DUCTWORK PRESSURE LOSS DETERMINATION UTILIZING BUILDING INFORMATION MODEL

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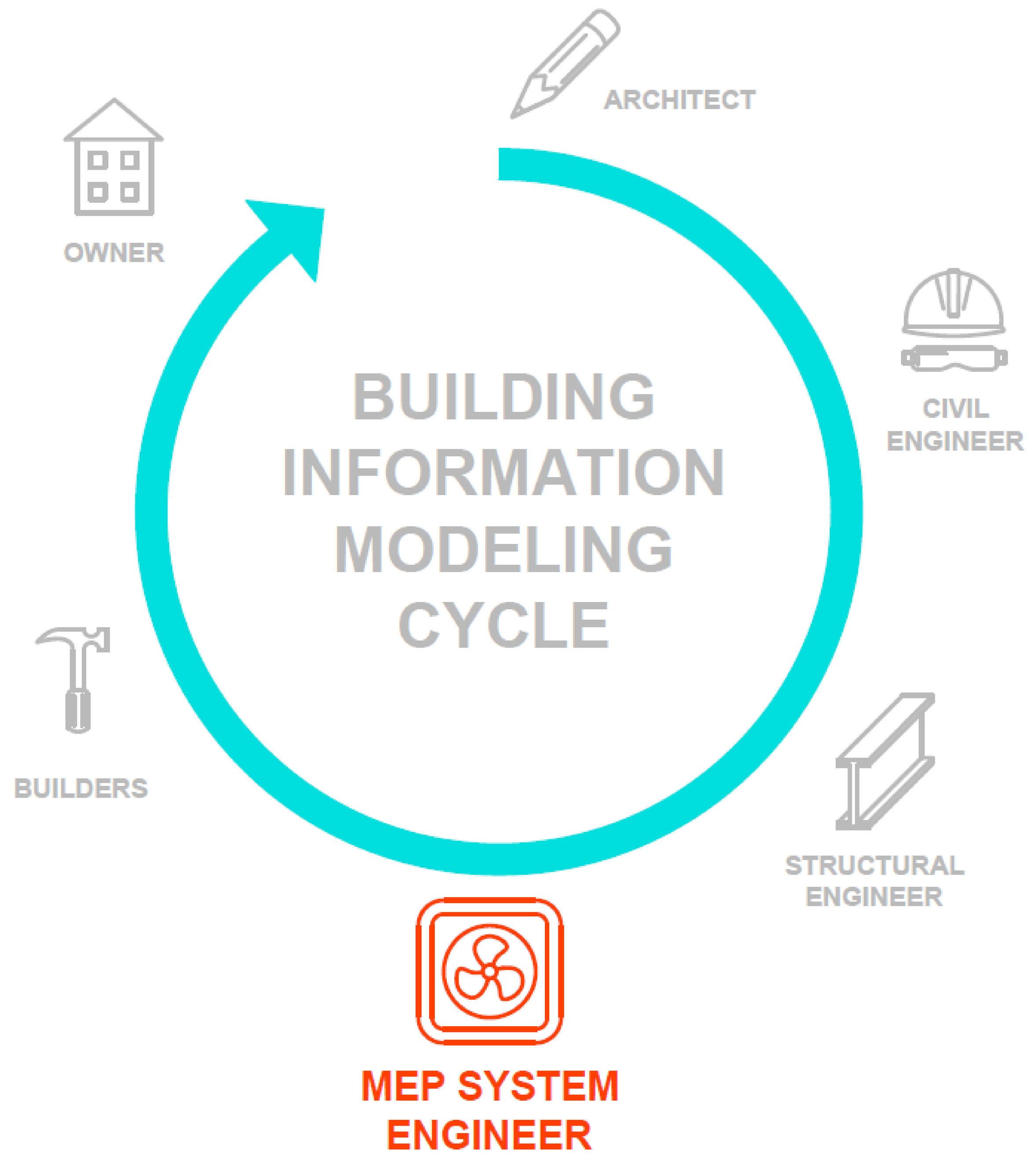


INTRODUCTION

Building industry has been undergoing digitalization. Digitalization is mainly based on sharing of data information, and transformation of an attitude to building project documentation. These changes fully touch all segments of building industry, including HVAC specialization. Such activities can take an advantage of BIM principles in not only an efficient approach to building data processing but also design automation in a form of analyses. As an example can be mentioned analyses of pressure loss in ductwork. The analyses of pressure loss in ductwork are necessary for optimal design of a ventilator, which is an essential part influencing electrical energy consumption in a building and its proper design can significantly influence building operating costs.

