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SUSTAINABILITY OF WATER AND SANITATION SYSTEMS

The Mainren model for sustainable built environment

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DIFFERENT METHODS AND techniques can be applied for problem solving in rehabilitation and maintenance of buildings and sanitation. These methods and techniques are often not interrelated and therefore lead to conflicting solutions. This is in particular the case when new criteria, like life cycle costs and sustainability are introduced. We collected existing methods and techniques and combined them into a (simple) framework / model. Meanwhile adding some of our own research results. When 'going now through' the model with a 'problem' one is more sure to have arrived at the optimum solution for that problem.

Description of the Mainren model

The name Mainren is an acronym for Maintenance and Renovation (Dutch: Ohren model) and consists of a set of interlinking modules a upto g (fig. 1).

The modules are in a logical order from establishing the existing situation up to feed back of realized technical improvements.

The model demonstrates itself at best with the forms, tables and figures instead of text.

However in this paper not much space is available. Therefore each module will be briefly described with 'microscopic' pictures of the most important items. The oral presentation of this paper allows full-size presentation of pictures. Modules f and g are not discussed here as these are still under development.

Inspection

For inspection of the situation a selection has to be made out of various inspection methods. The choice depends on the future purpose of the inspection results: for strategical, tactical or operational reasons. As such the inspection may range from one element in a few structures to all elements in all structures. The method of inspection and collecting information depends further on whether it is done for safety, historical value, production process, functioning of the elements / installations, financial consequences due to damage or for repair. The actual inspection can be done by measuring, picturing, video, touching, etc.

Figures 3, 4 and 5 show detailed measuring for the preparation of "as built" drawings. These drawings can also be used to indicate e.g. location of cracks in walls and other bad spots. A data base has to be used to store and retrieve this information.

Analysis

When working out the survey, the existing situation can be analyzed and causes of problems met. By means of a so called 'priority matrix' (fig. 6) the occurrence and degree of a problem can be indicated; which supports future decision making. There are also lists available of

Figure 1. Mainren model, modules (Erkelens, 1995a).

Figure 2. Relation inspection types and targets.

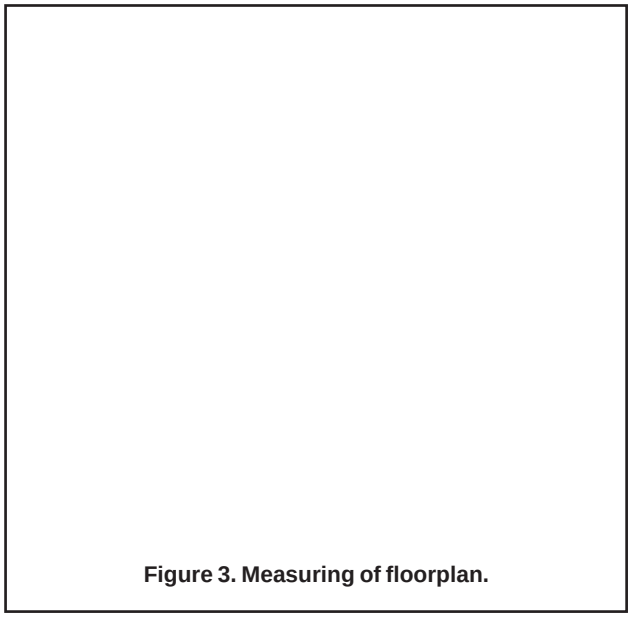

Figure 3. Measuring of floorplan.

