

# THE METHODOLOGY IN VISUAL EXAMINATIONS IN BUILDING PATHOLOGY

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## **Abstract**

*Among the building pathological examinations the visual inspection on the spot plays role in the quick assessment of damage and in defining the appropriate way of expedient examinations. Casing the joint can be effective only if the expert applies properly all his collected knowledge about the existing building constructions, their behaviour and about the exterior factors which take effects on them. The large number of different constructions, the complexity of the mechanism of the effects among the elements and the specialisation of building diagnostics profession cause that the execution of examinations became more difficult task. The examination system outlined in this article offers the complex entirety of diagnostic observation for its applicants while gives methodological help in executing the failure analysis.*

## **Introduction**

The global scale social and environmental problems raise questions on the field of architecture which are not answered yet. The built environment plays an important role in the development of the observable critical position.

- The fast growth of population of earth – the number of human beings accelerates the 10 thousand million in 2050 [1]- evokes that the stock of buildings should be duplicated in hundred years.
- Only in Hungary the 25% of yearly energy consumption – which means 300 Petajoule (1 Petajoule equals the heating value of 24 million kgs of paraffin) – is directed to operating buildings [2].
- 40% of the whole energy consumption is directed to build, use and pull down buildings. A large part of waste materials derives from the building trade.

Today it became clear that the present process can not be kept for a long time, a fundamental change in approach have to be attained in the architects' society for the sake of the future. The right way should be found to satisfy all requirements with the less environmental loading. Thus the protection of available built environment (maintenance) and updating came to the front. The building pathology got a key position in the maintenance process.

## **The Role Of The Building Pathology**

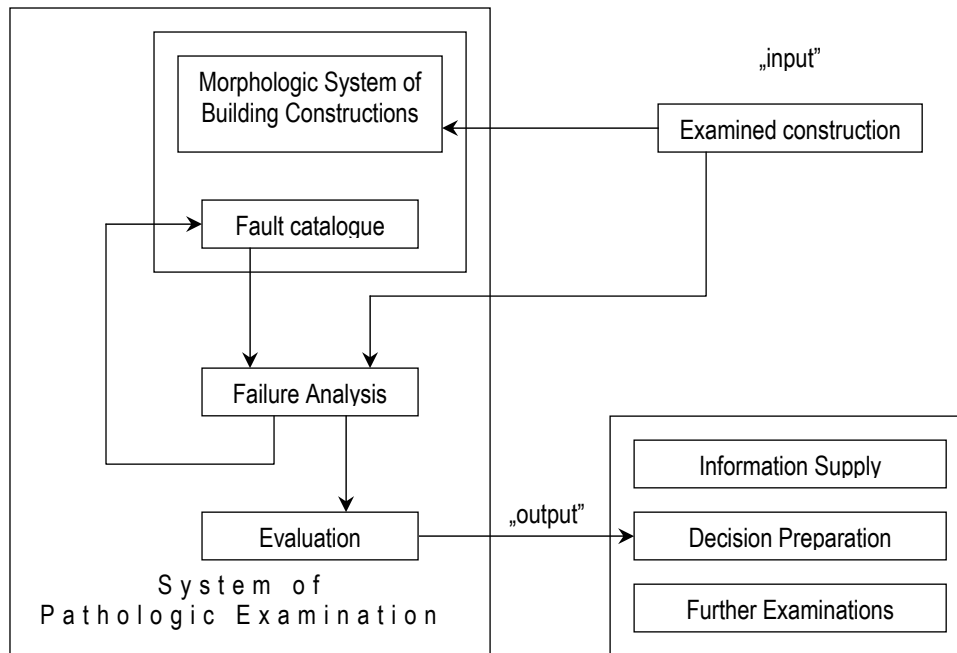
The expert's task during the maintenance process is to observe the failures, establish their scale, name their source and suggest possible solutions for repairing them. The constructor designs keeping the results of diagnostic inspections in view for eliminating any possible failures. The task in the process of justice is to ascertain the responsible factors of defects. Hence the role of building pathology differs in certain cases, but one can state, that the main duty is the decision assistance.

The relation between building pathology and architecture – building factory – building technology can be various – as it can be seen in the studies about diagnostic examinations – but the determination of the task of building pathology throws light on the link: the rational decision making is essential on all areas of architecture for the interest of reliability and effective production. Thus an important role falls on the decision assistance, that is why the report of it has to be professional and objective.