In order to optimize and analyse the design it is possible to utilize information contained in a digital model, where modelled ductwork geometry is used as a background for determination of pressure loss. These can be obtained by an incorporation of geometrical parameters into a relation of fitting pressure loss coefficient when an information of pressure loss amount is obtained even in a modelling phase. Geometrical parameters can further be used to obtain pressure loss values from tables. The main aim of this article is to describe utilization of relation among determination of loss pressure coefficient in elbows. Such relations were obtained in laboratory measuring and implemented in BIM software Revit in a form of an additional application.

METHODOLOGY

Relations for the elbow pressure loss coefficient were obtained from the laboratory measuring of a real rectangular cross-sectioned elbow fitting. For the experiment zinc-plated elbow (0,7 mm thickness) was selected. Individual 90° and 45° elbows were measured and also subsequent pairs of elbows, different direction 45° and 90° with different length of straight parts. These compositions were measured for 3 different proportions of sides in rectangular cross-section.

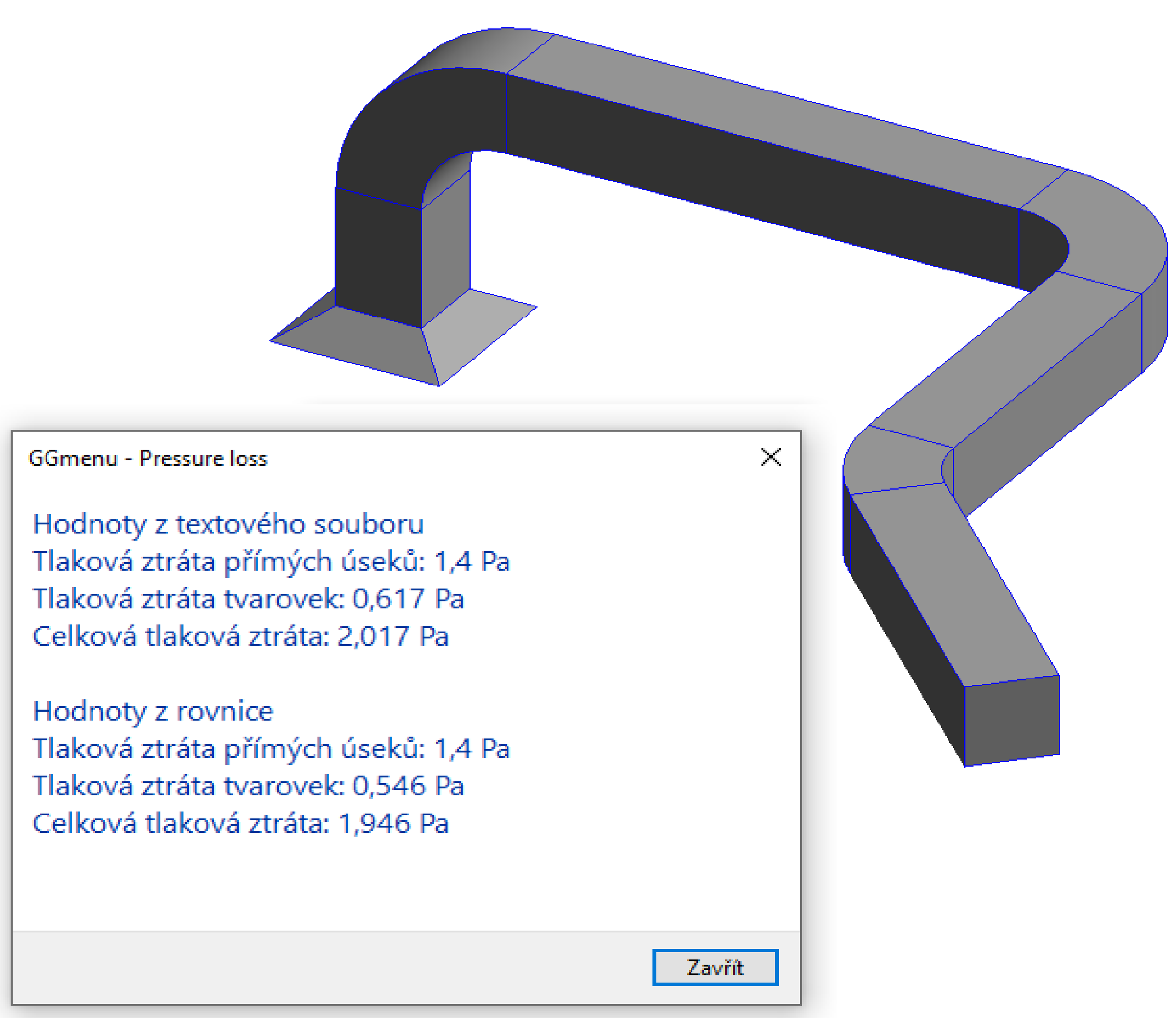
RESULTS

First, key geometrical parameters of measured ductworks and subsequently by the least square method relations were determined. As key geometrical parameters were chosen:

- length of intervening *L* part,
- width of W duct part,
- height of H duct part.

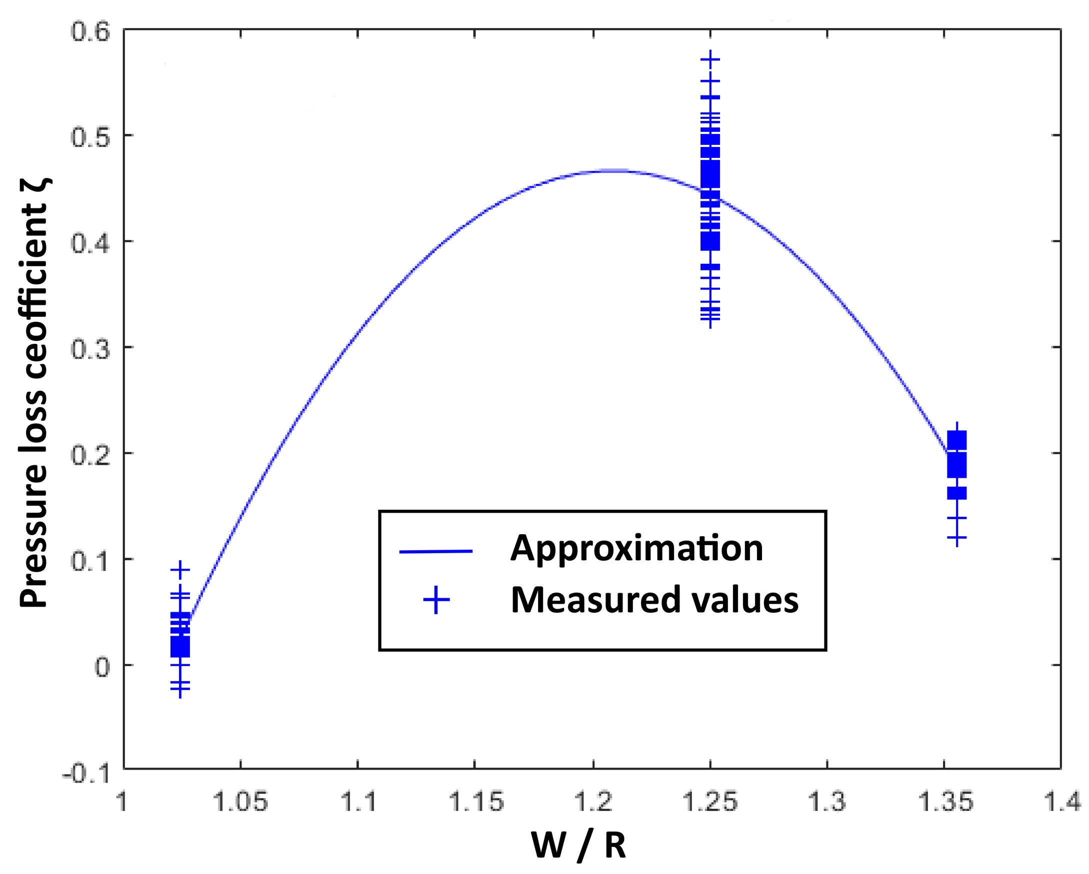
Final relations were determined and implemented into the additional application of *Revit Ductwork Pressure Loss Calculator* for loss pressure calculation in Revit. The application is an add-in of an original software, which is using incorporated geometrical parameters of the model. From these parameters it derives essential information for distribution of the ductwork branch into individual components, which are subsequently classified based on the fitting type and corresponding calculation relation is assigned based on its modelled geometry, out of which parametric values are obtained.

