Krzysztof Schabowicz
....
imię i nazwisko

ZAŁĄCZNIK 2B

AUTOREFERAT PRZEDSTAWIAJĄCY OPIS DOROBKU I OSIĄGNIĘĆ NAUKOWYCH W JĘZYKU ANGIELSKIM

Wrocław, dnia 24 listopada 2014 r.

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The author's review of his own research

1. First name and surname: Krzysztof Schabowicz

2. Diplomas and academic degrees held

a. 1996: MSc, Faculty of Civil Engineering at Wrocław University of Technology, main field of study – building engineering, specialization – building & building technology, title of MSc thesis: "Contemporary single-family housing construction systems", MSc thesis supervisor: Andrzej Moczko, PhD, eng.

b. 2003: Doctor of Technical Sciences, Institute of Building Engineering at Wrocław University of Technology, discipline – building engineering, specialization – general construction, title of PhD thesis: "The non-destructive identification of the compressive strength of concrete by means of artificial neural networks", PhD thesis supervisor: Prof. Jerzy Hoła, Hab. PhD

3. Employment in research units

a. from 01.10.1996 to 30.09.2004: assistant lecturer at the Faculty of Civil Engineering, the Institute of Building Engineering, the Department of General Construction, Wrocław University of Technology; at the same time from 01.10.1997 to 30.09.2002: PhD student at the Faculty of Civil Engineering at Wrocław University of Technology;

b. from 01.10.2004 until now: adiunkt (lecturer) at the Faculty of Civil Engineering, the Institute of Building Engineering, the Department of General Construction, Wrocław University of Technology.

4. The author's scientific achievement according to art. 16 sect. 2 of the Academic Degrees and Titles and Arts Degrees and Titles Act of 14 March 2003 (Law Gazette no. 65, item 595 with amend.):

a. Scientific achievement title

"A methodology for testing unilaterally accessible concrete structures by means of state-of-the-art acoustic methods"

b. Publications being part of scientific achievement

Monographic series of publications:

1) **Schabowicz K.**; Modern acoustic techniques for testing concrete structures accessible from one side only, *Archives of Civil and Mechanical Engineering*, DOI: DOI: 10.1016/j.acme.2014.10.001, **IF = 1.331, MS&HE (Ministry of Science and Higher Education) score = 20.**

   Unassisted work, 100% share.

2) **Schabowicz K.**; Ultrasonic tomography – the latest non-destructive technique for testing concrete members – description, test methodology, application example, *Archives of Civil and Mechanical Engineering*, 2014, Vol. 14, No. 2, 295-303. **IF = 0.963, MS&HE score = 20.**

   Unassisted work, 100% share.

3) **Schabowicz K.**, Suvorov V. Non-destructive testing of a bottom surface and construction of its profile by ultrasonic tomography, *Russian Journal of Non-destructive Testing*, 2014, Vol. 50, No. 2, 109-119. **IF = 0.217, MS&HE score = 15.**

   My contribution to this work: the idea for and concept behind the work, the survey of literature, the co-writing of the description of: the test method, the process of constructing tomographic images (including its changes), the design of the test stand, the joint carrying out of the tests and processing of their results, the interpretation of the test results and the formulation of the conclusions. I estimate my share at 70%.

4) Gorzelańczyk T.; Hoła J.; Sadowski Ł.; **Schabowicz K.**: Methodology of non-destructive identification of defective concrete zones in unilaterally accessible massive members, *Journal of Civil Engineering and Management*, 2013, Vol. 19, No. 6, 775-786. **IF = 2.016, MS&HE score = 40.**

   My contribution to this work: the joint carrying out of the tests, processing and interpreting the test results, the co-development of the test methodology. I estimate my share at 25%.

5) **Schabowicz K.:** Methodology for non-destructive identification of thickness of unilaterally accessible concrete elements by means of state-of-the-art acoustic techniques, *Journal of Civil Engineering and Management* , 2013, Vol. 19, No. 3, 325-334, **IF = 2.016, MS&HE score = 40.**

   Unassisted work, 100% share.

6) **Schabowicz K.**, Hoła J.: Non-destructive elastic-wave tests of foundation slab in office building, *Materials Transactions*, 2012, Vol. 53, 296-302, **IF = 0.588, MS&HE score = 25.**

My contribution to this work: the idea for the work, the joint carrying out of the tests and processing of their results, the interpretation of the test results, the formulation of the conclusions I estimate may share at 70%.

7) Hoła J.; Sadowski Ł.; **Schabowicz K.**: Non-destructive identification of delaminations in concrete floor toppings with acoustic methods, *Automation in Construction*, 2011, Vol. 20, 799-807, **IF = 1.500, MS&HE score = 40.**

My contribution to this work: the joint carrying out of the tests, processing and interpreting the test results and the co-development of the test methodology. I estimate my share at 33%.

8) Hoła J.; **Schabowicz K.**: State-of-the-art non-destructive methods for diagnostic testing of building structures - anticipated development trends, *Archives of Civil and Mechanical Engineering*, 2010, Vol. X, Nr 3, 5-18, **IF = 0.383, MS&HE score = 9.**

My contribution to this work: the co-development of the work concept, the survey of literature, the co-writing of the description of the methods and the joint processing of the results. I estimate my share at 50%.

c. Review of research objective and achieved results

Structures made of concrete are subjected to tests for different reasons and at different times during their erection and service. Many test methods can be used for this purpose. Considering their degree of invasiveness, the methods can be divided into destructive methods, semidestructive methods and non-destructive methods. Mainly samples taken from structures (much less often members or whole structures) are subjected to destructive tests. Samples, members and whole structures are subjected to semidestructive tests. The material structure integrity is locally slightly and usually superficially breached during semidestructive tests. Whereas in non-destructive tests no such breach occurs. Large surface areas can be tested to a considerable depth in this way and the tests can be repeated many times (in the same location over time).

When the investigated structure is accessible from one side only, being in contact with the ground or water, many of the non-destructive methods cannot be used to test it. Examples of such structures are the foundations and walls of basement car parks, the walls of tunnels and interceptors and the structural members of hydro-engineering structures. Therefore it becomes then necessary to use non-destructive test methods suitable for diagnosing unilaterally accessible structures.

In the monographic series of publications [1-8], entitled.: **"A methodology for testing unilaterally accessible concrete structures by means of state-of-the-art acoustic methods"** I presented my own studies on the non-destructive testing of unilaterally accessible concrete structures by means of state-of-the-art acoustic methods, and an original methodology developed for this purpose. Such tests are applied to structures without damage or defects in order to, e.g., confirm that the thickness of a unilaterally accessible structural member agrees with its design thickness, and to structures with invisible defects (in other words, imperfections) in order to identify them. Imperfections (damage, defects) are understood here as causing deterioration in the condition of a component or the whole structure in comparison with the original or design condition. There can be geometric or material imperfections. The monographic series covers the following imperfections: improper structure thickness, delamination of concrete layers, large air voids, zones of concrete macroheterogeneity, and cracks. In my opinion, the above imperfections have a significant effect on the durability and safe service of concrete structures.

The thickness of a newly built structure must be known usually for the purpose of its final quality acceptance to check if the thickness is consistent or inconsistent (because of a geometrical imperfection) with the design. In the case of a concrete structure which has been in service for many years, one must determine its thickness to check its load bearing capacity when the design documents are missing. When a concrete structure on one of its sides is in contact with ground water or dammed up water, its thickness cannot be determined by drilling through the structure and so non-destructive methods must be used. Examples of such structures are the foundations and walls of underground garages, the structural members of hydro-engineering structures and the walls of tunnels and collecting pipes in both newly built structures and the ones being in service for many years, as shown in figure 1.

Due to, e.g., the faulty execution of multilayer concrete structures a loss of material continuity (no interlayer bond) may occur, as illustrated in figure 2.

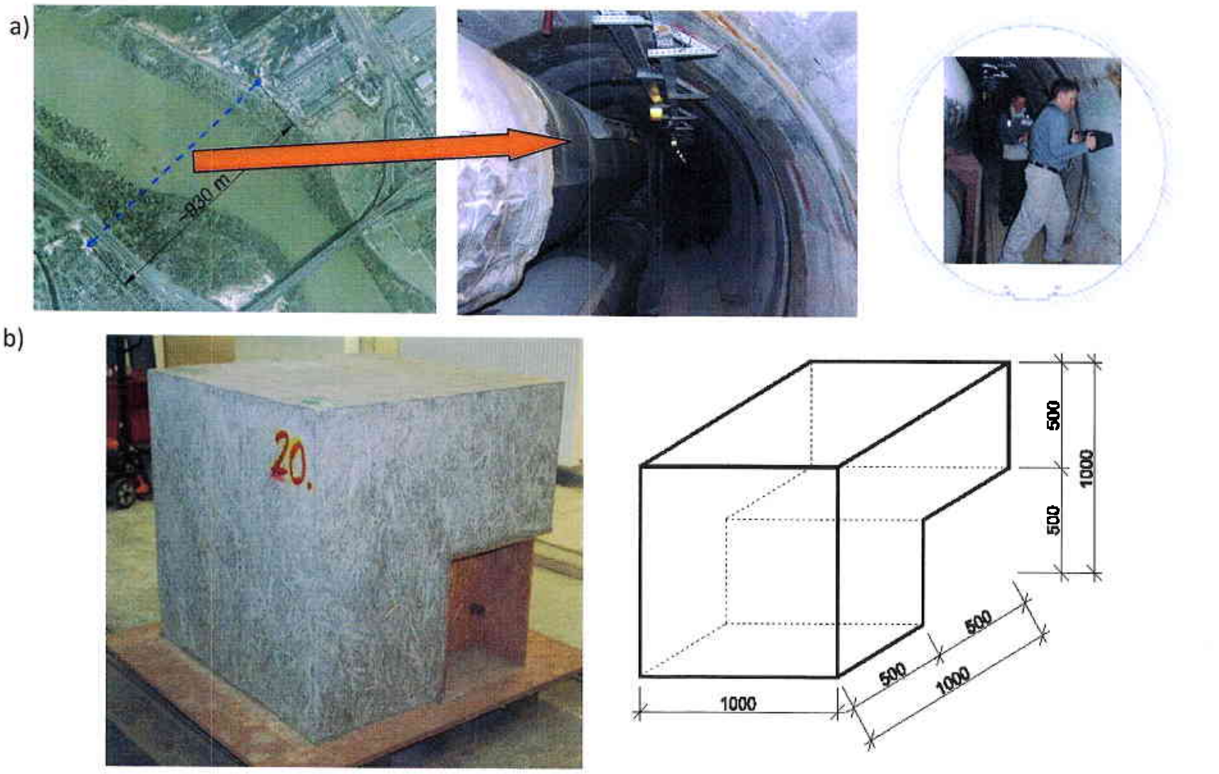


Fig. 1. Illustration of geometrical imperfection – incorrect thickness of structure: a) concrete tunnel under Vistula and its cross-sectional view b) view and schematic of tested component.

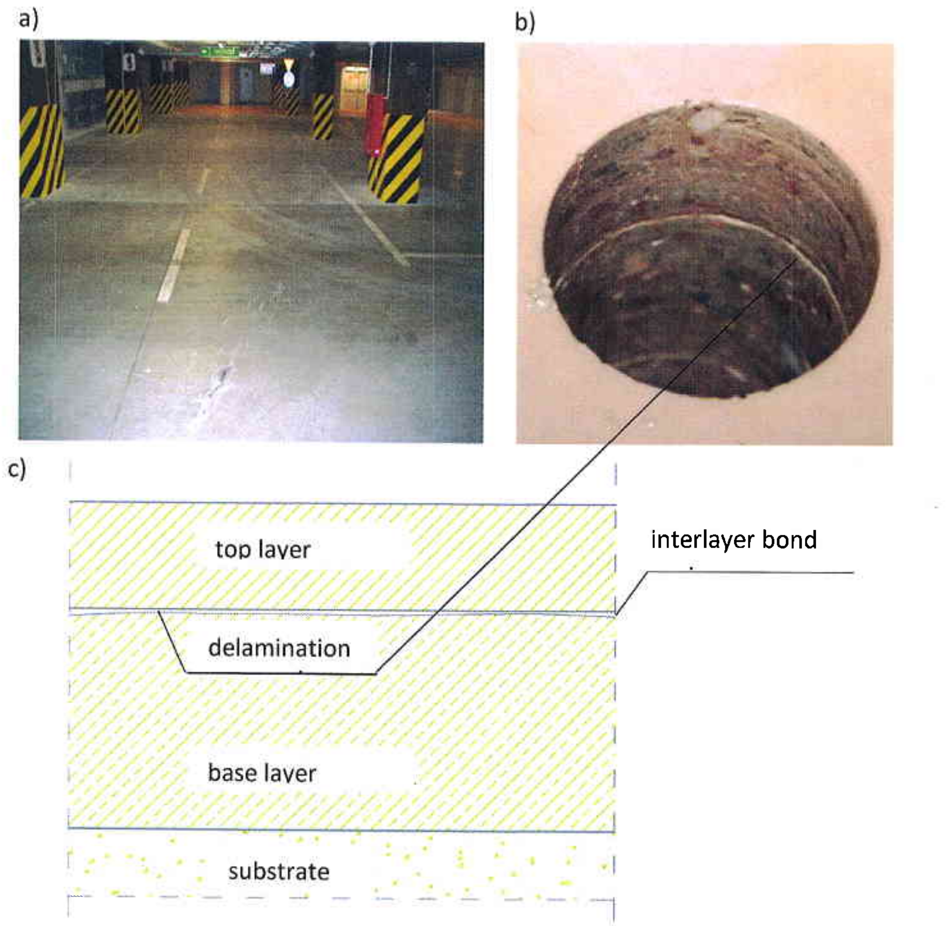


Fig. 2. Illustration of material imperfection – delamination at interface between concrete layers: a) view of floor in indoor underground car park, b) test pit in car park floor, c) schematic of delamination.