## **The Methodology In Visual Examination in Building Pathology**

During every decision making an arisen question has to be answered. A decision making gains its meaning if one is able to choose from two or more solutions. Its effectiveness is suitable if the most acceptable is found from all

alternatives. The answers – which have to be found by the decision assistance – should be formed considering the comparability. This is attainable with common approach and method. The operation of the system can be seen on figure 1.



**Figure 1: The operation of the methodology on principle**

### ***The Morphologic System of Building Constructions***

The terminologies of the constructions differ by the sections of the building industry, that can lead to misunderstandings and explanation chaos. This difficulty is obvious for experts, experiments have been done from several ways. Unification and systematisation of building constructions requires considerable scientific research with special regard to inserting new terminologies to the existing ones.

For solving this problem, a research team was established by the Institute of Building Science (ÉTI), Budapest, under the guidance of dr. György Kunszt. In 1974 the team published the thesaurus of the information system of ÉTI, while the basis of systematization of terminologies of building industry was laid down.[3]

As a result of a research project at the Faculty Of Architecture And Building Construction at the University Of Applied Sciences, Győr, the morphologic system of building construction – that is based on the thesaurus – came into being [4]. Among its application areas – beside the construction design – building pathology appears on the first place.

This morphologic system helps in the complete survey of construction varieties. In case of proper application of the system the examined element is insertable into the constructional library – thus one becomes acquainted with the alternatives of the construction, that gives wider outlook to the possible solutions and their weak points for the experts and designers as well.

### ***The Fault Catalogue***

The evaluation of diagnostic examinations can be construed for itself in many cases, it can not be compared with others. The cause of this situation can be found in the use of different terms, different methods, that leads to different judgement and different explanations of experienced failures and defects. Surmounting these difficulties and promoting the differentiated orientation, a professional fault catalogue provides solution. The preparation of this catalogue is a considerable task, with a background of the systematization of collected failures and the scientific knowledge of the constructions and effects.

The fault catalogue is a system of existing results of diagnostic examinations which are classified from the view of building constructions. This catalogue is built up by the direction of morphologic system. The research of the failures of the constructions on this way – which gives references to the possible relations – can result a more complex and profound evaluation. Before building up the fault catalogue the questions of failure analysis should be clarified. The practical points of view are [5]:

1. assessment of the degree of danger, aftermaths of failure
2. alternatives for repairing the failures

3. assessment of the cause and the responsible factors of failures
4. assessment of the cost of failure
5. employment of experiences of failure, documentation
6. systematization

The complete catalogue focuses on the building constructions, contains a list of failures caused exterior factors and defects of other building constructions or elements.

The systematization of collected failures and defects has to be executed keeping the further use and simplicity in view. The graphical display of morphologic system has difficulties, because the diagram can not be shown in the system of plane graphs. The application of computers ceases this problem, that partly simplifies the treatment, partly requires substantial regard.

In many cases, the diagnostic evaluations enlighten new inferences that can involve the checkup of the database of the examination method. For simplifying the time-consuming and difficult working up and for the useability of the catalogue it is expedient to supplement the morphologic system with the possibility that the data come to an enlargeable and pliable database. Beside this, one has to reckon with the appearance of new constructions and materials.

The experienced phenomenon seldom ensues alone. The examined defect is more frequently a member of a chain of failures, that means the fault sources from another or it is responsible for further defects.

The success of examination depends on the thoroughness of its performance. The method gives the experts possibility and support in learning the failures which occur in the buildings and their constructions – in the desired details.

For this reason, the applicator can find references to the phenomena which follow the defect, that can determine the further direction of examination.

The subject and character of examinations are different in many point of view, that is why the recognition needs a lot of experience. The graphical examinations attached to the database can be a considerable aid for experts with the use of abstraction. During the detailed examination the figures give visual information, thus give starting point – the examination becomes faster and more professional.

The fault catalogue is a subsystem of the morphologic system of building constructions in the expert system. The order of the failures to the constructions is obvious: the experienced phenomena on the named construction are the elements of its subsystem. In further steps one gets to know these failures by pictures and finds informations about causes and consequences.

During the systemic analysis the expert receives a detailed and comprehensive outlook about the defects which determines the maintenance process of buildings and their elements. But it is not always necessary, moreover the arisen questions often makes the examination long-lasting. In certain cases the examination focuses onto one group of questions only (i.e. the responsibility). This fact has a remarkable importance in forming the system of fault catalogue: the optional enlargeability and restrictability of questions influence its effectiveness.

