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Non-destructive identification of cracks in unilaterally accessible massive concrete walls in hydroelectric power plant

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ABSTRACT

This paper presents a methodology for the non-destructive location and identification of cracks in unilaterally accessible massive concrete walls by means of the state-of-the-art acoustic methods of impulse response and ultrasound tomography. An example of the practical verification of the methodology used to investigate the concrete structure of a hydroelectric power plant is provided.

1. Introduction

Because of their great thickness and the huge mass of concrete they incorporate, the massive walls of hydroelectric power plants are prone to cracking [1,2]. Cracks are understood here as discontinuities in part or whole of the thickness and height of a structural member. Cracks may form when the thermal stresses generated by the exothermy of the cement during the erection of walls exceed the tensile strength of the young concrete. They may also arise as a result of concrete shrinkage. In the course of service cracks in the walls may also appear as a result of, e.g., changes in the temperature of the concrete due to: the cyclic annual changes in the temperature of the water flowing through the hydrotechnical system, the deformation of the soil medium or sustained vibrations generated by the operation of the turbines. Prone to cracking are first of all the wall regions where the concrete is of poorer quality, e.g. is excessively porous due to the separation of the concrete mixture components or its insufficient vibration or because the larger aggregate particles were not entirely coated with the concrete mixture [3]. Cracks can be divided into through cracks (extending across the whole thickness of the wall) and non-through cracks, as illustrated in Fig. 1. Both types of cracks

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adversely affect the safe service of a facility and its durability [4]. If one takes into account the fact that most of the massive walls of hydroelectric power plants are accessible from only one side, it becomes apparent that the location and identification of such cracks, especially the ones invisible from the accessible side, is very difficult.

According to the literature on the subject [5–8], non-destructive methods, e.g. the latest acoustic methods such as ultrasound tomography [9] and the impulse-response method [10], are highly suitable for the location and identification of cracks in unilaterally accessible walls. The methods are increasingly used in the diagnosis of massive structures made

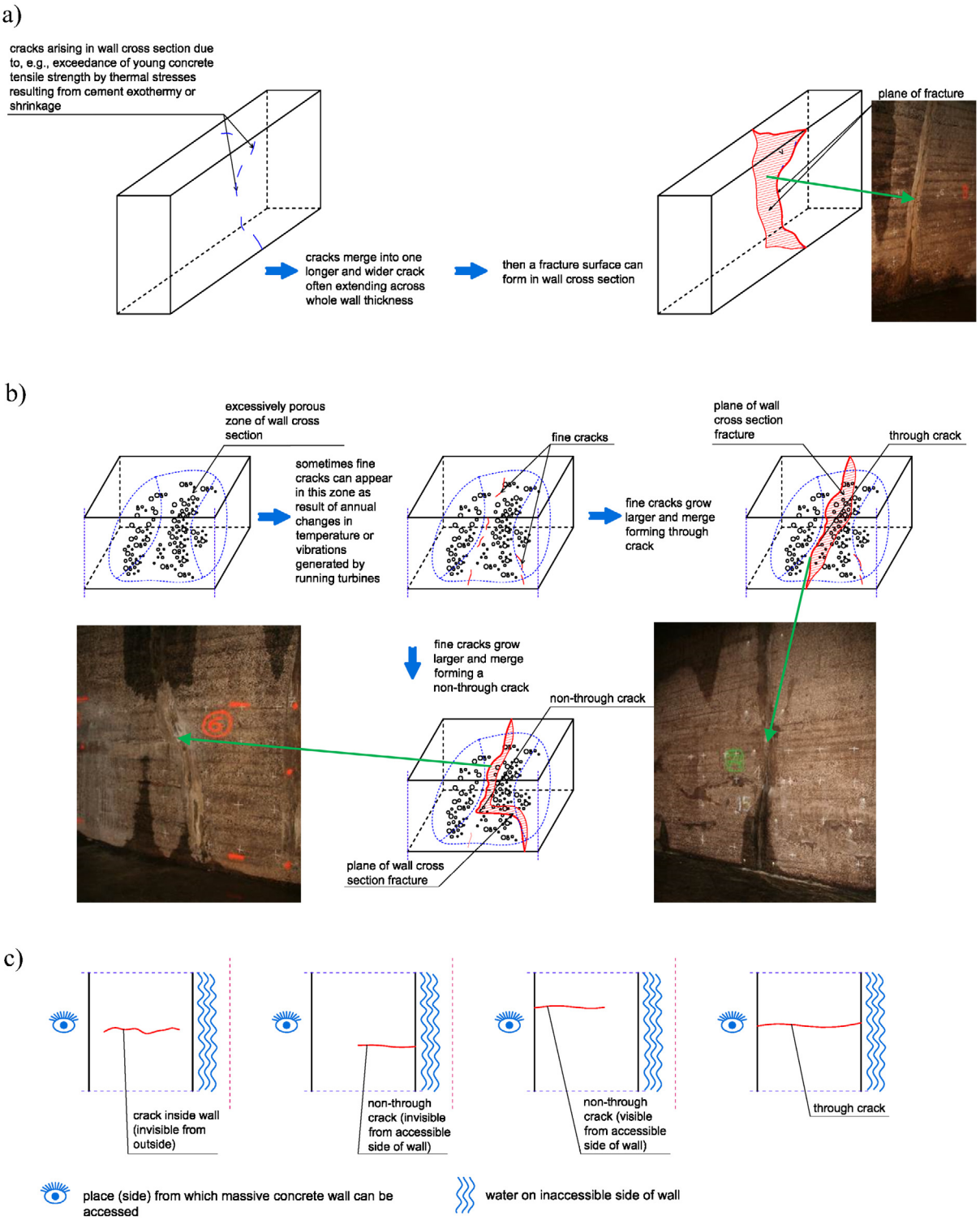

Fig. 1 – Typical cases when cracks arise in massive concrete walls: (a) at construction stage; (b) during service; (c) possible courses of cracks in wall cross section.