This material imperfection, called delamination (debonding between layers), results in a reduction in the load bearing capacity and durability of the structure. Therefore, for example, prior to the final acceptance and hand-over of structures, especially heavily loaded large-area structures, such as garage floors, tests are carried out to check the interlayer bonds and to locate any delaminations. The non-destructive pull-off method is usually used for this purpose, but the effectiveness of this method to a large extent depends on the number of test points. According to the standard, one test point per 3 m^2 of the area to be tested should be adopted. However this is not enough if the boundaries of the area where delamination occurs are to be precisely determined. Then it is necessary to adopt a denser grid of test points, which is tantamount to a significant breach of structural integrity.

Material imperfections in the form of large air voids may arise in the joints between structural members. Such imperfections are understood to be material discontinuities much larger than the maximum diameter of the aggregate in the concrete from which the member was made, as shown in figure 3.

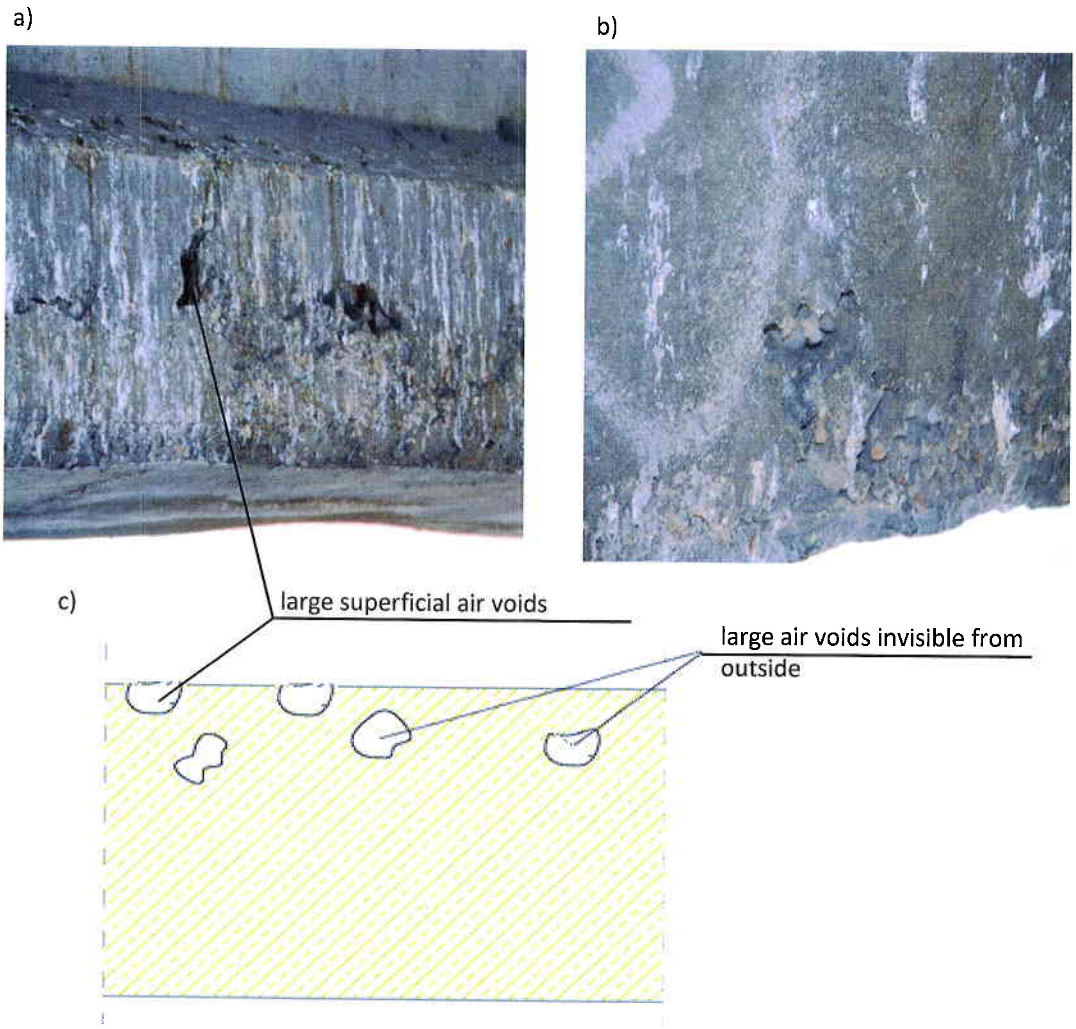


Fig. 3. Illustration of material imperfection – large air voids: a), b) fragment of structure with visible large superficial air voids, c) schematic of fragment of structure cross section with visible and invisible air voids.

The places where they occur are the so-called weak places in the structure since the reinforcement there is not covered with concrete. Large air voids (invisible on the surface) can be located through exploratory boreholes, but this is not always effective. One cannot determine the size of an air void in this way, which makes repair difficult. Neither the non-destructive radiological method can be used to locate such imperfections.

In unilaterally accessible massive structures, such as hydraulic power plants and dams zones of concrete macro-heterogeneities may form, as illustrated in figure 4.

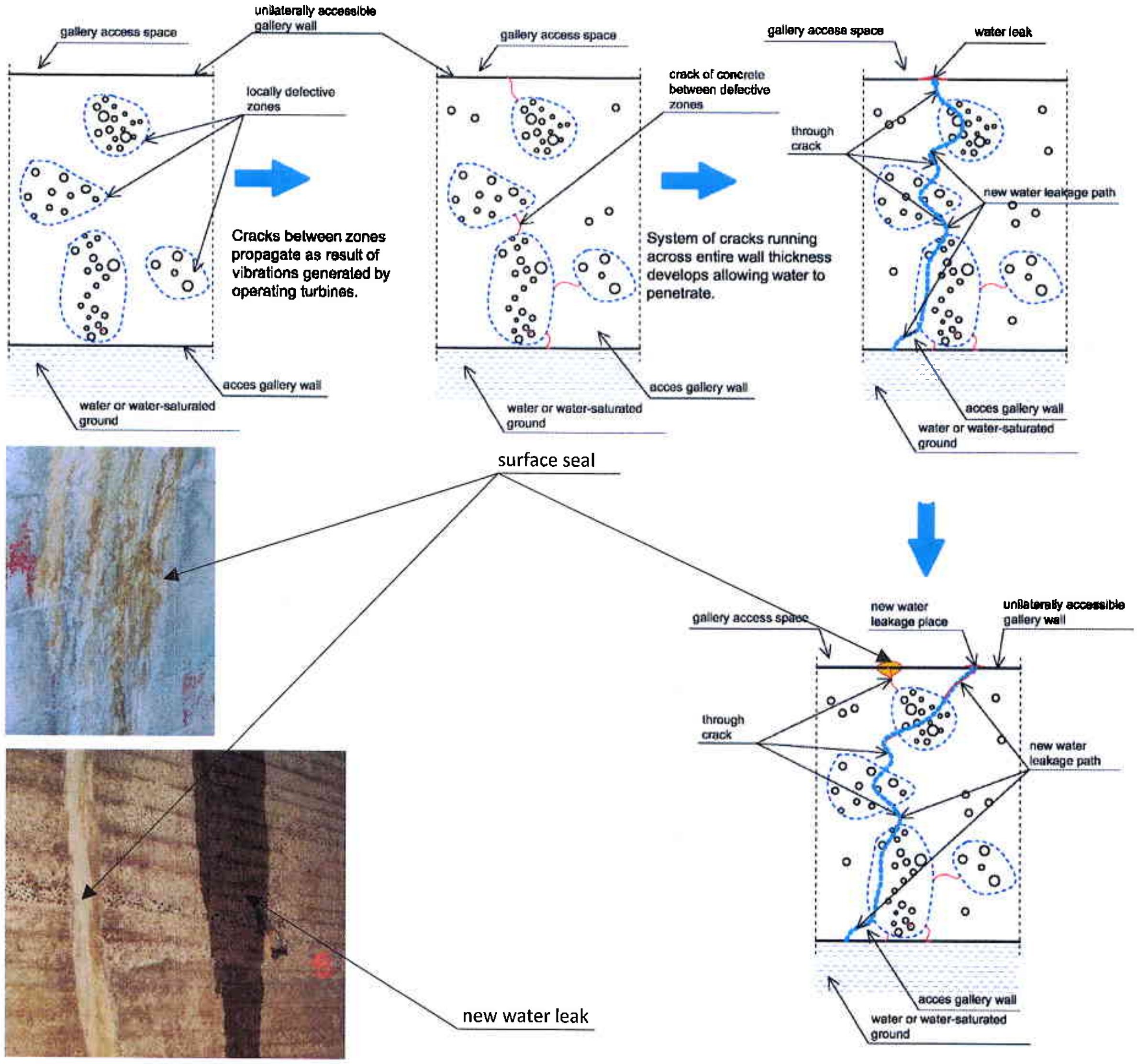


Fig. 4. Illustration of material imperfection – zones of concrete macroheterogeneities. Scheme of the formation of these zones in the massive concrete wall

The macroheterogeneities should be understood as material discontinuities smaller than the air voids described above, but forming a zone whose volume is considerable. At the construction stage massive structures are particularly susceptible to the formation of defective zones (material imperfections) in them due to, for example, the improper compaction of concrete, the use of too coarse aggregate or the insufficient surrounding of the aggregate particles with cement mortar. The concrete in such zones is excessively porous and under unilateral water pressure combined with the service vibrations of the structure a through fracture, understood as the loss of material continuity across the whole cross-section of the structure, tends to develop, as indicated in [4].

Often it is also necessary to determine the depth of a crack understood as a material discontinuity on some of the structure cross-sectional area, whose depth and length are significantly larger than its opening, as shown in figure 5. Water often leaks through such a crack. The depth, length and opening of the latter may increase over time, leading to the failure condition of the structure. The depth of a crack is usually determined by taking a drill core sample, but when there is water on the other side of the wall exerting pressure on the latter, this method is rather risky.

a) b)

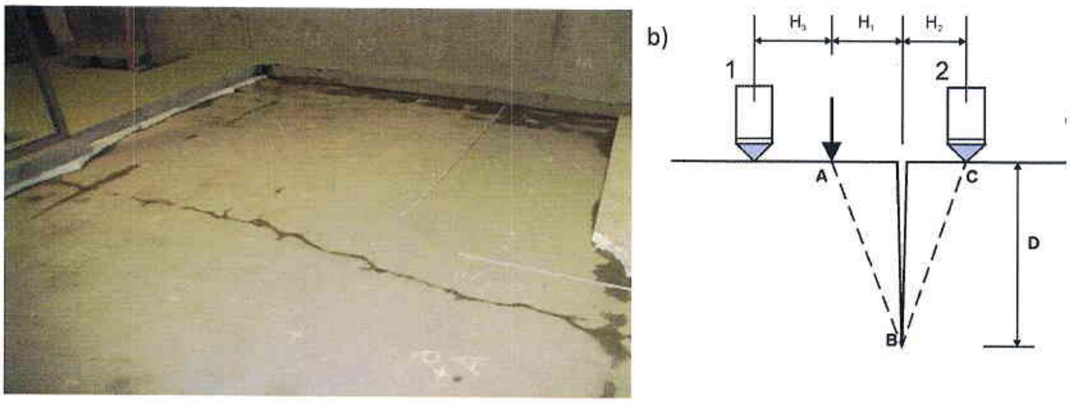


Fig. 5. Illustration of material imperfection – crack: a) view of cracked foundation slab, b) schematic showing how crack depth is determined.

The work initiating the monographic series entitled: "A methodology for testing unilaterally accessible concrete structures by means of state-of-the-art acoustic methods" and showing the need to address this topic is paper [8]. It presented the latest non-destructive acoustic methods suitable for testing concrete structures accessible from only one side and their classification. It should be noted that paper [8], published towards the end of 2010, has attracted considerable attention. The paper has been cited 27 times acc. to the *Web of Science* database and 31 times acc. to the *Scopus* database. Currently it ranks second on the list of the most cited works published in the journal *Archives of Civil and Mechanical Engineering* (which is in the JCR database).

Figure 6 shows a slightly modified classification (based on [8]) of the acoustic methods suitable for testing unilaterally accessible concrete structures. This classification was presented in [1]. Figure 7 shows (on the basis of [1]), the suitability of the particular state-of-the-art non-destructive acoustic methods, used individually or combined, for testing unilaterally accessible concrete structures.

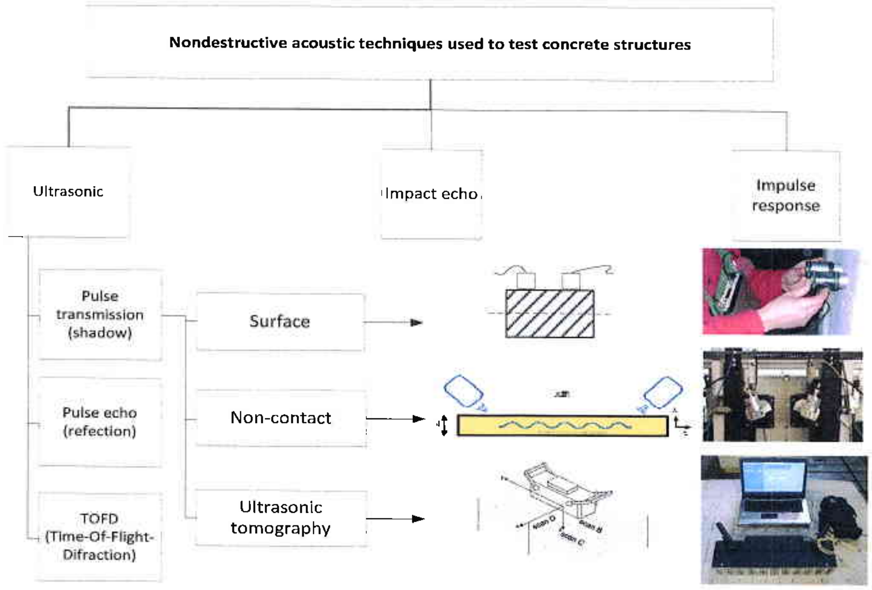


Fig. 6. Classification of non-destructive acoustic methods suitable for testing unilaterally accessible concrete structures [1, 8].

