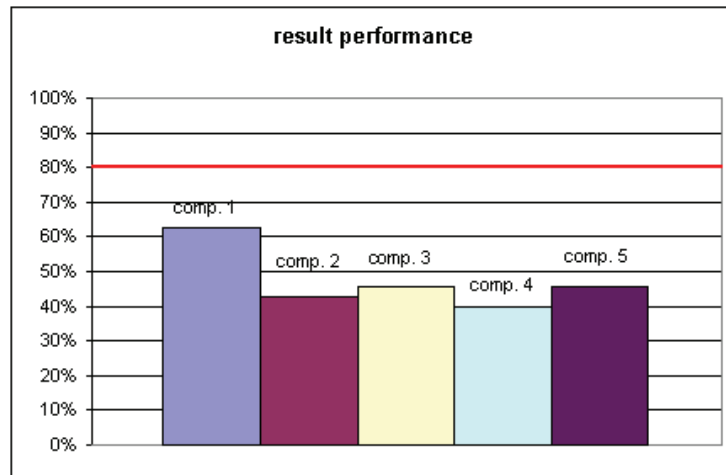


Figure 2. Performance results of the companies participating in the prequalification.

The conclusion of this result was to organize a retraining sewer inspection course with a main focus on practical performance. The sewer inspection in the project has to be done with the description according to EN 13508-2. Therefore a course with main focus on coding according to EN-13508-2 and practical performance was organised. This course which will be further organised by the ÖWAV showed the importance of a practical inspection under guidance. Both, contractors and clients attended this course to be intensively informed about the new coding standard.

The last step in raising the quality was a test sewer-inspection by using inspection software according to the EN 13508-2. The results have shown that the quality of the performances reached a satisfying level.

There will be the need for some more modifications of the process and therefore the need for going several times through the PDCA cycle to reach a high level of quality of the inspection results. The next modifications of the CCTV inspection process should lead to a process structure consisting of the following steps:

- *Tendering*
- *Evaluation of the company incl. equipment and personnel*
- *Contract assignment incl. safety and health instructions*
- *Delivery of inspection tasks incl. maps and digital data to the contractor*
- *Test inspection of predefined section*
- *Evaluation of first results incl. check of digital data exchange*
- *Main inspection accompanied by client or contracted engineer attending to their duties*
- *Delivery of inspection results in complete digital form*
- *Control of results according to quality and data management standards*
- *Additional claims if necessary*
- *Accounting*

For the evaluation of the inspection companies and the continuous survey of the inspection results a nationwide institution should be founded to minimise the costs for this step.

2.2.2 Suggestions for optimised training and retraining

Not only for sewer inspection personnel but also for engineers and decision makers in this field training is necessary for raising the quality of the results. The engineers need the know-how to understand the work of the inspection personnel for a high quality tendering process.

Within the national sewer inspection courses, up until now no examination of the practical ability of participants took place. There is only a test stretch at which the participant can make a short camera run. To carry out such a practical test within the scope of the basic course is problematic both from organisation and time. An alternative to this would be a type of comparison and qualification test as it is dealt within the water tightness tests according to the national standard. Hereby the service companies have to come with their own equipment to a test ground and must carry out investigations under the supervision of a monitoring agency. The test stretch to be inspected must be changeable to such an extent (test run pool at the place of training), that it displays different damage with each examination. In the course of this examination the technical equipment, handling with regard to safety and protection of labour and the inspection results are monitored. A private austrian company already has built a test facility which is open for training courses with several sewers of different materials and diameters buried with all kinds of defects (see EPC, 2006).

3 RESULTS

The performance results of the prequalification demonstrated the need for an implementation of a quality control for CCTV inspection in Austria. None of the inspection companies could reach the former defined level of 80% of the evaluation matrix, which was part of the standardised tender documents.

The conclusion of this result was to organize a sewer inspection course with a main focus on practical performance. The sewer inspection in the project has to be done with description according to EN 13508-2. Therefore a course with main focus on coding according to EN-13508-2 and practical performance was organised. This course showed the importance of a practical inspection under guidance. Both, contractors and clients attended this course to be informed about the new coding standard.

The last step in raising the quality was a test sewer-inspection by using inspection software according to the EN 13508-2. The results have shown that the quality of the performances reached a contented level.

4 CONCLUSIONS

The following points must be taken into account for the implementation of a Quality Management System in Austria:

- Introduction of a quality mark

All prerequisites, such as the equipment, training, experience of personnel and other requirements, could be laid down in a national standard or advisory leaflet.

It could be included in the articles of incorporation for the national Quality Mark that a basic examination is to take place – technology, personnel, quality of work – and then, at certain intervals, an examining engineer can monitor a construction site every two years, there check the safety equipment in accordance with our specifications

and the compliance with the safety regulations and take away a copy (video/DVD) of the inspection runs.

An expert takes over the checking of the inspection video and assesses how many conditions were not recorded and the quality of the recorded conditions.

- Admission to the trade

Admission to the trade can be seen in direct connection with the quality of the equipment and personnel of the service firms. Currently there are no limitations for the registration for the trade "Sewer cleaner".

- Improvement of training and retraining

Not only for sewer inspection personnel but also for engineers and decision makers in this field training is necessary for raising the quality of the results.

- Standard documents for invitation to tender

A further significant step towards quality assurance is the creation of standard documents for invitation to tender. First, a clear definition of the requirement of the client requires a correspondingly high quality offer from the contractor. The requirements of the documents for invitation to tender, elaborated in the project refer to the above points.

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