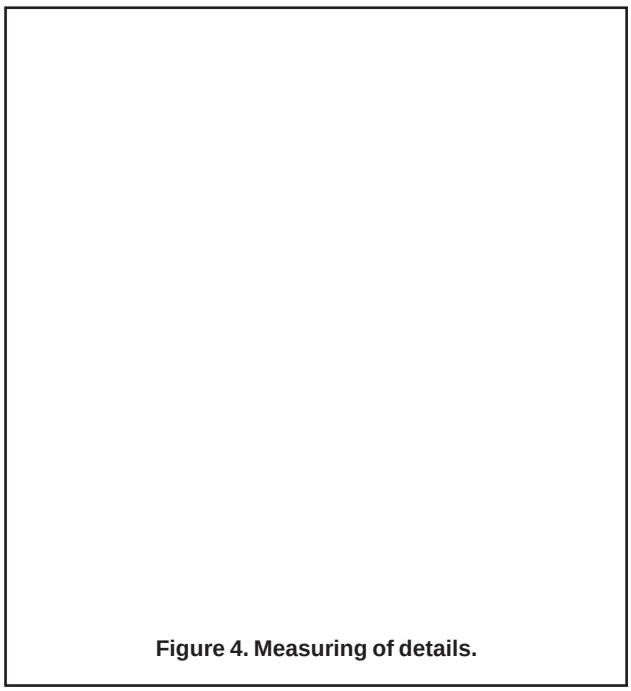

Figure 4. Measuring of details.

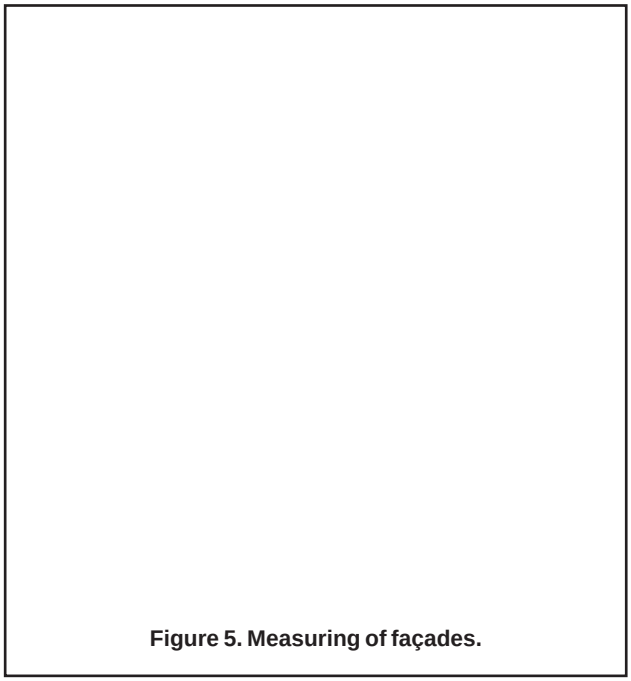

Figure 5. Measuring of façades.

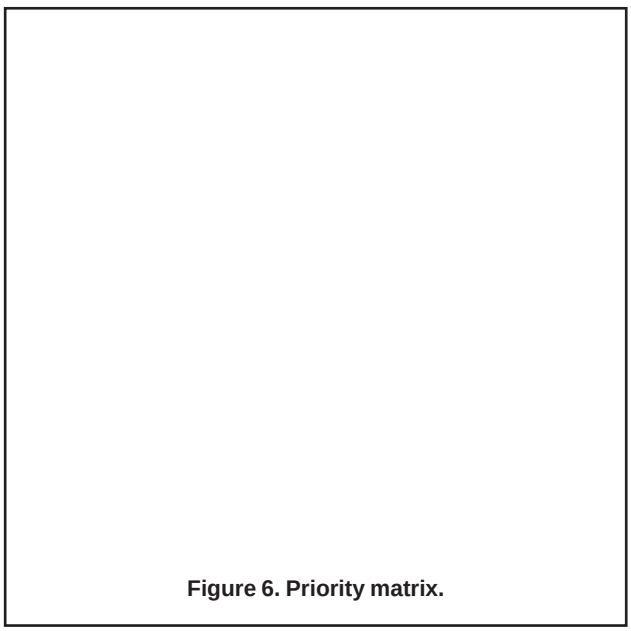

Figure 6. Priority matrix.

most frequently occuring problems. In the case of cracks in walls / façades we can analyse the cause of the cracks based on what we saw and what we measured while comparing with lists (fig. 7).

Another method is using a fault-free analysis which leads us to the cause of a problem. We distinguish thereby: mechanical, biological, physical and chemical causes. Fig. 8 shows a biological degradation diagram for a concrete balcony plate.

Relations between problems can also be studied in a relational matrix (fig. 9) which shows that problem 'D' (e.g. heat resistance of a roof) has most of the relations to the other problems met. The tackling of problems can begin with solving this main problem. In fig. 10 this main problem is put in the center of the relational diagram with problems.