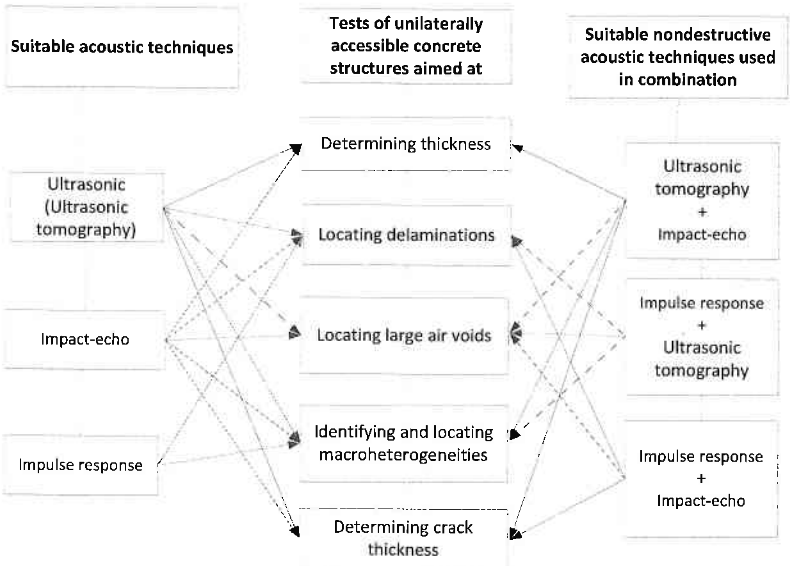


Fig. 7. Suitability of state-of-the-art non-destructive acoustic methods, used individually or combined, for testing unilaterally accessible concrete structures [1].

In order to test unilaterally accessible concrete structures one must select the proper method, equipment and methodology making it possible to detect and identify possible defects. If it is not known, e.g., what kind of imperfection is to be tested, it is necessary to carry out preliminary tests (using a selected method and equipment) and a heuristic analysis of the test results in order to select the proper test method, equipment and most importantly, methodology, as shown in figure 8. The situation is simpler when it is known (e.g. on the basis of information supplied by the client) what kind of imperfection is to be tested. The location, extent (the size of the affected area) and intensity (the advancement of the change dependent on the kind of defect) of the identified (diagnosed) imperfection are useful in further analysis.

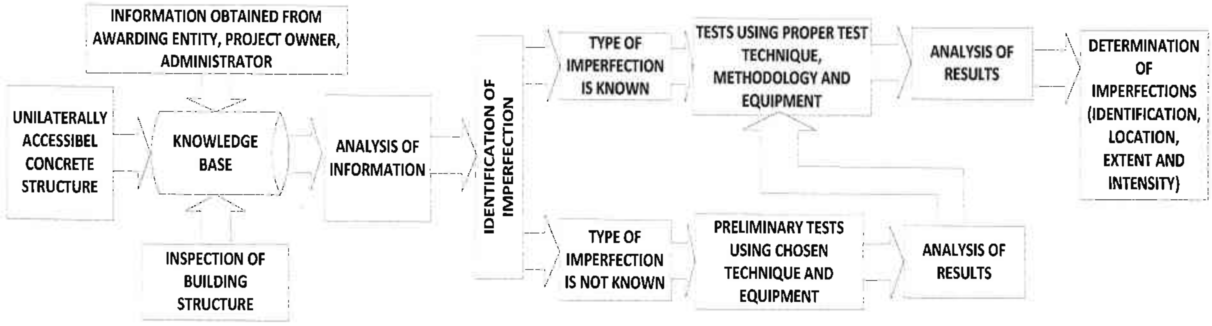


Fig. 8. General procedure for testing unilaterally accessible concrete structures.

The next papers [2-7] in the monographic series present the results of my own full-scale tests of building structures of different types by means of the state-of-the-art non-destructive acoustic methods described in [8]. The results provided the basis for developing original methodologies for testing unilaterally available concrete structures with regard to:

- the non-destructive determination of incorrect thickness by means of the ultrasonic tomography method and the impact-echo method combined [5],
- the non-destructive location of delaminations by means of the impulse response method and the impact-echo method combined [7],
- the non-destructive identification and location of large air voids by means of the ultrasonic tomography method [2],
- the non-destructive identification and location of zones of concrete macroheterogeneity by means of the impulse response and the ultrasonic tomography method combined [4],
- the non-destructive determination of crack depth by means of the impact-echo method, and using the ultrasonic tomography and the impact-echo combined [1].

The application range for the on-site verified methodologies and their advantages and disadvantages were presented in papers [2, 4-7].

It should be noted that the full-scale testing of structures requires teamwork. Hence the results of the tests carried out as part of a team were reported collectively in [4, 7].

An analysis of the full-scale test results provided me with inspiration to carry out laboratory tests, the results of which were reported in monographic series papers [2, 3]. On the basis of the test results the previously developed methodologies for non-destructively determining incorrect thickness and non-destructively locating large air voids in unilaterally accessible concrete structures by means of the ultrasonic tomography method were refined [2]. It should be noted that paper [2], published in the second quarter of 2014 in the journal *Archives of Civil and Mechanical Engineering*, has now three citations according to the *Scopus* database.

In the laboratory I made 50 specimens modelling a geometrical imperfection and material imperfections (fig. 9). The specimens were made of C25/30 concrete with up to 8 mm aggregate and their dimensions were: 1000 x 1000 x 1000 mm, 500 x 1000 x 1000 mm, 500 x 500 x 1000 mm, 500 x 500 x 500 mm. I used the specimens to non-destructively test selected imperfections. Selected results of the tests have already been reported [2, 3]. The remaining results are being processed for publication. Figure 10 presents exemplary test results obtained by means of an ultrasonic tomograph for the specimen shown in fig. 9b.

a) b)

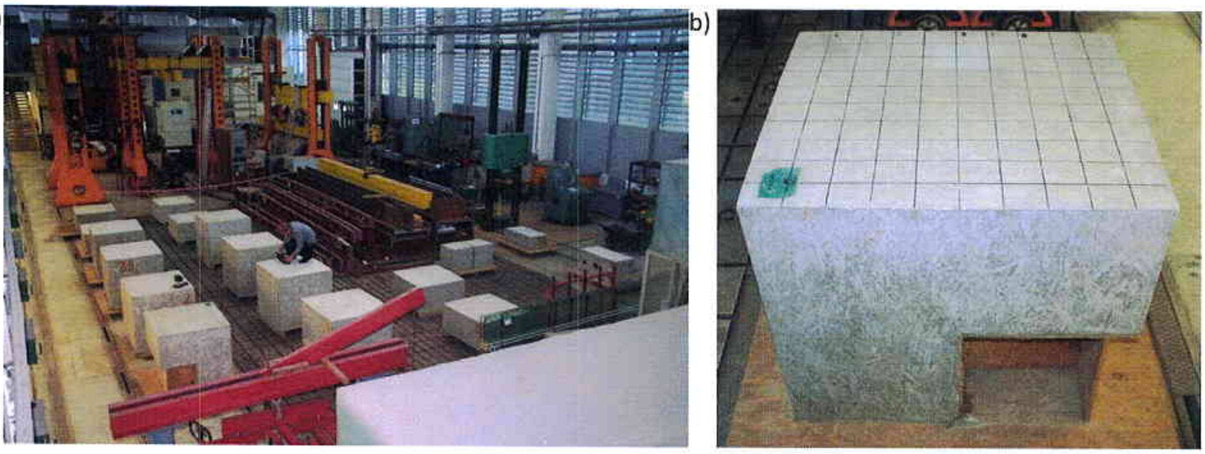


Fig. 9. View of specimens prepared for testing geometric imperfection and different material imperfections by means of non-destructive acoustic methods (a) and close-up of specimen used to verify methodology for determining incorrect thickness (b).

The laboratory tests were a vital part of my research since on their basis I created a knowledge base useful for the analysis of the results of tests carried out on actual building structures.

Paper [1] sums up and closes the monographic series of publications. It systematizes my achievements stemming from the research reported in [2-7], concerning my own original methodologies for the non-destructive testing of selected geometrical and material imperfections in unilaterally accessible concrete structures by means of state-of-the-art acoustic methods plus my own original methodologies for determining crack depth. In my opinion, the literature lacked such a comprehensive study.

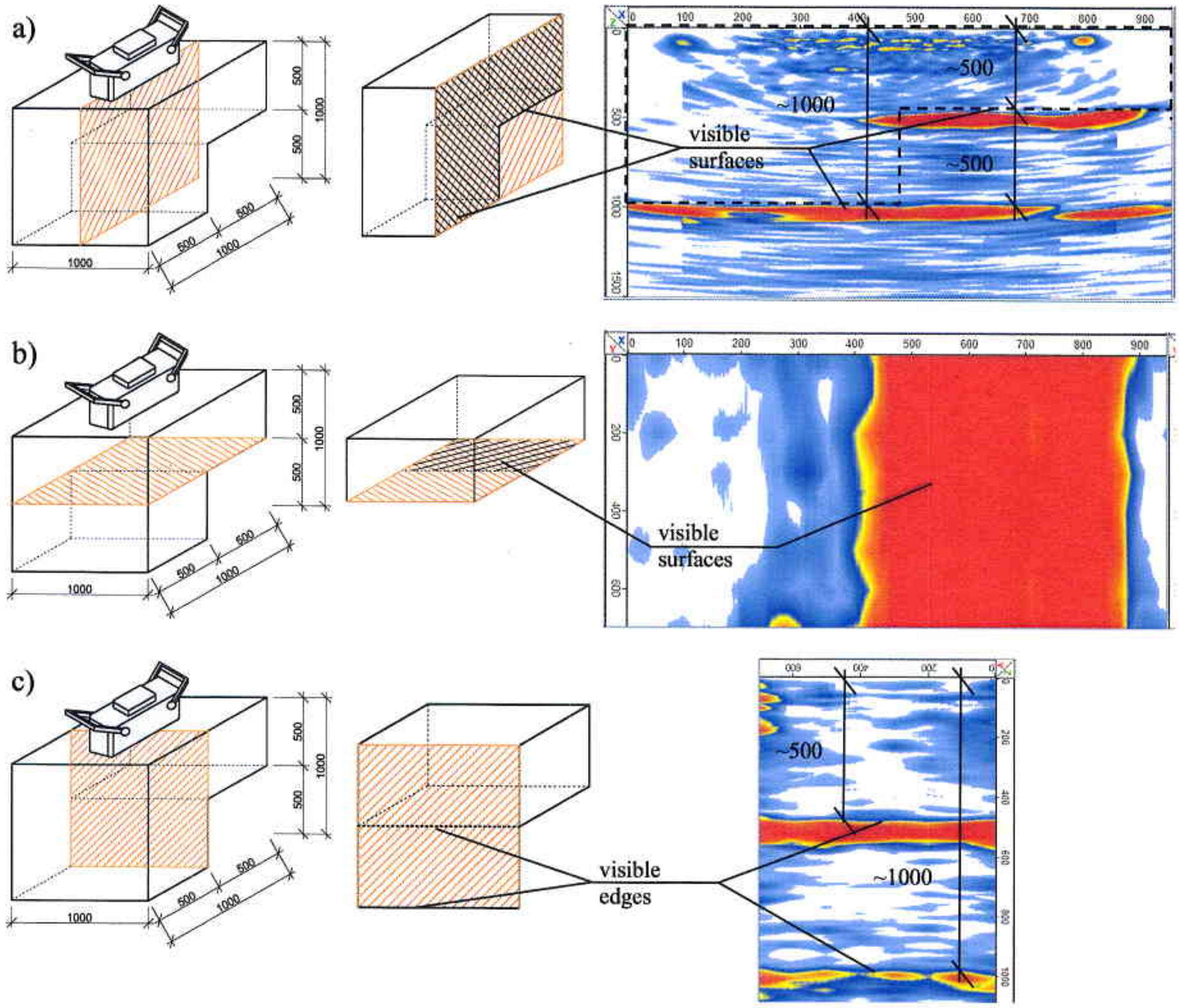


Fig. 10. Exemplary results obtained by means of ultrasonic tomograph for specimen shown in fig. 9b: a) image B, image C, c) image D [2].

1) Determination of incorrect thickness of structure

My own methodology for determining incorrect thickness in unilaterally accessible concrete structures by means of the ultrasonic tomography method is presented in figure 11 [1]. It has been slightly modified in comparison with its original versions presented in [2, 5]. Using the ultrasonic tomography method one acquires flat images of the inside of the tested concrete structure, in three mutually perpendicular directions. By closely analyzing the images one can determine the thickness and in this way locate incorrect places, their extent and intensity (changes in thickness) in unilaterally accessible concrete structures.

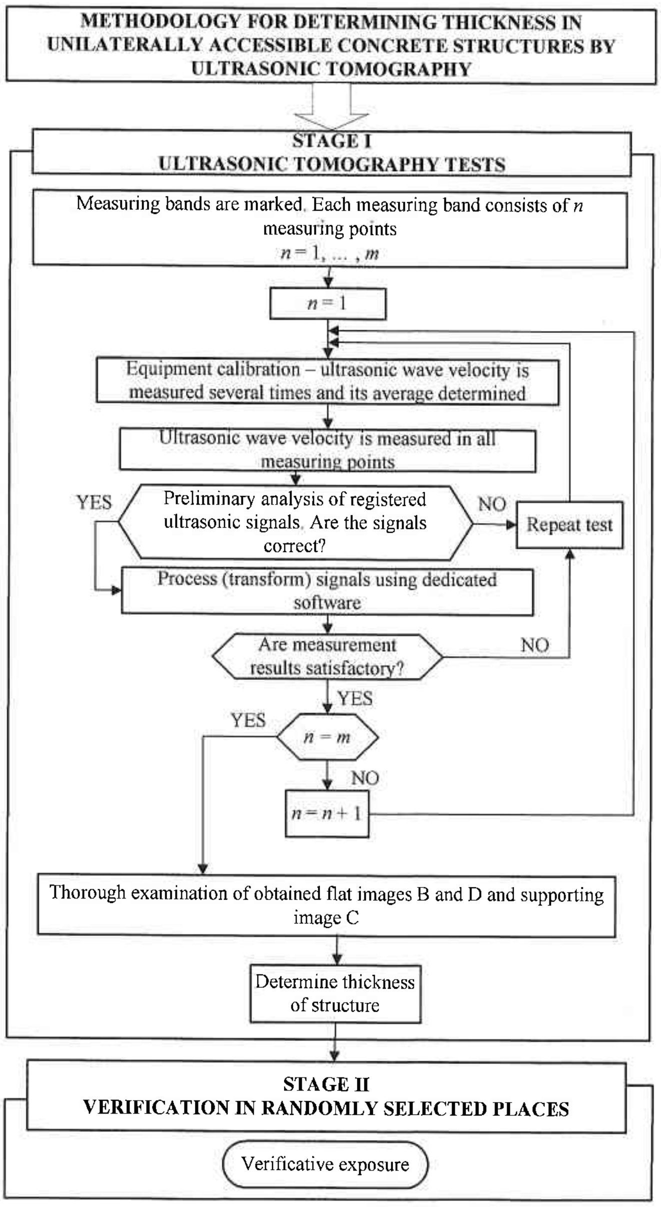


Fig. 11. Methodology for determining incorrect thickness in unilaterally accessible concrete structures by means of ultrasonic tomography method [1].

