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Original Research Article

Evaluating the construction methods of cold-formed steel structures in reconstructing the areas damaged in natural crises, using the methods AHP and COPRAS-G

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ABSTRACT

One of the major principles of crisis management, aimed at converting the emergency situations into the normal state by considering sustainable development and all safety regulations, is based on the reconstruction of the damaged areas. To achieve this, the use of cold-formed steel structures, allowing for cost saving in materials and flexibility in the implementation method, seems to be highly suitable for reconstructing the damaged areas. These structures may be implemented by using three types of construction, including panelized, modular construction and, finally, construction of stick-built buildings. For this purpose, a conference meeting for identifying important criteria was held and twelve experts in four scientific areas, including civil engineering, economy and architecture, as well as top managers, participated in this conference. Then, the experts took part in assigning weights to important criteria and evaluating the alternatives. In the present research, the AHP method for weighing the important criteria, as well as a novel multi-criteria decision-making method called 'Complex Proportional Assessment of alternatives with Gray relations' (COPRAS-G) for evaluating the alternatives, were applied. The COPRAS-G deals with criteria determined by the gray relational grade. The criterion values are expressed in intervals. The results show that the construction quality is the most important criterion, while panelized construction is the best way of reconstructing the damaged areas. The research results presented in this paper can be useful for crisis management in any country of the world.
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1. Introduction

One of the advanced methods of industrial construction of buildings is based on using cold-formed steel structures [1–5]. In addition to high speed of construction, these structures, compared to other structures, have a high ratio of carrying capacity to weight, which results in the decrease in steel consumption. Another advantage of these structures is very high flexibility of the method of their construction [6–8]. A very high speed of the construction of these buildings and various systems used for connecting their structural members, have increased the use of the considered structures in North America, Europe, Australia, and Japan, so that 15,000 houses were built with these types of structures in America in 1993, 75,000 houses—in 1996, and about 375,000 houses—in 2002 [2,9]. In general, the use of cold-formed steel structures allowing for construction cost reduction has economic justification, while the light weight of the elements facilitates their transportation [10].

More than 40 various natural disasters have been recorded in the world, including destructive earthquakes and floods that require the study of critical conditions [11,12]. One of the fundamentals of crisis management is associated with reconstruction of the damaged area, taking into account the sustainable development and all the immunity criteria [13–17]. To this end, the use of cold-formed steel structures allowing for higher speed of construction, saving in materials, and flexibility of the construction methods used for reconstructing the damaged areas, compared to other buildings, seems more suitable [18–20]. For example, the successful use of these structures in Italy in the areas damaged by the earthquake can be mentioned [10].

Londofo et al. [6] carried out some studies of the construction methods based on using cold-formed steel structures, and examined different kinds of linkages of their members. They demonstrated the use of the construction method based on the considered type of structures at the construction levels, representing stick-built buildings, panelized construction (using prefabricated elements), and modular construction.

Cold-formed steel structures have developed through research [21–27]. Many research works have been performed on seismic behavior of cold-formed steel structures, with AISI studies being the most important ones [28,29]. This community has also published the regulations in this field. Fiorino's research on seismic behavior of cold-formed steel structures with the side system of steel shear walls, performed in 2003, can also be mentioned [10,18,19]. In this work, the conclusion was made that cold-formed steel structures with the considered structural system are sufficiently strong against the earthquake load and wind, and they can be used in the earthquake zones.

As mentioned above, a great number of research works have been performed on seismic behavior of these structures, and their efficiency in carrying the earthquake load has been recorded. However, no research has been made so far into the problem of choosing the optimal method of construction based on the use of these structures in damaged areas. Thus, the emphasis in the present research is placed on choosing the optimal construction method based on the

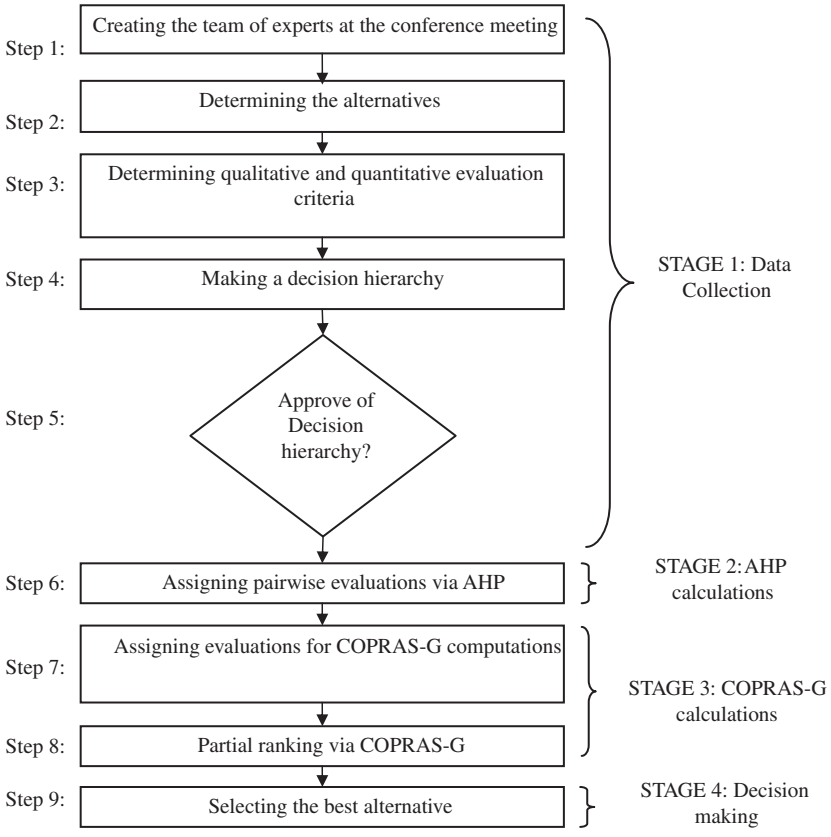

Fig. 1 – Schematic representation of the process proposed for cold formed steel structures selection process.

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