### ***The Failure Analysis***

The plural society accepts the subjectivity which appears in the evaluations, but its degrees influences the process of decision making (i.e. at the assessment of the order of intervention in a building maintenance system). The proper evaluation is attainable with suitable method, which involves the objective failure analysis.

During studying different – building pathologic, quality insurance, safety system – failure analyses, one can notice that the process raises several questions: what do we call failure? What is the aim of the examination? Are any further examinations necessary?

At the process of pathologic examination one must not forget that the building constructions are elements of a complex system – of the building. In many situations the noticed failure leads to defects of other constructions which do not link directly to the target of the examination.

The fault tree analysis is an assistance method in safety systems and risk analyses, far from the area of building science. Its application in the process of building pathology is accounted by the similarities of the elements of methods and the thorough technique. With its aidance all the relations which seemed to be difficult at first sight can be mapped easily with the knowledge of failures.

A fault tree is a logic diagram [6] that displays the interrelationships between a potential critical event (accident) in a system and the reasons for this event. The reasons may be environmental conditions, human errors, normal events (events which are expected to occur during the life span of the system) and specific component failures. A properly constructed fault tree provides a good illustration of the various combinations of failures and other events which can lead to a specified critical event. The fault tree is easy to explain to engineers without prior experience of fault tree analysis.

An advantage with a fault tree analysis is that the analyst is forced to understand the failure possibilities of the system, to a detailed level. A lot of system weaknesses may thus be revealed and corrected during the fault tree construction.

A fault tree is a static picture of the combinations of failures and events which can cause the TOP event to occur.

The fault tree construction always starts with the TOP event. We must thereafter carefully try to identify all fault events which are the immediate, necessary and sufficient causes that result in the TOP event. These causes are connected to the TOP event via a logic gate. It is important that the first level of causes under the TOP event is developed in a structured way. This first level is often referred to as the TOP structure of the fault tree. The TOP structure causes are often taken to be failures in the prime modules of the system, or in the prime functions of the system. We then proceed, level by level, until all fault events have been developed to the required level of resolution. The analysis is in other words deductive and is carried out by repeated asking "What are the reasons for ..... ?"

## Crack On The Facade Wall Of An Apartment House



The operation of the system described above becomes perceptible with an example from the practice (see figure 2.). the horizontal crack which runs through the facade wall clearly shows the complexity of failures [7] – and the reason why comprehensive examination has to be made before repair in several occasions. At first sight it seems to be a „simple” crack which can be hidden by a symptomatic therapy (see figure 3.)

**Figure 2. : A horizontal crack formed on the facade wall**



**figure 3: wrongly repaired horizontal crack on facade wall**

The proper visual examination can be done effectively in the following steps:

1. definition of the examined building construction;
2. after identification the weak points of it become known;
3. the experienced failure can be selected from them;
4. the background database and explanations of fault catalogue provides help in failure analysis and raises the possibility of further examinations of the elements;
5. by the method of fault tree analysis the fault tree can be built up, naming the horizontal crack for the TOP event. The unknown relations can be fed back to the fault catalogue (for the analysis of our example see figure 4).
6. detailed evaluation of the failure; providing information (i.e. about the proper way of repair) advise to further examinations.