My own methodology for determining incorrect thickness by means of the ultrasonic tomography methods and the impact-echo combined is presented in figure 12 [1]. This is a slightly modified version of the method in comparison with that presented in [5].

According to this methodology, first flat images of the inside of the tested concrete structure in three mutually perpendicular directions are obtained using the ultrasonic tomography method and by examining them one estimates the thickness of the structure with an accuracy of about 20-30 mm. Then tests are carried out using the impact-echo method in order to verify and make more precise the thickness estimate obtained by the ultrasonic tomography method in the first stage of the investigations. An elastic wave is excited in each of the measuring points and amplitude-time spectra are recorded, which are then converted into amplitude-frequency spectra. By analyzing the spectra one can determine the thickness, extent and intensity of the irregularities with an accuracy of about 5-10 mm, whereby the results obtained in stage I can be fine-tuned, which was verified by the laboratory tests described above.

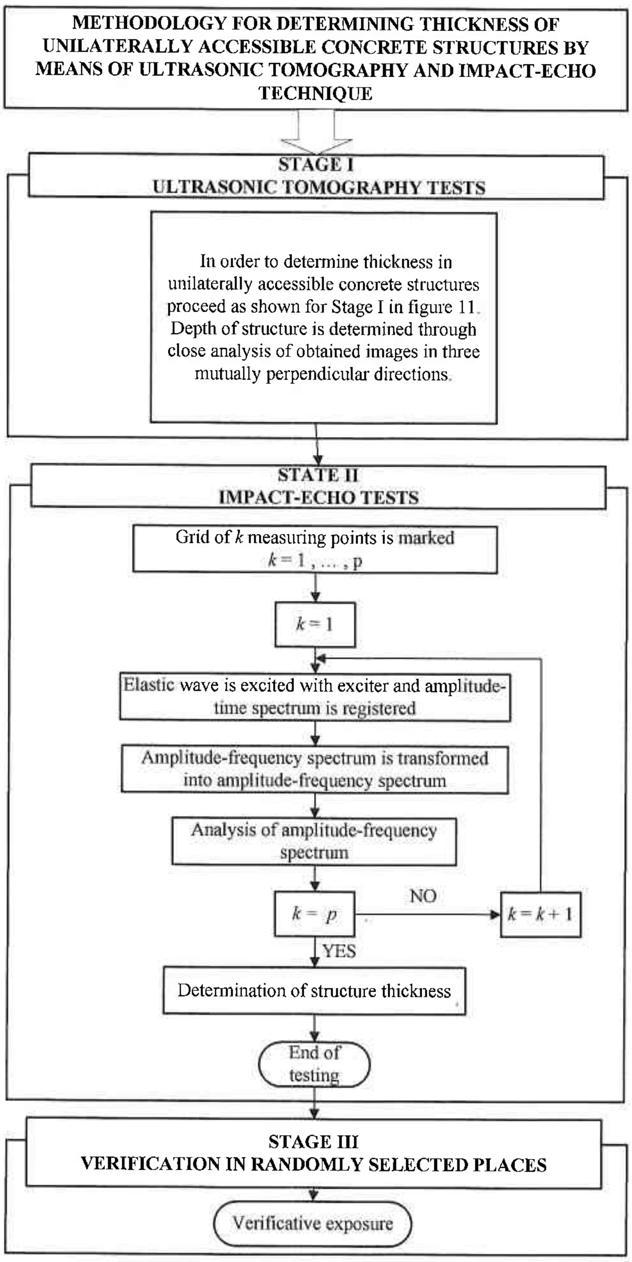


Fig. 12. Methodology for determining incorrect thickness in unilaterally accessible concrete structures by means of ultrasonic tomography method and impact-echo method combined [1].

In the case of the above two methodologies, it is recommended to verify the results in a randomly selected place (or places) by making a test borehole.

I have verified the two methodologies by applying them to actual building structures [5, 6], as shown in figure 13, and through laboratory tests on specially prepared specimens [2]. Paper [5] has now 1 citation according to the *Web of Science* database and 3 citations acc. to the *Scopus* database while paper [6] has 10 citations acc. to the *Web of Science* and 11 citations acc. to *Scopus*.

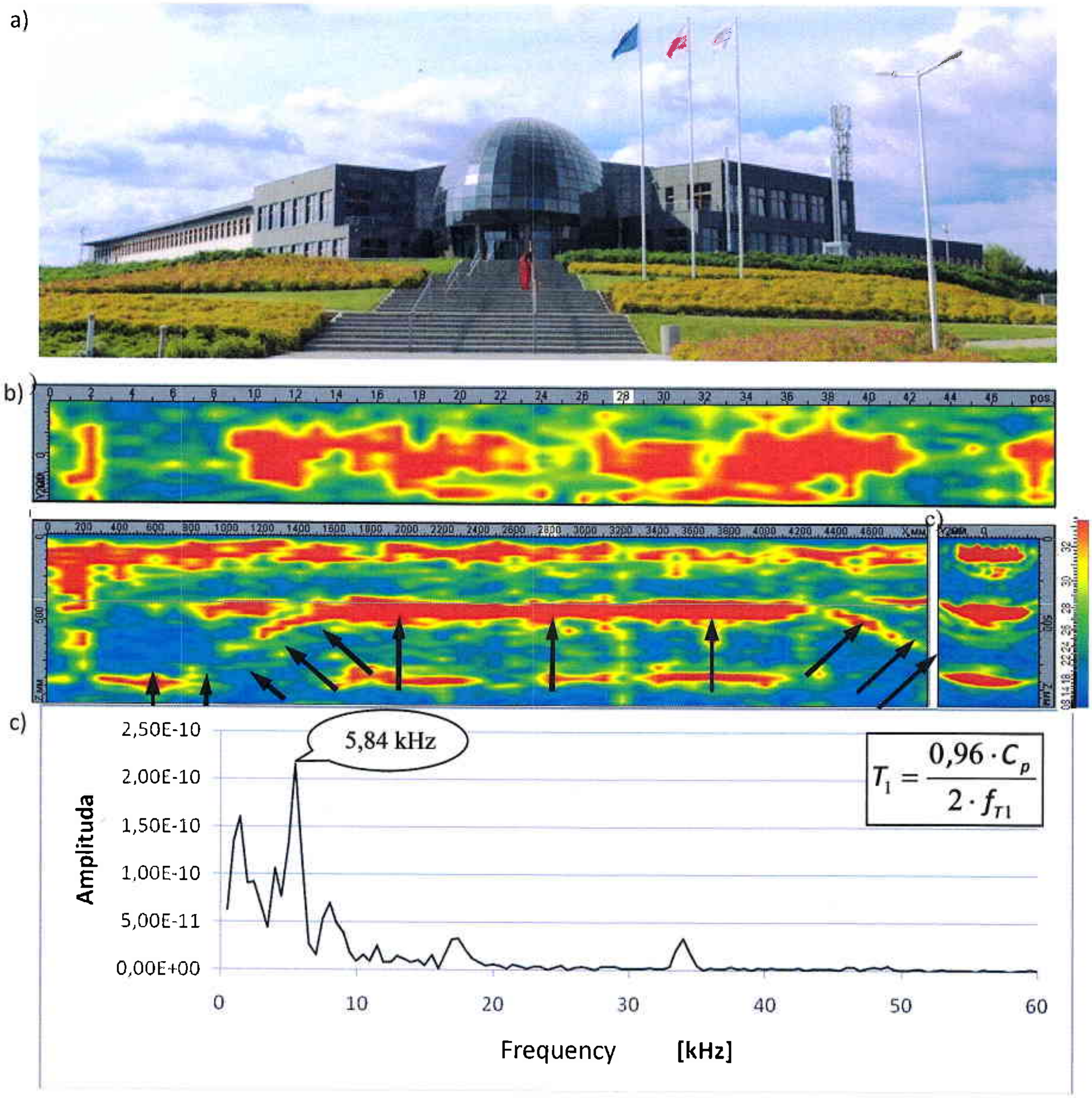


Fig. 13. Verification of methodology for determining incorrect thickness in unilaterally accessible concrete structures by means of ultrasonic tomography method and impact-echo method combined, on exemplary building structure [5, 6]:
a) general view of structure, b) exemplary foundation slab thickness images C, D and B obtained by ultrasonic tomograph,
c) amplitude-frequency spectrum of elastic wave registered in middle part of foundation slab by impact-echo equipment.

2) Location of delaminations

The two-stage methodology for locating delaminations in unilaterally accessible concrete structures by means of two state-of-the-art non-destructive methods: impulse response and impact-echo combined, which I co-developed [7], is presented in figure 14 below. The methodology is slightly modified in comparison with that presented in [7].

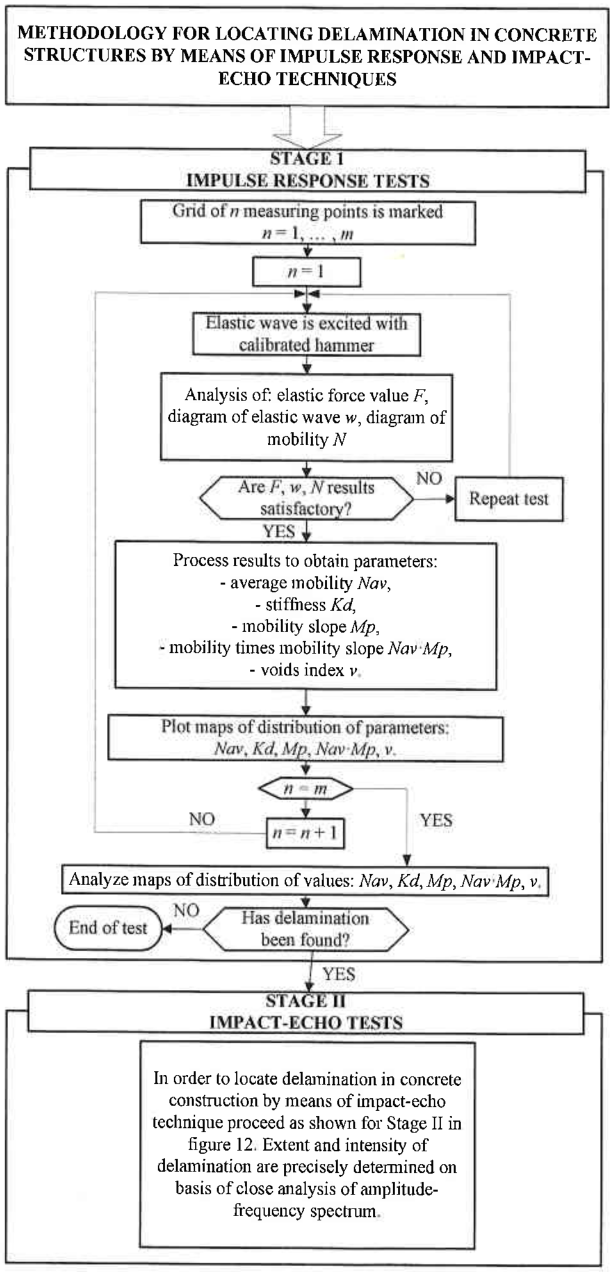
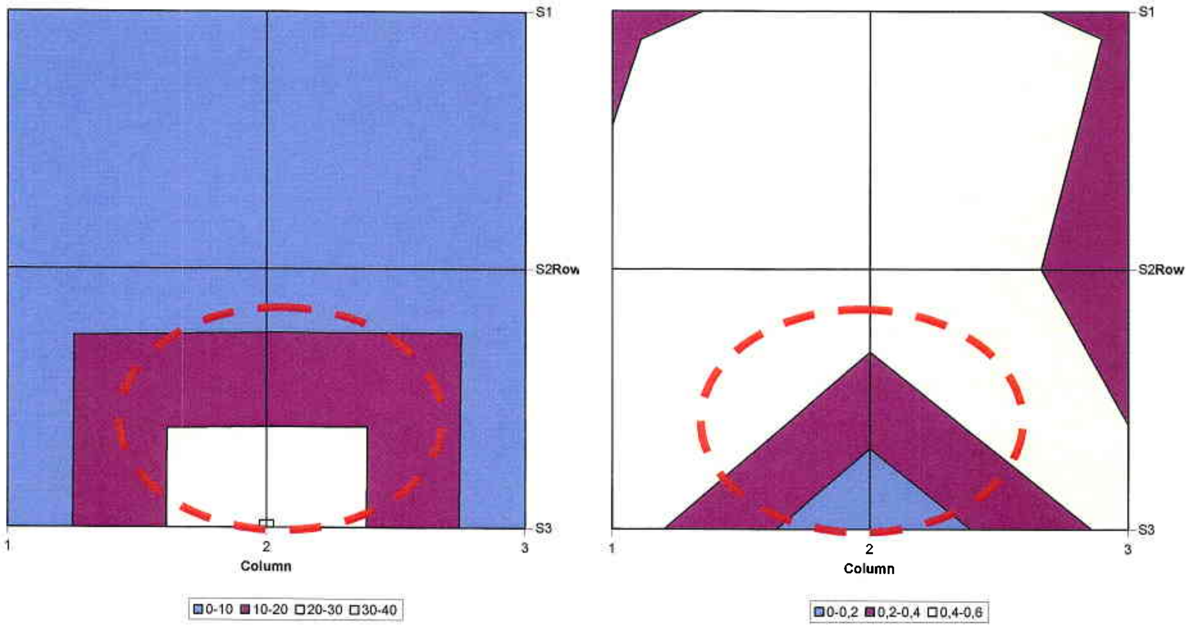


Fig. 14. Methodology for locating delaminations in unilaterally accessible concrete structures by impulse response method and impact echo method combined [1].