Criteria

The criteria can come from more sources: (I) the available methods and techniques, (II) the philosophy of the designer, wishes of the client and (III) the building by-laws inclusive of sustainability and (IV) the location and context of the building / sanitation object concerned. From the point of sustainability we use a list of prefered materials for selecting as developed in the Netherlands.

Also we have considered integrated 'life cycle management' which means:

a) Closed cycles of materials

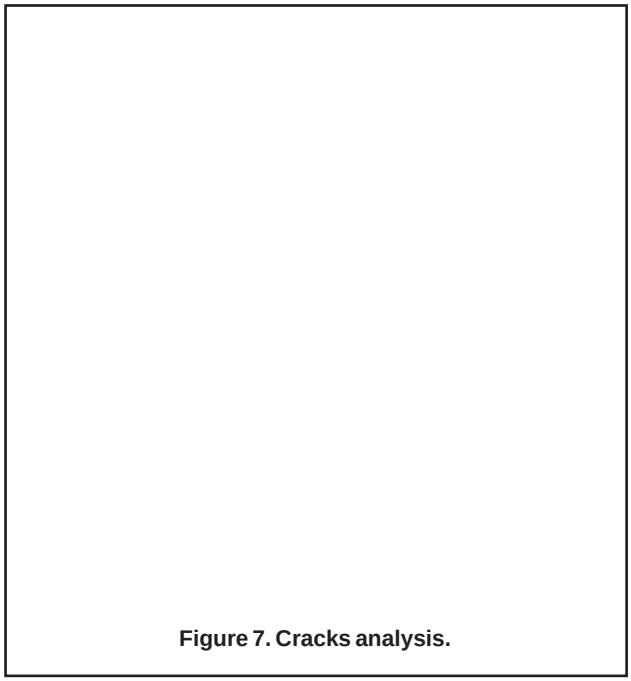

Figure 7. Cracks analysis.

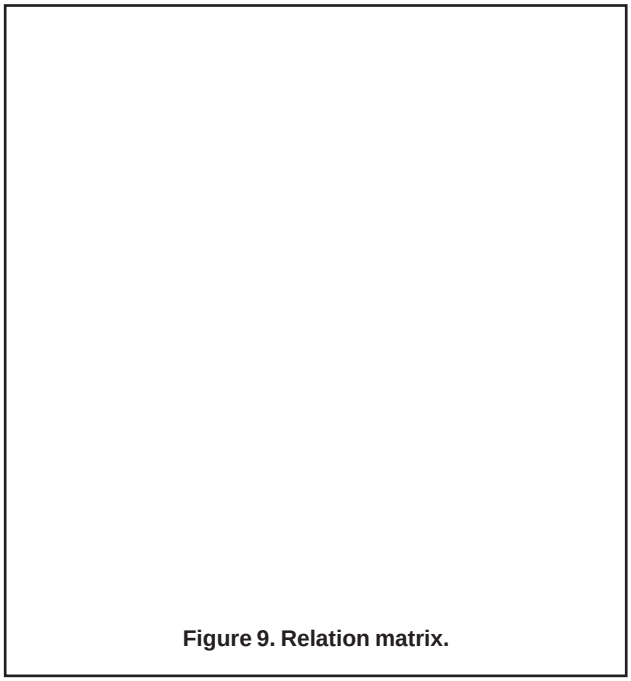

Figure 9. Relation matrix.