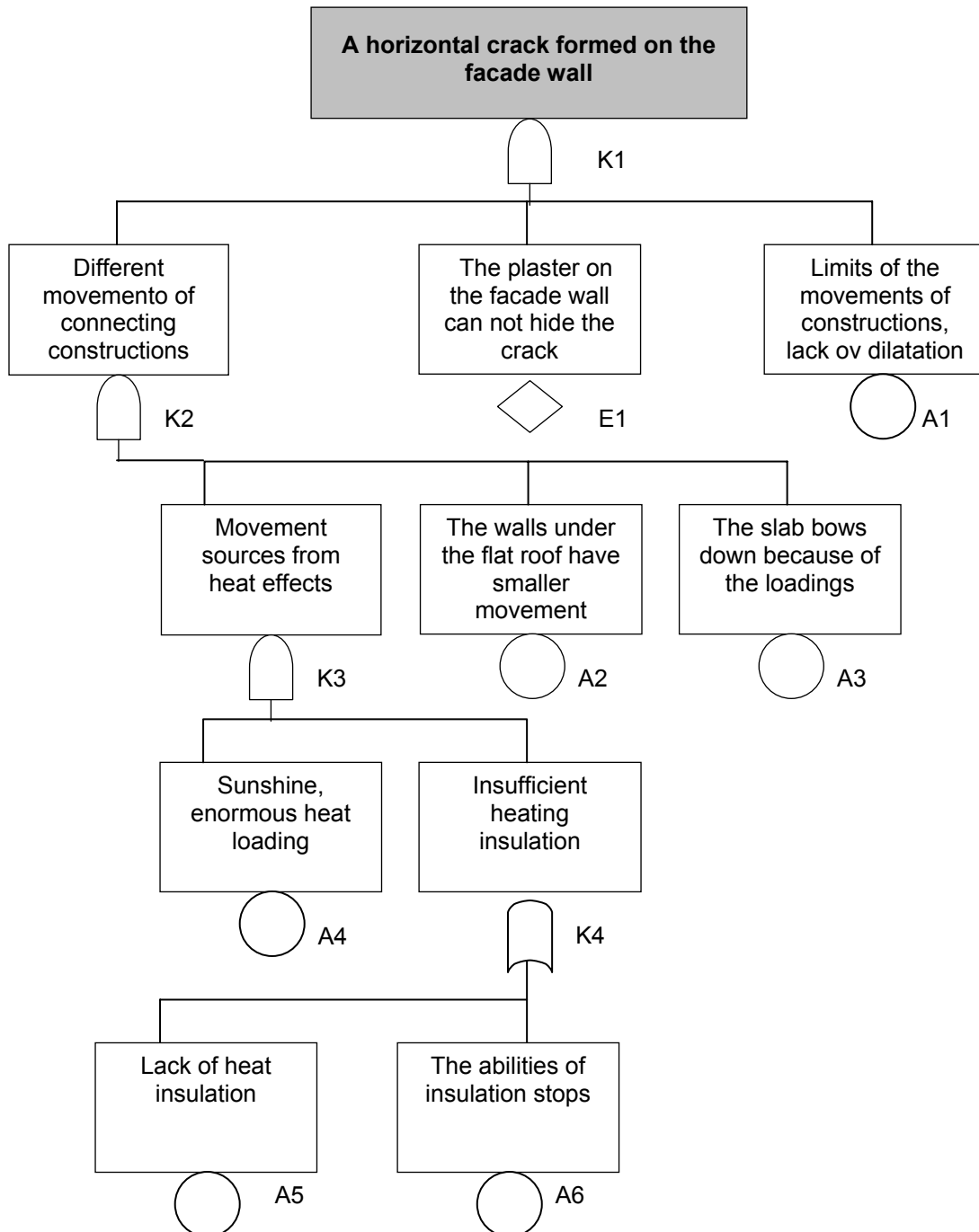


Figure 4.: the use of fault tree analysis

## Summary

The system of building pathology that is shown briefly above offers aid for the experts by getting to know the faults which appeared already, the examinations become faster without harmful influences to the execution.

The application of computer facilitates the review of the morphologic system and beyond processing data provides possibility to enlarge them.

Summing up the morphologic system can be determined a system which collects and systematizes experiences of the foregoing and gives them to the applicants (experts, designers, maintenance companies, etc.). thus one can establish that the systematization of building constructions and their failures is useful for the trade of architecture.

## References

- [1] UN, Long-Range World Population Projections: Two Centuries of World Population Growth 1950-2150, 1992
- [2] Dr. Zöld, András: Energiafelhasználás, *in.* Környezetbarát építés szerkezetei, BME, Épületszerkezettani Tanszék, Tanszéki Segédlet, 1999
- [3] Dr. Kunszt, György: Az ÉTI Tematikai információs rendszerének teaurusza, Budapest, 1974.
- [4] Dr. Koppány, Attila: Az épületszerkezetek morfológiai rendszere, Széchenyi István Főiskola, Győr, 1994.
- [5] ÉVM 5. sz. CPB: Épülethibák szemrevételezéses diagnosztikai vizsgálata, ÉTK, Budapest, 1984.
- [6] CARA Fault Tree Analysis, GECO Defence, Norway, 1999.
- [7] Székely, László: Épületszerkezetek elváltozásainak káros hatásai, disszertáció, Budapest, BME, 1985.