According to the above methodology, first the defective area is approximately, i.e. with an accuracy of 250-500 mm in plan (depending on the measuring grid size), determined and then the boundaries (extent) of this area are more precisely (with an accuracy of 50-100 mm in plan) determined and the delamination intensity (thickness) is estimated, as shown in fig. 14 [1]. This methodology has been verified by applying it to a building structure [7] and exemplary results are presented in fig. 15. Paper [7] was published towards 2011 and according to the *Web of Science* database has been cited 14 times while according to the *Scopus* database it has been cited 16 times.

a)

b)



c)

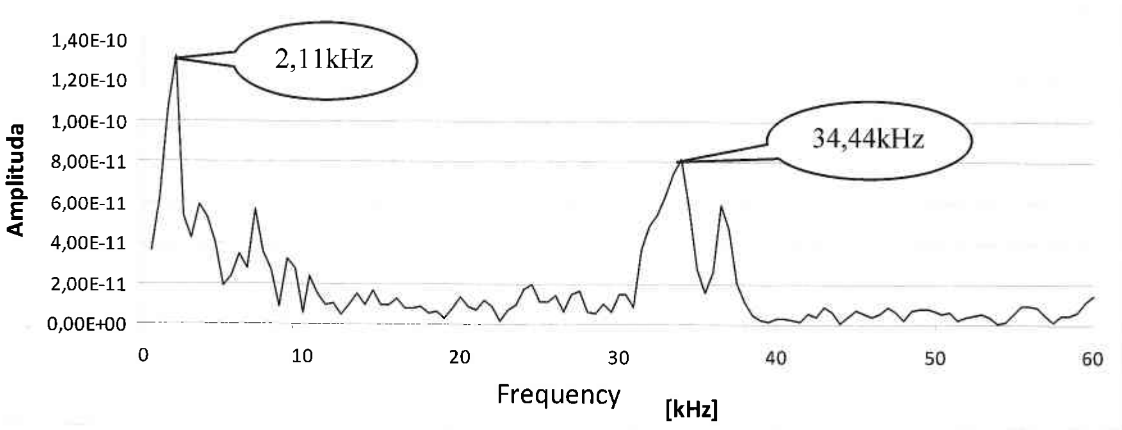


Fig. 15. In-situ verification of methodology for locating delaminations in unilaterally accessible concrete structures by means of impulse response method and impact echo method combined [7]: general view of building, b) exemplary maps of characteristic parameters for foundation slab in which delaminations were detected: map of average mobility and map of dynamic stiffness, c) elastic wave amplitude-frequency spectrum registered by impact-echo method in part of foundation slab with delaminations.

3) Location of large air voids

The methodology for the non-destructive location of large air voids in unilaterally available concrete structures by means of the ultrasonic tomography method is shown (in a slightly modified version in comparison with that presented in [2]) in figure 16 [1].

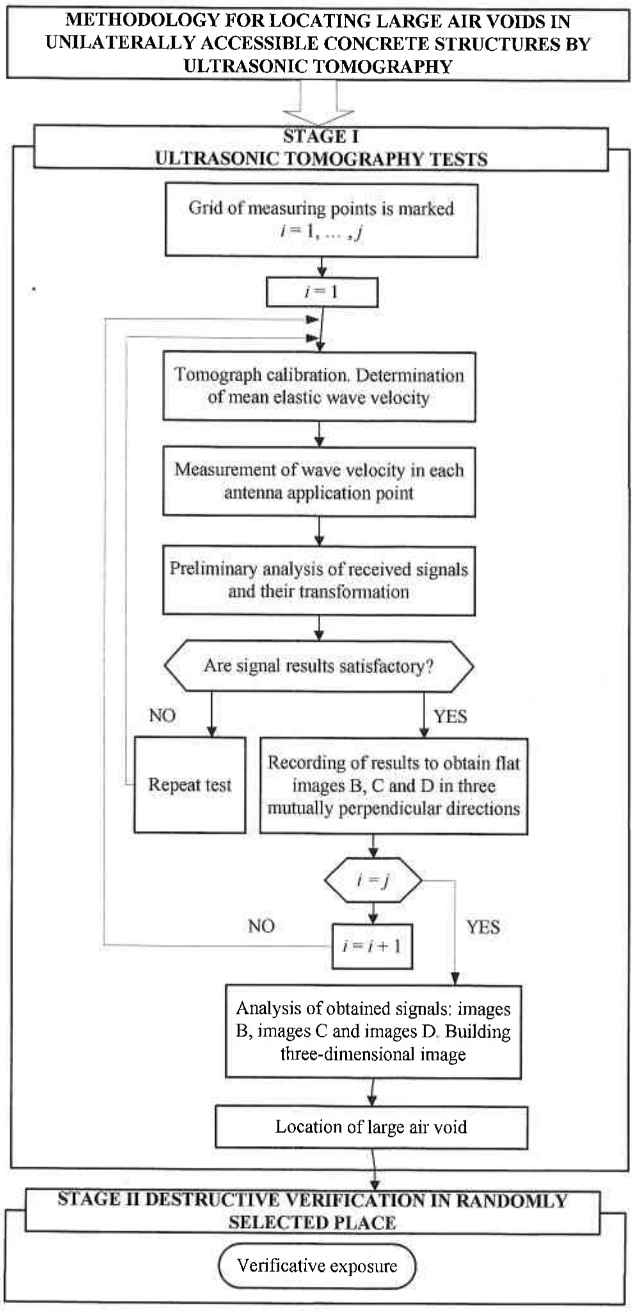
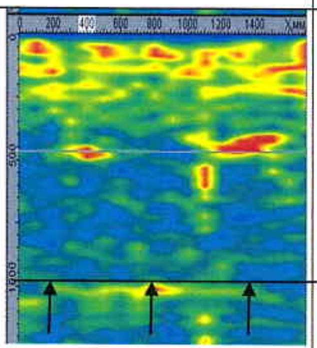
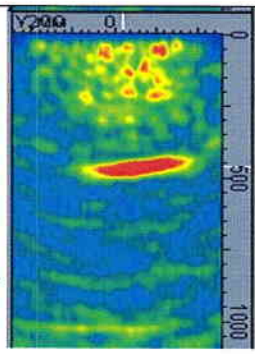
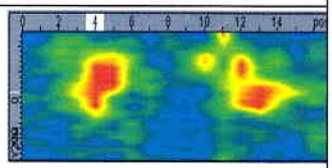
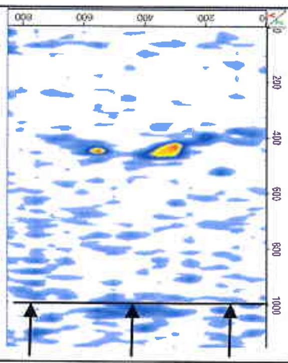
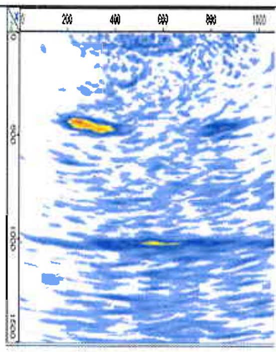
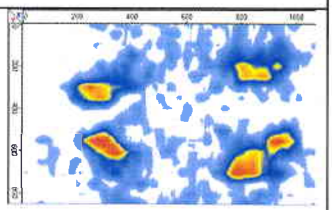
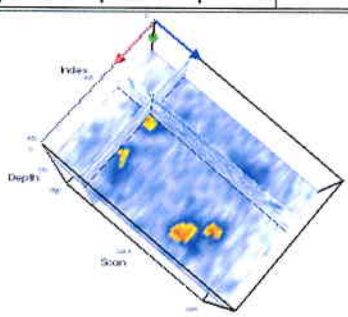
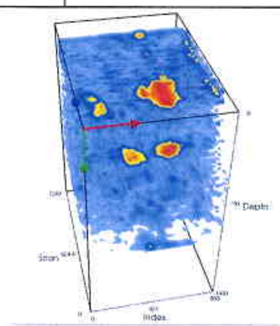


Fig. 16. Methodology for locating large air voids in unilaterally accessible concrete structures by means of the ultrasonic tomography method [1].

As regards the procedure, this methodology is similar to the methodology for determining thickness, presented in figure 11 in section 11. The methodology was developed on the basis of laboratory tests. Similar specimens as described above with modelled material imperfections in the form of inclusions with density about one hundred times lower than the density of the concrete were tested. The test results were reported in, e.g., papers [2, 3] and exemplary results are presented in table 1. The laboratory tests were carried out after difficulties in interpreting test results had been encountered during tests conducted on site. Paper [3] was published towards the end of the first quarter of 2014 and now has 1 citation according to the *Scopus* database.

Table 1. Exemplary results of non-destructive tests carried out by means of ultrasonic tomograph for specimen with modelled material imperfections in form of foamed polystyrene inclusions [3].

Sample during concreting and ready sample			
	Scan D	Scan B	Scan C
Scan D, B and C obtained by means of older model of ultrasonic tomograph			
Scan D, B and C obtained by means of latest ultrasonic tomograph			
Results obtained by means of latest ultrasonic tomograph, in form of three mutually perpendicular cross sections and three-dimensional image			

4) Identification and location of zones of concrete macroheterogeneities

The methodology, of which I am the co-author, for the non-destructive identification and location of zones of concrete heterogeneities in unilaterally accessible massive structures by means of the impulse response method and the ultrasonic tomography method combined is presented in figure 17 [1]. This version of the methodology is slightly modified in comparison with that presented in paper [4]. As demonstrated in [4], the combined use of the two methods ensures reliable test results.

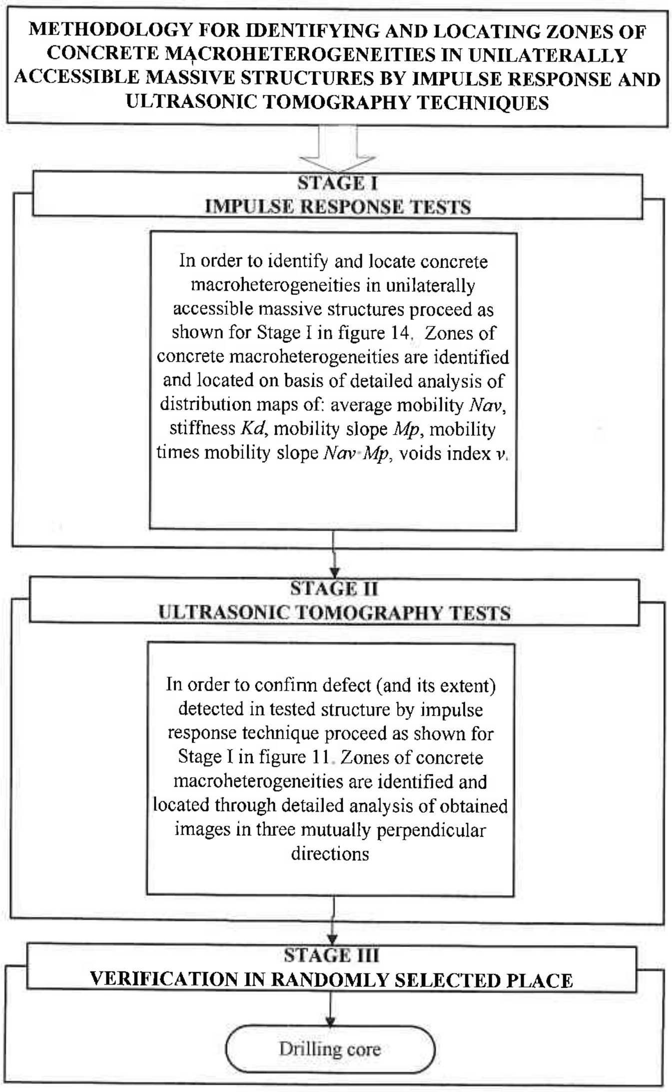


Fig. 17. Methodology for identifying and locating zones of concrete macroheterogeneities in unilaterally massive structures by means of impulse response method and ultrasonic tomography method combined [1].

It is proposed to carry out the tests in two stages. First, defective concrete zones in the tested structure are identified and located by the impulse response method. In the second stage, the defect detected in the structure by the impulse response method is confirmed and located along the depth (extent) with an accuracy of 20-30 mm by the ultrasonic tomography method. This is done through a detailed analysis of flat images obtained in three mutually perpendicular directions, showing the inside of the concrete structure in the tested zone. Also this methodology has been verified by applying it to a building structure [4]. Exemplary test results are presented in fig. 18. Paper [4] was published towards the end of 2013 and now has 3 citations acc. to the *Web of Science* database and 4 citations acc. to the *Scopus* database.