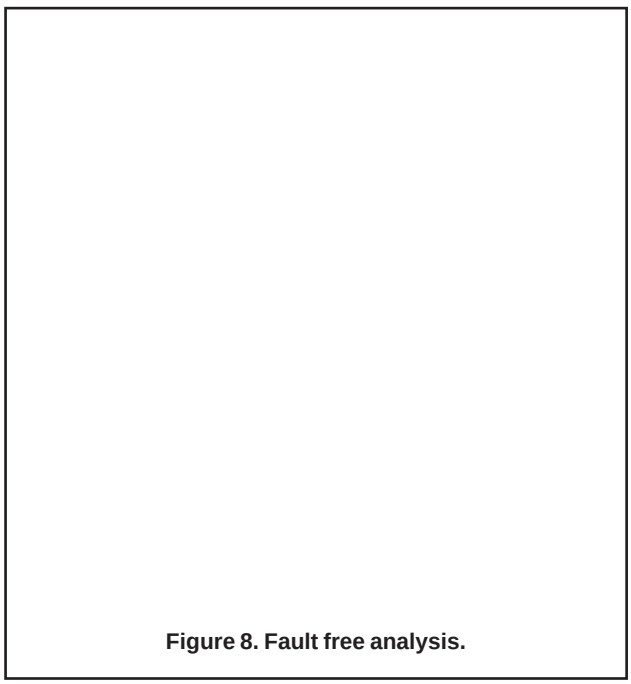

Figure 8. Fault free analysis.

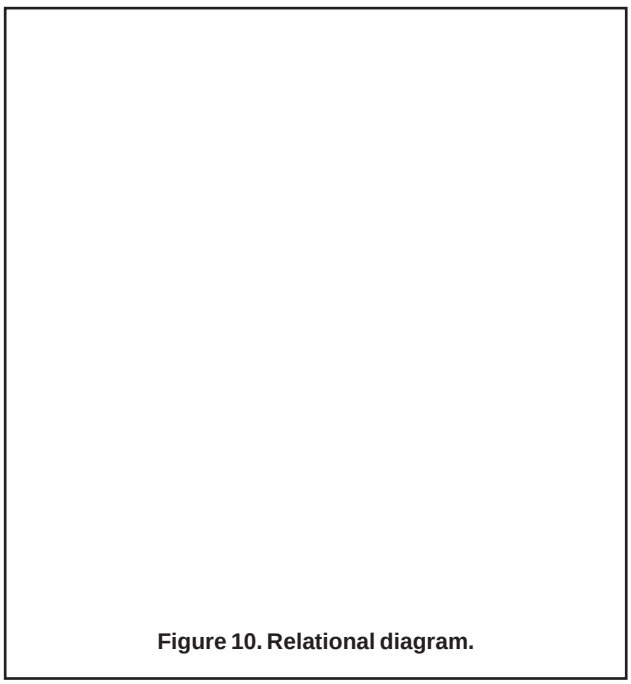

Figure 10. Relational diagram.

b) Prevention of residual waste flows and increased recycling of building- and demolition wastes and
c) Reduced residual emissions in the environment during production of building materials and the building process and improve quality of design and execution.

Solutions

The generation of solutions for problems can be done in various ways and depends on the above criteria. Measures may range from just a facelift up to full / upgrading. Solutions for future maintenance may be sought in maintenance minded design, this can be either design for minimum maintenance and / or maintenance friendly design.

For generating of solutions we can use a variations matrix (a checklist for possible solutions, fig. 11).

Synthesis

When it comes to the selection of the best solution, we need a system for comparing these against the criteria. Figure 12 shows in a schematic way a balance between architectural-historical feelings and its use performance. The various solutions can influence this balance. The final choice depends amongst others on the client. More quantively we can value the solutions against criteria

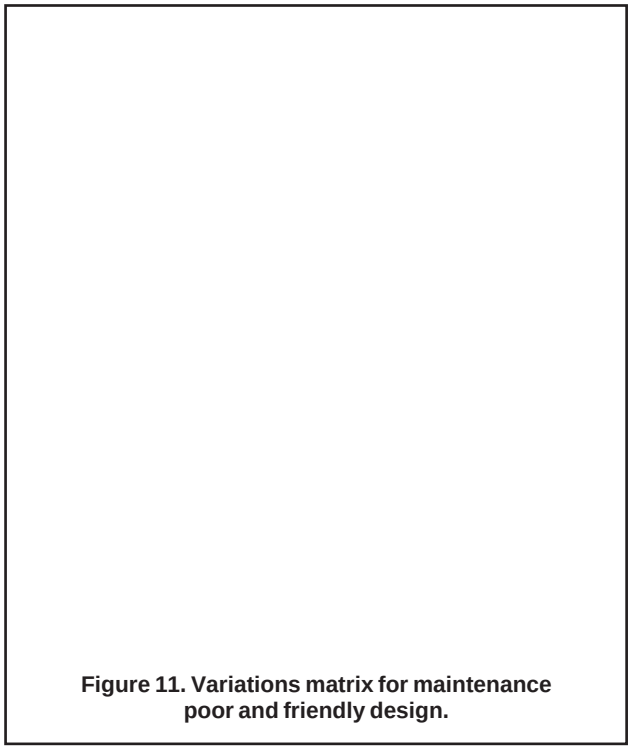

Figure 11. Variations matrix for maintenance poor and friendly design.