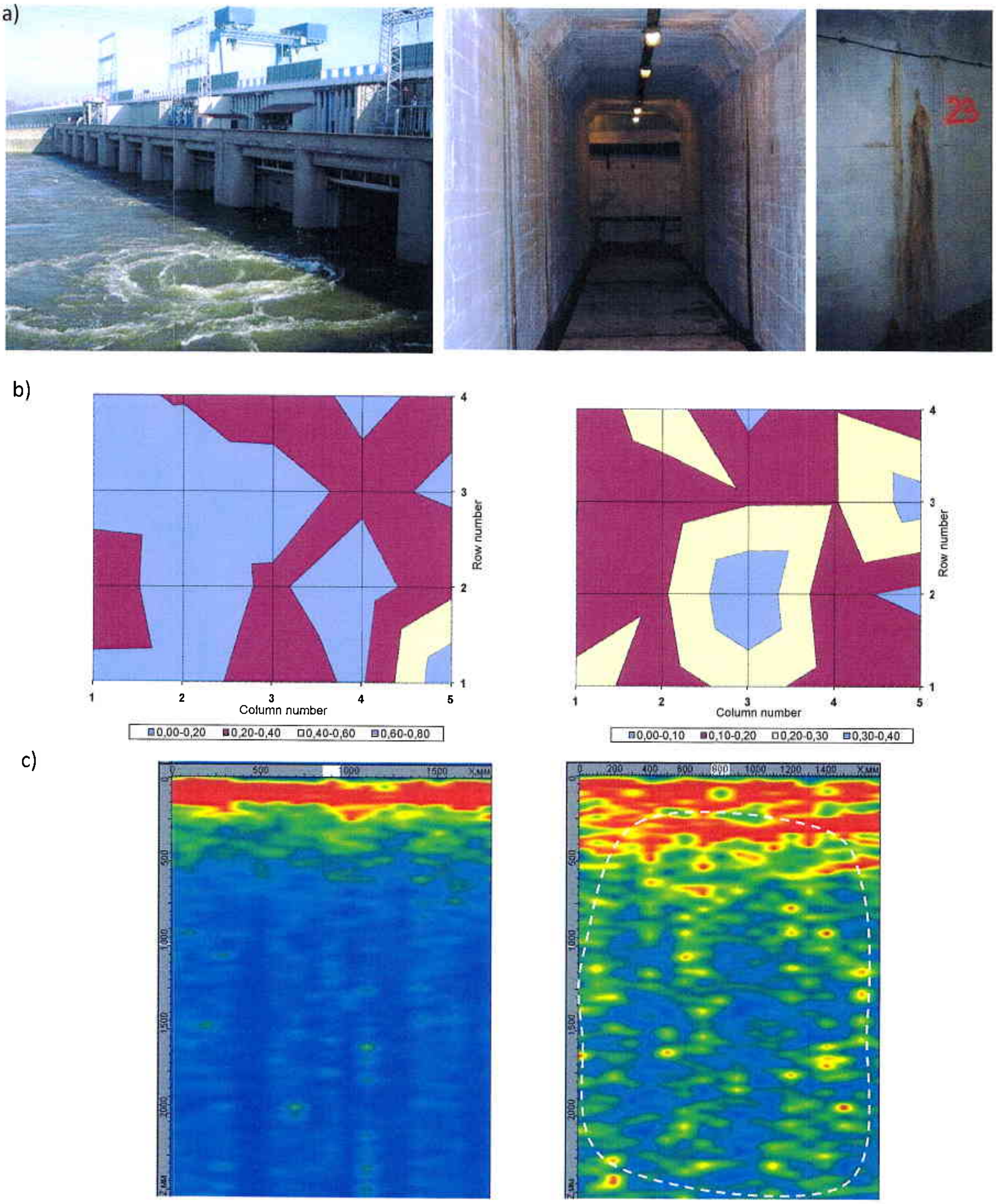


Fig. 18. Verification of methodology for identifying and locating defective (macroheterogenous) concrete zones in unilaterally accessible massive structures by means of impulse response method and ultrasonic tomography method on building structure [4]: general view of building, b) exemplary maps of stiffness, c) exemplary images D obtained by ultrasonic tomograph.

5) Determination of crack depth

My own methodology for non-destructively determining the depth of cracks in unilaterally accessible concrete structures by means of the impact-echo method is shown in figure 19 [1] and described below.

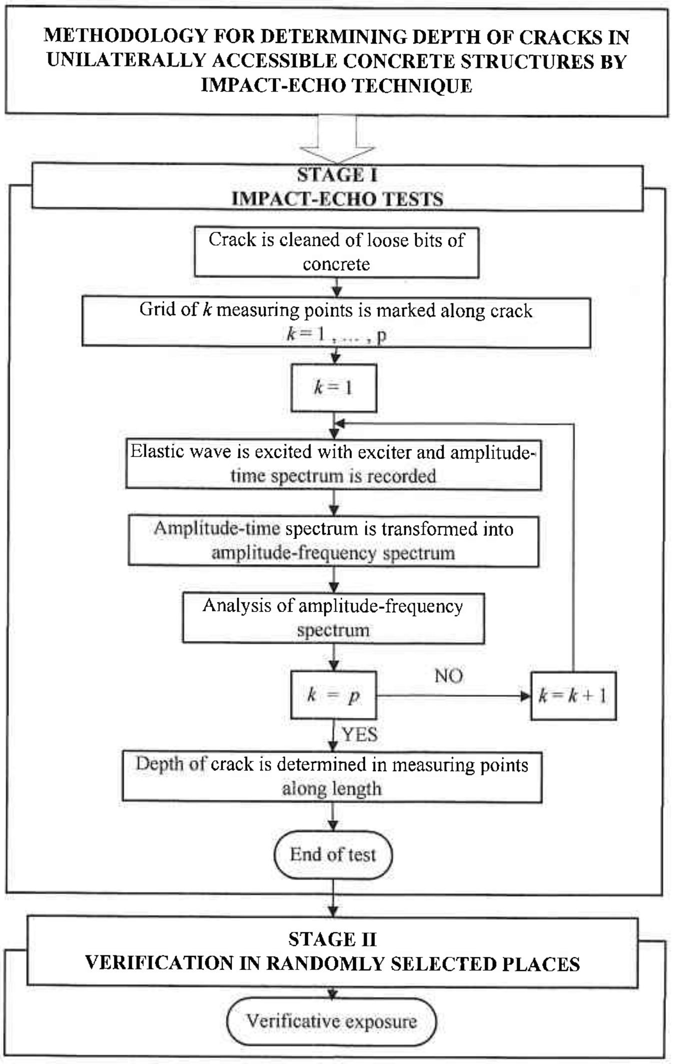


Fig. 19. Methodology for determining depth of cracks in unilaterally accessible concrete structures by impact-echo method [1].

As it is specified in figure 19, the depth of a crack (after the latter is cleaned from loose bits of concrete) is determined along its length with an accuracy of 5-10 mm by analyzing the amplitude-frequency spectrum and then random destructive tests (a test pit or core sample) are carried out. In this way the extent and intensity (changes in depth) of a crack can be determined. This is particularly useful when there is water in the crack and an impact-echo test cannot be performed along the whole depth of the crack (although the water can be temporarily removed, one never knows to what depth it has been actually removed).

The testing of cracks can be difficult because of their geometry. One of the more difficult cases is when a vertical crack is invisible on the surface and so it cannot be located using visual methods. Then it is proposed to carry out tests using the combination of the state-of-the-art non-destructive methods of ultrasonic tomography and impact-echo, as shown in fig. 20 [1].

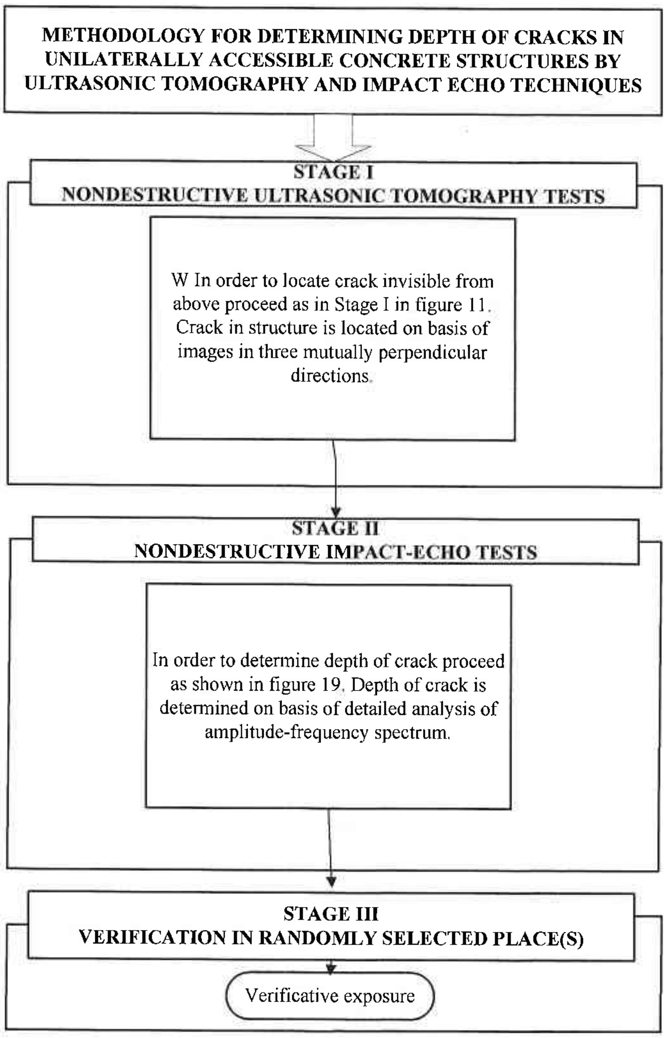


Fig. 20. Methodology for determining depth of cracks invisible on surface in unilaterally accessible concrete structures by means of ultrasonic tomography method and impact-echo method combined.

In stage I a crack is located using the ultrasonic tomography method and in stage II its extent and intensity are determined by the impact-echo method. Crack depth is determined with an accuracy of 5-10 mm.

In the case of the two methodologies, verification through a test pit in a randomly selected place(s) is recommended. The above test methodologies have been verified by on-site tests and laboratory tests. Exemplary test results are shown in fig. 21.

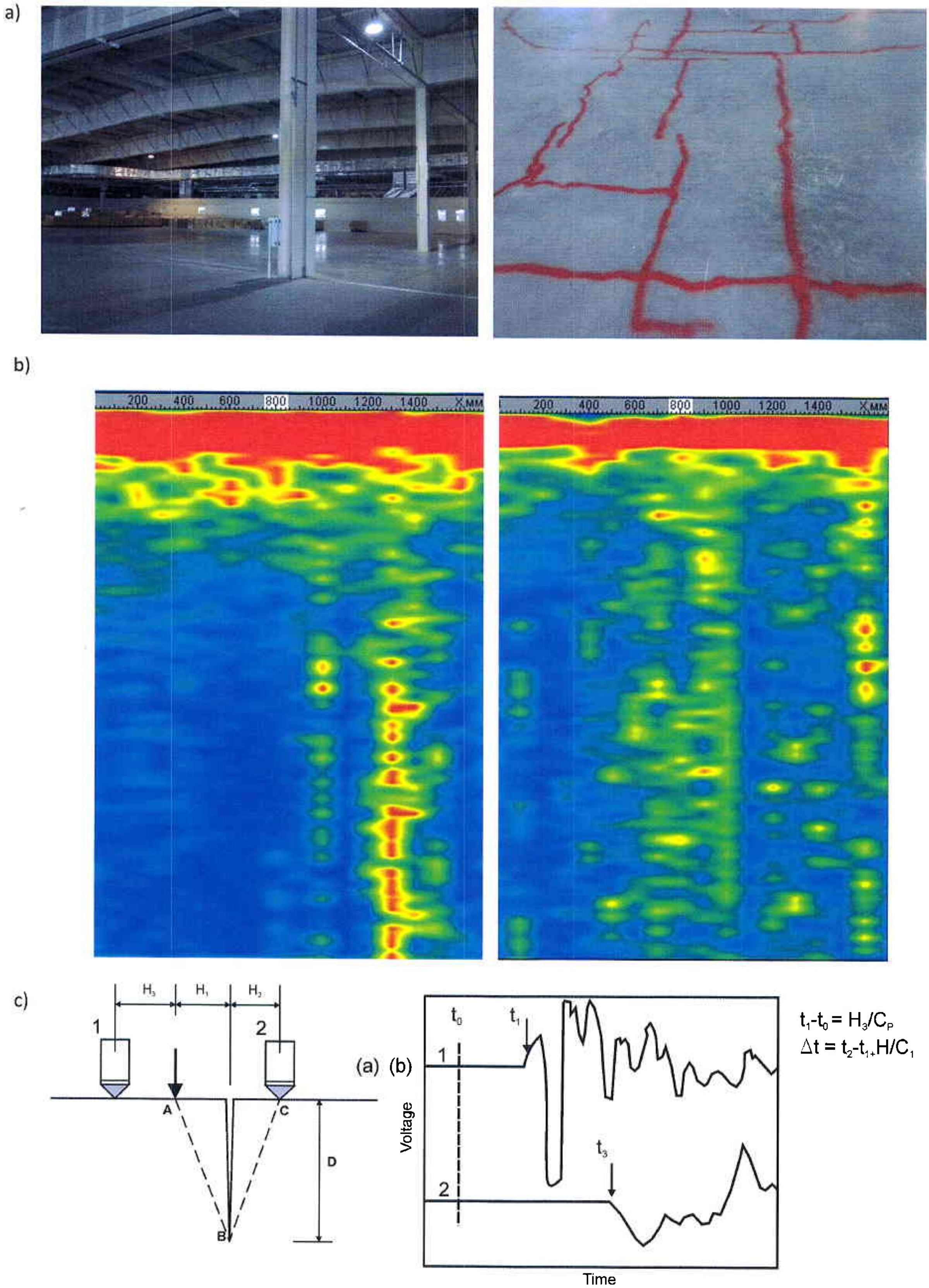


Fig. 21. Verification of methodology for determining depth of cracks in unilaterally accessible concrete structures by ultrasonic tomography method and impact-echo method on building structure: a) general view of tested industrial shed and floor, b) exemplary images D obtained by ultrasonic tomograph, c) exemplary determination of crack depth by impact-echo method.

6) Recapitulation

The monographic series of publications [1-8], entitled: **"A methodology for testing unilaterally accessible concrete structures by means of state-of-the-art acoustic methods"** comprises the results of my own research on the basis of which I have developed the original methodologies for the non-destructive testing of unilaterally accessible concrete structures by means of acoustic methods to identify such imperfections as: improper structure thickness, delamination of concrete layers, large air voids, zones of concrete macroheterogeneities, and cracks. In publications [1-8] I specified the range of application of the methodologies and their limitations.

Table 2 lists, acc. to [1], the above (geometric and material) imperfections occurring in unilaterally accessible concrete structures, together with the terms proposed for their description and the assigned (mentioned earlier) state-of-the-art non-destructive acoustic methods suitable for testing such structures [1].

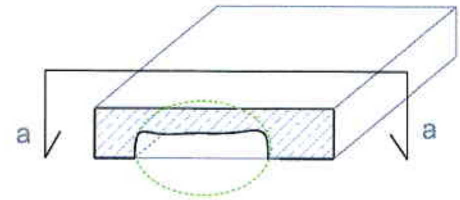
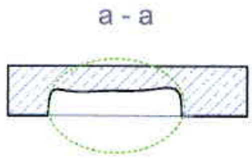
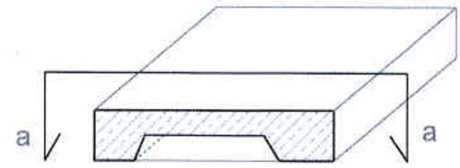
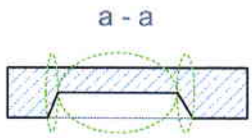
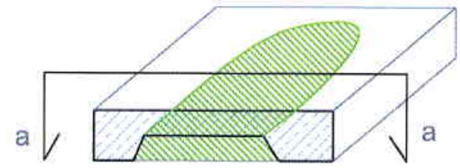
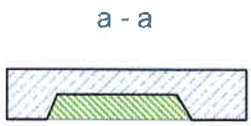
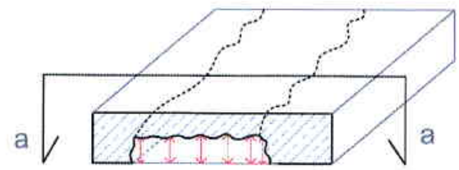
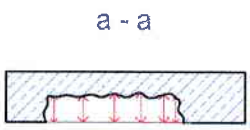
Table 2. Selected imperfections occurring in unilaterally accessible concrete structures, together with terms proposed for their description and assigned state-of-the-art non-destructive acoustic methods suitable for testing such structures [1].

Type/description of imperfection \ Test method		ultrasonic tomography method	impact-echo method	impulse response method	ultrasonic tomography + impact echo	impulse response + ultrasonic tomography	Impulse response + Impact-echo
Incorrect thickness of member	identification	●	●	-	●	-	-
	Location	●	●	-	●	-	-
	Extent	●	●	-	●	-	-
	Intensity	o	o	-	o	-	-
Delamination	identification	●	●	●	●	●	●
	Location	●	●	o	●	●	●
	Extent	●	●	●	●	●	●
	Intensity	-	o	-	o	-	o
Large air voids	identification	●	●	-	●	●	●
	Location	●	●	-	●	●	●
	Extent	●	●	-	●	●	●
	Intensity	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Zones of concrete macroheterogeneities	identification	●	●	●	●	●	●
	Location	●	●	●	●	●	●
	Extent	●	●	o	●	●	●
	Intensity	-	o	-	o	-	o
Cracks	identification	●	●	-	●	-	●
	Location	●	-	-	●	-	-
	Extent	-	●	-	●	-	●
	Intensity	-	●	-	●	-	●

Symbols: ● – suitable method, o – partially suitable method, - – unsuitable method, N.A. – not applicable

The terms, i.e. identification, location, extent and intensity, proposed in table 2 for describing the imperfections are explained, using as an example the geometric imperfection, in table 3. The proposed terms, based on tests carried out by the state-of-the-art non-destructive acoustic methods, make the description of the imperfections in unilaterally accessible concrete structures more precise and, in my opinion, represent an original scientific and research achievement.

Table 3. Explanation of proposed terms for describing geometric imperfection in unilaterally accessible concrete structures tested by means of non-destructive acoustic methods.

Description of imperfection	Illustration of imperfection description	
	View	Cross section
1. Identification An imperfection (incorrect thickness of the structure) is found to be present.		
2. Location The place of occurrence of the imperfection in the cross section of the structure is determined with accuracy dependent on the equipment used.		
3. Extent The size (surface area and volume) of the place where the imperfection occurs is determined with accuracy dependent on the equipment used.		
4. Intensity The degree of advancement of the imperfection (the distribution of locally incorrect thickness in the whole place of its occurrence)		

As table 2 shows, the ultrasonic tomography method and the impact-echo method are particularly suitable for solving the problems connected with the testing of imperfections, such as incorrect structure thickness, delamination of concrete layers, large air voids, zones of concreted macroheterogeneities and cracks, occurring in unilaterally accessible concrete structures.

The methodologies developed by the author on the basis of his own research have been verified by applying them to building structures whereby their practical suitability has been confirmed.

Since the imperfections mentioned above can result in a reduction in the load-bearing capacity, durability and safety of the use and further service of building structures, it is necessary to know the methods suitable for searching for the imperfections and their testing.

The presented monographic series of publications constitutes a recapitulation of my own research on testing unilaterally accessible concrete structures by means of the state-of-the-art non-destructive acoustic methods.

In my opinion, my most important scientific and research achievements are:

1. The development of the original methodologies for the non-destructive determination of incorrect thickness in unilaterally accessible concrete structures by means of the ultrasonic tomography method as well as the combined use of the latter method and the impact-echo method, and the on-site verification of the methodologies.
2. The co-development of the original methodology for the non-destructive location of delaminations in unilaterally accessible concrete structures by means of the combined methods of impulse response and impact-echo, and the on-site verification of the methodology.
3. The development of the original methodology for the non-destructive location of large air voids in unilaterally accessible concrete structures by means of the ultrasonic tomography method, and the on-site verification of the methodology.
4. The co-development of the original methodology for the non-destructive identification and location of zones of concrete macroheterogeneities in unilaterally accessible concrete structures by means of the impulse response method and the ultrasonic tomography method combined, and the on-site verification of the methodology.
5. The development of the original methodologies for the non-destructive determination of the depth of cracks in unilaterally accessible concrete structures by means of the impact-echo method and the combined methods of ultrasonic tomography and impact-echo, and the on-site verification of the methodologies.
6. The creation of the knowledge base based on laboratory tests, the analysis of the test results and the verification and fine-tuning of the original methodologies for the non-destructive determination of selected geometric and material imperfections in unilaterally accessible concrete structures by means of the state-of-the-art acoustic methods.
7. The assignment of the non-destructive acoustic methods to the testing of the selected imperfections in unilaterally accessible concrete structures and the proposal of terms describing the imperfections.

8. I was one of the first persons in Poland to apply the ultrasonic tomography method to the testing of the selected geometric and material imperfections in unilaterally accessible concrete structures.

5. Review of other scientific and research achievements

a. Before receiving PhD degree

In July 1996 I defended (summa cum laude) my MSc thesis entitled: "Contemporary single-family housing construction systems", supervised by Andrzej Moczko, PhD, eng., at the Civil Engineering Faculty of Wrocław University of Technology, main field of study: Building Engineering, specialization: building & building technology and in the same year I began research and teaching work as assistant at the Department of General Construction in the Institute of Building Engineering at the Civil Engineering Faculty of Wrocław University of Technology.

In June 1997 I registered for the PhD degree in the Institute of Building Engineering, submitting the title of my PhD thesis: "The non-destructive diagnostic testing of concrete by means of artificial neural networks" whose supervisor became Prof. Mieczysław Kamiński, hab. PhD, eng. In 1977 working as assistant I began my doctoral studies at the Civil Engineering Faculty of Wrocław University of Technology. At that time I also began collaborating with Prof. Zenon Waszczyszyn, hab. PhD, eng. from Cracow University of Technology on the use of artificial intelligence in building engineering. I became a member of the research team formed by the Professor for this purpose.

In the years 1998-2000 I stayed in the United States where I took part in a research project run in collaboration with the Illinois Institute of Technology in Chicago, devoted to the use artificial neural networks in the insurance sector. I this way I developed my scientific interests in artificial intelligence.

After my return from the United States I focused my scientific interests on the identification of the compressive strength of concrete by means of artificial neural networks on the basis of parameters evaluated using non-destructive methods. In 2000 I began collaborating with Prof. Jerzy Hoła, hab. PhD, eng., who by the decision of the Council of the Institute of Building Engineering at Wrocław University of Technology became my new supervisor, and I made the original title of my PhD thesis more specific by changing it to "The non-destructive identification of the compressive strength of concrete by means of artificial neural networks".

In September 2002 I finished my doctoral studies and submitted my PhD thesis entitled "The non-destructive identification of the compressive strength of concrete by means of artificial neural networks". Besides, I was then the author and co-author of 16 papers, including 7 published abroad. I defended the PhD thesis summa cum laude in February 2003. The reviewers of the thesis were: Prof. Zenon Waszczyszyn, hab. PhD, eng. and Prof. Mieczysław Kamiński, hab. PhD, eng.

In my PhD thesis I presented the results of my experimental studies and numerical analyses relating to the identification of the compressive strength of concrete by means of artificial neural networks on the basis of non-destructively evaluated parameters. This research subject proved to be highly productive. Through experimentation I built up a comprehensive database containing parameters determined by several non-destructive methods for ordinary concrete and high-performance concretes for the purpose of identifying compressive strength by means of unidirectional backpropagation neural network with a conjugate gradient algorithm and the unidirectional mulitlayer Lavenberg-Marquardt neural network, without being it necessary (as before) to determine empirical dependences or to match hypothetical curves. I developed a methodology for this identification. The new method of identifying the compressive strength of concrete was successfully verified by applying it to building structures, e.g. to a Wrocław University building being then erected.

As part of my PhD thesis I carried out a critical survey of the current state of knowledge concerning non-destructive methods of assessing the compressive strength of concrete and the then existing methods of identifying this strength. I also carried out a survey of artificial neural networks, their principal types, structure and training algorithms, providing examples of the more interesting applications of ANNs in building engineering. On the basis of the survey I selected the neural networks most suitable for the task set in the PhD thesis.

On the basis of the results of test carried out by me and by other researchers I created a knowledge base for seven concretes differing in mainly their compressive strength and aggregate type, containing parameters measured by the particular non-destructive methods as well as destructively determined bulk density and compressive strength. As a result, patterns for training and testing artificial neural networks were developed.

The theses advanced were tested through experiments and numerical analyses, using the database and selected artificial neural networks, and also verified by carrying out tests on real building structures.

The advanced theses were proved and the objective was achieved. Finally, conclusions were drawn from the experimental and analytical results, providing answers to the theses. I also indicated the directions for further research, including the extension of the database and attempts at employing obligational and probabilistic neural networks and genetic algorithms.

I consider the principal scientific and research achievements of the PhD thesis to be:

a) the experimental demonstration of the usefulness of artificial neural networks for the identification of the compressive strength of concrete on the basis of parameters evaluated by non-destructive methods, showing that the type and structure of the ANN and its training algorithm have a bearing on identification accuracy and indicating the ANNs most suitable for the particular task;

b) the development of the modern methodology for the reliable non-destructive identification of the compressive strength of concrete by means of artificial neural networks and its verification on building structures;

c) the creation of the knowledge base for ordinary and high-performance concretes for the identification of the compressive strength of concrete by means of artificial neural networks.

The above are original achievements documented in scientific publications, e.g. in [sect. II E: 39, sect. II F: 28, sect. II L: 43, 44, 47-49 in Annex no. 3], including in the *Journal Citation Reports* database, and in [sect. II A: 7 in Annex no. 3] cited 24 times acc. to *Web of Science* and 17 times acc. to *Scopus*.

b. After receiving PhD degree

Having received a doctor's degree, in October 2004 I began working as adiunkt (lecturer) in the Department of General Construction, in the Institute of Building Engineering at the Civil Engineering Faculty of Wrocław University of Technology, where I have been working ever since. I undertook research on non-destructive tests of concrete structures by means of acoustic methods: the ultrasonic method (also with the use of exponential heads, in collaboration with Bohdan Stawiski, PhD, eng.), the echo-sounding method, the impact-echo method, the impulse response method and the ultrasonic tomography method. I became particularly interested in ultrasonic tomography after taking part in 3D medical examinations performed in real time using this technique, thinking of the insights it would provide to the testing of concrete.

In 2006 I established collaboration with the inventor of the ultrasonic tomograph multihead ultrasonic measuring antenna Dr A. A. Samokrutov from Russia. The method of testing by means of this device was then little known. I was the one of the first researchers who began using this method in Poland. Out of scientific interest I began investigating both the theoretical and practical aspects of this subject, which resulted in the monographic series of publications presented above.

After receiving the PhD degree, besides investigating the problems discussed in the monographic series of publications I also undertook research work relating to:

1. the extension of the tests and the knowledge base to cover self-compacting concretes and concretes with a fly ash addition for the purposes of identifying the compressive strength of concrete by means of artificial neural networks on the basis of parameters evaluated by non-destructive methods;
2. the use of artificial neural networks in solving problems relating to the productivity of systems of earth-moving machines, consisting of excavators and hauling equipment;

3. the co-development of a non-destructive impedance tomography method for identifying the moisture content in brickwork;
4. the co-development of a production and testing technology for fibre cement boards.

Re pt. 1.

After receiving the PhD degree I continued the research work connected with the non-destructive identification of the compressive strength of concrete by means of artificial neural networks. Through experimentation I extended the knowledge base containing parameters determined by several non-destructive methods to cover new concretes with a fly ash addition, i.e. ordinary concretes, high-performance concretes and self-compacting concretes, for the purposes of the identification of their compressive strength by means of artificial neural networks. The developed original methodology for the neural identification of this strength was validated through laboratory tests and fine-tuned on building structures. These are original achievements documented in scientific publications, e.g. in [sect. II E: 35-38, 52, 53, sect. II F: 23, sect. II L: 31, 34, 38, 41 in Appendix 3], including in the *Journal Citation Reports* database, [sect. II A: 6 in Annex no. 3] which has been cited 9 times acc. to *Web of Science* and 12 times acc. to *Scopus*. Moreover, work [sect. II E: 37 in Annex 3] has been cited 25 times acc. to *Scopus*.