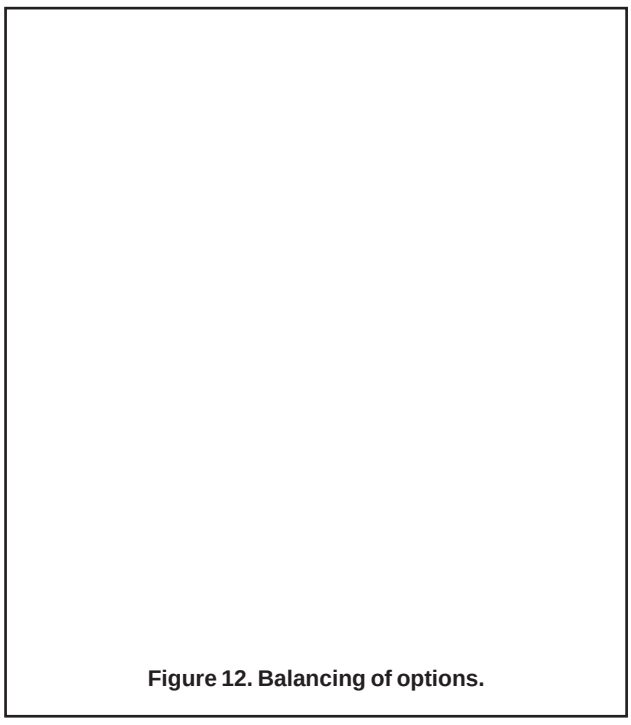

Figure 12. Balancing of options.

with the expected value method, which is a simplified multicriteria evaluation technique (figure 13). The lowest value represents the 'best' solution.

Conclusions

The Mainren model is still under development but it eases the work of the consultant. Not everything may be tackled with this model but it brings to light in a better way how decisions are being taken.

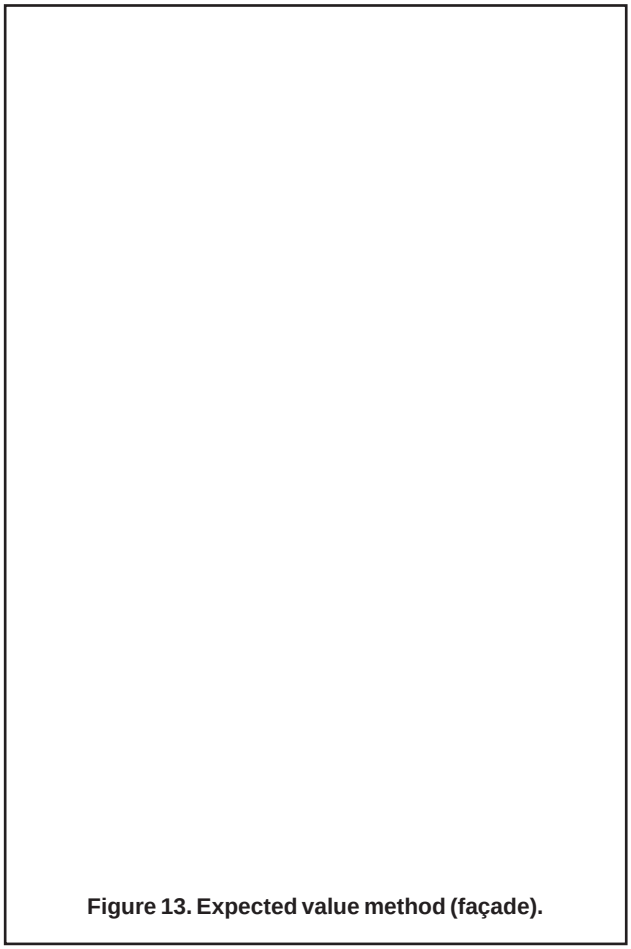

Figure 13. Expected value method (façade).

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