Re pt. 2.

Since 2005 I have been collaborating with Prof. Bożena Hoła, hab. PhD, eng. on the possibilities of applying artificial intelligence, especially artificial neural networks, to solve problems relating to the organization and harmonization of construction processes. As a result of tests carried out on building sites I acquired sets of data for the training and testing of artificial neural networks. Then I built an artificial neural network for predicting the productivity of systems of earth-moving machines, consisting of excavators and hauling equipment. My original achievements in this field have been documented in scientific publications listed in, e.g., [sect. II E: 26, 27, 48, sect. II L: 18, 21, 23, 28, 30 in Annex no. 3], including in *Journal Citation Reports* [sect. II A: 3, 4 in Annex 3], the first of which works has been cited 10 times acc. to the *Web of Science* and 11 times acc. to *Scopus* while the second has been cited 8 times acc. to *Web of Science* and 9 times acc. to *Scopus*.

Re pt. 3.

Simultaneously I was doing research on problems relating to the build up of moisture in masonry walls of buildings.

Since 2005 I took part (as contractor) in the Ministry of National Education research project no. 4 TO7E 045 entitled: "New tomographic method of assessing the degree of moisture accumulation in brick walls in building structures", which was completed in 2008. The project was carried out in collaboration with Electrotechnical Institute in Warsaw. The project research results were reported in the monograph (written in English) entitled: "New Tomographic Method of Brickwork Damp Identification" published by the Wrocław University of Technology Publishing House in 2010. It should be noted that the results of the research carried out as part of the project were highly practical, leading to the development of a new method of assessing and controlling the effectiveness of the forced drying of masonry walls and the effectiveness of damp-proof protections and hydrophobic membranes in walls. I intend to continue this research with the aim of producing testing equipment.

The research results and the knowledge and practical experience gained from the project, constituting original achievements, have been disseminated in Poland and abroad and documented by scientific publications, such as [sect. II E: 1, 28, 47, sect. II L: 14, 19, 24, 25 in Annex no. 3], including in the *Journal Citation Reports* database [sect. II A: 2, 5 in Annex no. 3], the former of which works has now 4 citations acc. to *Web of Science* and 6 citations acc. to *Scopus* while the latter has 1 citation acc. to both the Web of Science and Scopus.

Re pt. 4.

Since 2009 I took part, as contractor and manager of several tasks, in the Innovative Economy Project UDA-POIG.04.04/00-02-019/08 entitled: "Starting the innovative production of eco-friendly cellulose fibre cement boards" funded under Measure 4.4. "New investments with high innovative potential" of the Innovative Economy Operational Programme 2007-2013.

As part of this Measure, I co-developed a technology and line for producing fibre cement boards and developed an invention for which a patent bearing the title "A composite fibre cement material" and the number P.407678 has been filed. I also co-developed two inventions for which patents bearing the respective titles and numbers: "A climatic chamber for curing fibre cement boards during their maturing" number P.406159 and "A chamber for ageing tests" number P.406158 have been filed.

In collaboration with Prof. Mariusz Kaczmarek, hab. PhD, eng. from the Institute of Mechanical Engineering and Information Science at Kazimierz Wielki University in Bydgoszcz I co-developed a method and a measuring device for the non-contact and non-destructive assessment of the quality of moving board materials by means of ultrasonic plate (Lamb) waves. This method does not require any couplers, e.g. liquids or solids, between the ultrasonic transducers and the tested board. A patent bearing the title "A system of non-contact quality control of moving board materials" and number P.406963 has been filed for the method and the testing system.

Also the above constitutes an original achievement documented by publications [sect. II B: 1, sect. II C: 1-4, sect. II E: 3 in Annex no. 3].

6. Summary of scientific and research, teaching, organizational and engineering activities

a. Scientific and research activity after receiving PhD degree

The works published after receiving the PhD degree are summarily listed in table 4.

Table 4. Summary list of works published after receiving PhD degree.

No.	Type of work	Total number of works	Number of works after receiving PhD degree
1.	**Total number of publications**	**127**	**111 (16)**
2.	Papers in JCR database	15	15 (3)
3.	International monographs	1	1
4.	Books	2	2
5.	Chapters in books	13	13
6.	Papers in international journals not listed in JCR database	24	24
7.	Papers in national journals	15	13
8.	Papers at international conferences	29	22
9.	Papers at national conferences	27	20
10.	Edited books	1	1
11.	Total number of citations acc. to *Web of Science*	113	113
() works of one author			

A detailed list of all the works can be found in Annex no. 3. It is also presented below with some additional information:

- 15 papers published (after receiving the PhD degree) in JCR-listed journals, including:
  - 8 papers forming the monographic series of works published in JCR-listed journals, being the basis for initiating the habilitation procedure,
  - 7 papers published in JCR-listed journals, which are not part of the monographic series of publications,
- 1 monograph with an international reach;
- Number of citations:
  - 113 acc. to *Web of Science*,
  - 184 acc. to *Scopus*,
  - 369 acc. to *Google Scholar*;
- H-index:
  - 7 acc. to *Web of Science*,
  - 9 acc. to *Scopus*,
  - 10 acc. to *Google Scholar*;
- Total *Impact Factor* 14.135 (breakdown in table 5):

Table 5. Breakdown of *Impact Factor*.

No.	Journal	Year in which paper was published	Position in Annex no. 3	*Impact Factor*	MS&HE score
1.	*Archives of Civil and Mechanical Engineering*	2014	sect. I B: 1	1.331	20
2.	*Archives of Civil and Mechanical Engineering*	2014	sect. I B: 2	0.963	20
3.	*Russian Journal of Non-destructive Testing*	2014	sect. I B: 3	0.217	15
4.	*Journal of Civil Engineering and Management*	2013	sect. I B: 4	2.016	40
5.	*Journal of Civil Engineering and Management*	2013	sect. I B: 5	2.016	40
6.	*Journal of Civil Engineering and Management*	2013	sect. II A: 1	2.016	40
7.	*Materials Transactions*	2012	sect. I B: 6	0.588	25
8.	*Compel*	2012	sect. II A: 2	0.281	15
9.	*Automation in Construction*	2011	sect. I B: 7	1.500	40
10.	*Archives of Civil and Mechanical Engineering*	2010	sect. I B: 8	0.383	9
11.	*Automation in Construction*	2010	sect. II A: 3	1.311	32
12.	*Archives of Civil and Mechanical Engineering*	2008	sect. II A: 4	-	9
13.	*Przegląd Elektrotechniczny*	2007	sect. II A: 5	-	9
14.	*ACI Materials Journal*	2005	sect. II A: 6	0.419	20
15.	*NDT and E International*	2005	sect. II A: 7	1.094	32
			Total	**14.135**	**366**

- 24 papers in international journals not listed in JCR, including:
  - 4 papers which were not in the JCR database on the day when the paper was published, but now are in the JCR database,
  - 2 papers in *Archives of Civil Engineering*,
- 13 papers in national journals,
- 42 papers at conferences, including:
  - 22 papers at international conferences, including at three conferences with a world-wide reach,
  - 20 papers at national conferences,
- 30 attendances at conferences, including:
  - 15 attendances at international conferences,, including 3 conferences with a world-reach,
  - 15 attendances at national conferences,
- 36 delivered papers:
  - 18 papers at international conferences,
  - 18 papers at national conferences,
- 2 books,
- 13 chapters in books,
- 1 popular science article,

- 55 expert opinions and other studies ordered by various business entities, including 35 SPR series reports,
- 4 patent applications,
- 1 book editing,
- 23 reviews of papers, including 18 in JCR-listed journals: (*Archives of Civil and Mechanical Engineering, Automation in Construction, Journal of Civil Engineering and Management, Engineering Structures, NDT&E International, International Journal of Physical Sciences, International Journal of Water Resources and Environmental Engineering, Journal of Mechanical Engineering Research, African Journal of Engineering Research*),
- 8 reviews of papers presented at international conferences abroad (*2014 Global Conference on Polymer and Composite Materials (PCM2014), The 3rd International Conference on Civil Engineering and Urban Planning*, China; *The 9th and 10th International Conference "Modern building materials, structures and techniques"* Lithuania).

Since 2008 I have regularly attended the *World Conference on Non-Destructive Testing*, which is the principle conference on non-destructive testing. Since 2006 I have regularly attended the *European Conference on Non-Destructive Testing* – the second most important conference devoted to this subject. In 2009 I attended the international *Asia Pacific Conference on Non-Destructive Testing*, the most important conference on non-destructive testing in this part of the world. Since 2006 I have regularly attended the annual international conference *Defektoskopie* held in the Czech Republic and since 1998 I have regularly attended the annual National Conference on Non-Destructive Testing, where in 2006 I was awarded the prize for the best delivered paper. I have presented and delivered papers containing the results of my research 40 times at the above mentioned conferences.

In the years 2003-2013 I was awarded 10 Wrocław University of Technology Rector Prizes for my research and teaching activity and in 2013 I received the Bronze Medal for long service.

I am member of three national scientific-technical organizations (Annex no. 3, sect. III H p. 34). Since 1994 (then as a student) I was co-organizer and subsequently member (since 2006) of the scientific committee and the organizing committees of the periodic scientific-technical conference on "Renovation problems in general construction and in historic building structures", called REMO, in the years 1994, 1996, 1998, 2002, 2004.

Moreover, after receiving the Doctor of Technical Sciences degree I have been on short placements in 6 research institutions (5 of them abroad), on a domestic yearly professional placement and on 15 research and technical visits abroad.

I am the assistant supervisor of 1 registration and conferment procedure for a doctoral degree opened at the Faculty of Building Engineering and Architecture at Kielce University of Technology by

Aleksandra Krampikowska, MSc, eng. on 12 March 2014. The title of the PhD thesis is: "Analysis and verification of the development of degradation processes proceeding in reinforced concrete members under load by means of acoustic emission" approved by Faculty Council decision no. 140/14.

Currently I am the tutor of the "Etaksi" Scientific Circle (with 51 student members) at the Civil Engineering Faculty of Wrocław University of Technology. In collaboration with this circle I have taken part in the organization of student conferences, including the Puzzel 2013 Conference and the student conference of scientific circles held 7.12.2013.

b. Teaching activity

I give lectures and teach project and laboratory classes on such subjects as: General Construction, Building Code, Housing Construction, Fundamentals of Designing and Shaping Building Structures, and Maintenance and Diagnosis of Building Structures within full-time and part-time MSc and Engineering Degree studies. I have been the supervisor of 58 MSc and Engineering Degree theses within full-time and part-time studies. I have written about 40 reviews of such theses. In 2007 I was awarded the Minster of Construction Honourable Mention for the supervision of a diploma thesis.

As part of my teaching activity I have developed my own syllabi for the courses: Building Code and Maintenance and Diagnosis of Building Structures and updated the syllabi for the courses: General Construction, Housing Construction, Fundamentals of Designing and Shaping Building Structures.

Working in the continually upgraded Non-destructive Testing Laboratory I constantly update my knowledge and introduce new test methods and state-of-the-art equipment into the syllabi, whereby the students can familiarize themselves with new test methods and through on-site classes (also on Wrocław University of Technology buildings under construction) can apply them in engineering practice.

I am the co-author of two university textbooks. The first textbook entitled: "The computing of conventionally erected building structures" published in 2006 by Dolnośląskie Wydawnictwo Edukacyjne in Wrocław was awarded the Minster of Construction Honourable Mention in 2007. There have been five editions (2006, 2007, 2009, 2010, 2013) of this book. In 2009 I initiated the writing of a book entitled: "Materials for project classes in general construction" published by Dolnośląskie Wydawnictwo Edukacyjne. There have been three editions (2009, 2011, 2013) of this book.

I am lecturer in the postgraduate studies "Management, maintenance and appraisal of properties" run at the Civil Engineering Faculty of Wrocław University of Technology and on the course

"Construction regulations" run every 6 months by the Polish Association of Building Engineers and Technicians in Wrocław.

c. Organizational and engineering activity

As a representative of adiunkts I have been member of the Council of the Civil Engineering Faculty of Wrocław University of Technology for the terms: 2005-2008, 2008-2012 and 2012-2016. During the 2005-2008 and 2008-2012 terms I was the secretary of the Faculty Electoral Committee and in the current term (2012-2016) I am its member. In the 2012-2016 term I am member of the Faculty Evaluating Committee at the Civil Engineering Faculty of WUT. In 2012 I was elector in the Electoral College at the Civil Engineering Faculty of WUT for the election of the Dean for the 2012-2016 term. During the 2005-2008 and 2008-2012 terms and partially during 2012-2016 term I was Coordinator for Promotion at the Civil Engineering Faculty of WUT. Since 2008 I have been the tutor of the "Etaksi" Scientific Circle at the Civil Engineering Faculty of WUT.

Since 20006 I have held the unlimited building licence for designing and managing construction work and since 2009 I have been a mycological building surveyor of the Polish Association of Building Mycologists.

Since 2006 I have been member of the Committee for the Restoration, Modernization and Renovation of Building Structures in the Polish Association of Building Engineers and Technicians in Wrocław. In 2010 I was awarded the Honorary Gold Badge of the Polish Association of Civil engineers and Technicians.

Since 2008 have served as an expert in the Arbitration Court at the Lower-Silesian Chamber of Commerce.

During the 2010-2014 term, as a representative of building engineers, I was member of the District Disciplinary Court at the Lower-Silesian District Chamber of Building Engineers. In 2013 I was awarded the Silver Badge of the Polish Chamber of Building Engineers.

In 2014 as a representative of building engineers I was elected delegate to the Convention of the Lower-Silesian District Chamber of Building Engineers for the purpose of electing new bodies of the Lower-Silesian District Chamber of Building Engineers. I was elected deputy chairman of the District Disciplinary Court at the Lower-Silesian District Chamber of Building Engineers for the 2014-2018 term.

A detailed list of all my scientific and research, teaching, organizational and popularization achievements is contained in Annexes 3 and 4.

Krzysztof Schabowicz