Part of the addition is also an implemented calculation based on the table, which can be edited. Users can thus change both parameters and coefficient values. Individual values can also be re-multiplied by additional coefficients. This function is for example used for re-multiplication of elbows of an angular length different from 90°. Initial table includes values of elbow coefficients and reduction of rectangular and circular cross-section published by ASHRAE Association.



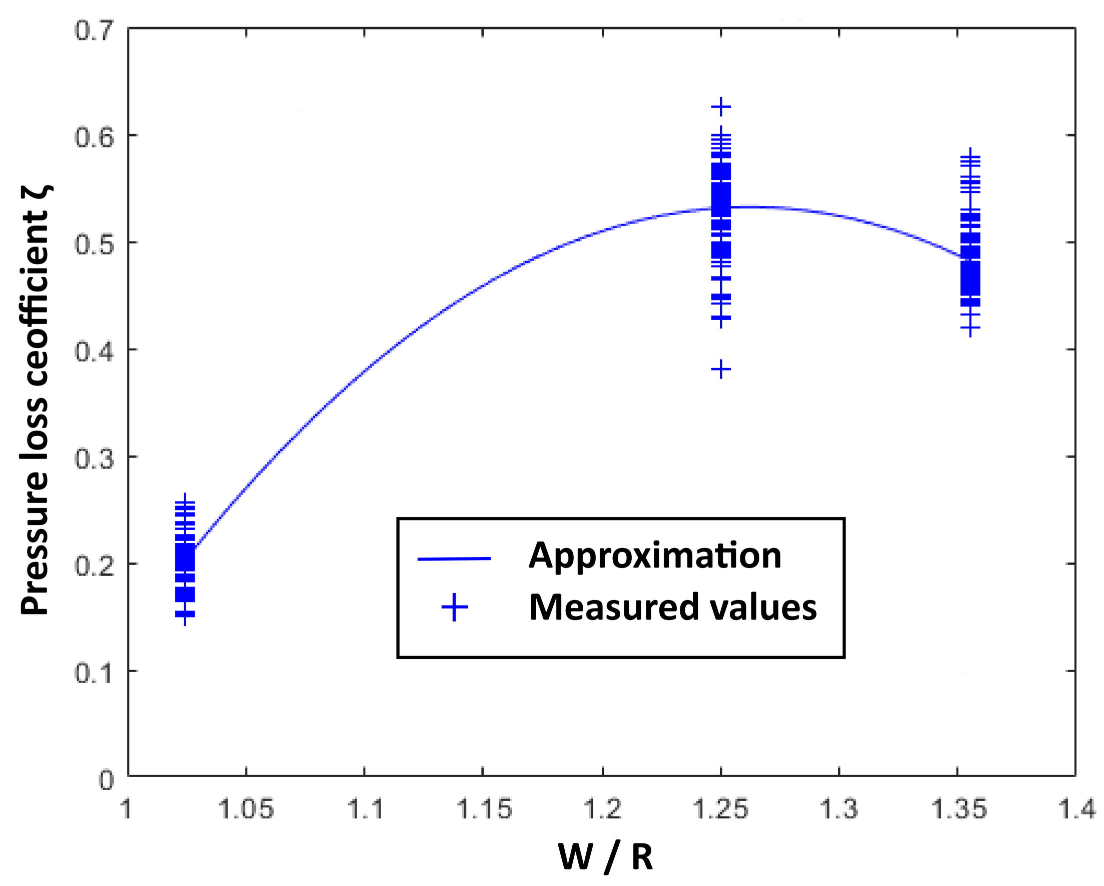
Elbow 1 × 45°

$$\zeta = -12{,}970\left(\frac{W}{R}\right)^2 + 31{,}350\frac{W}{R} - 18{,}490$$



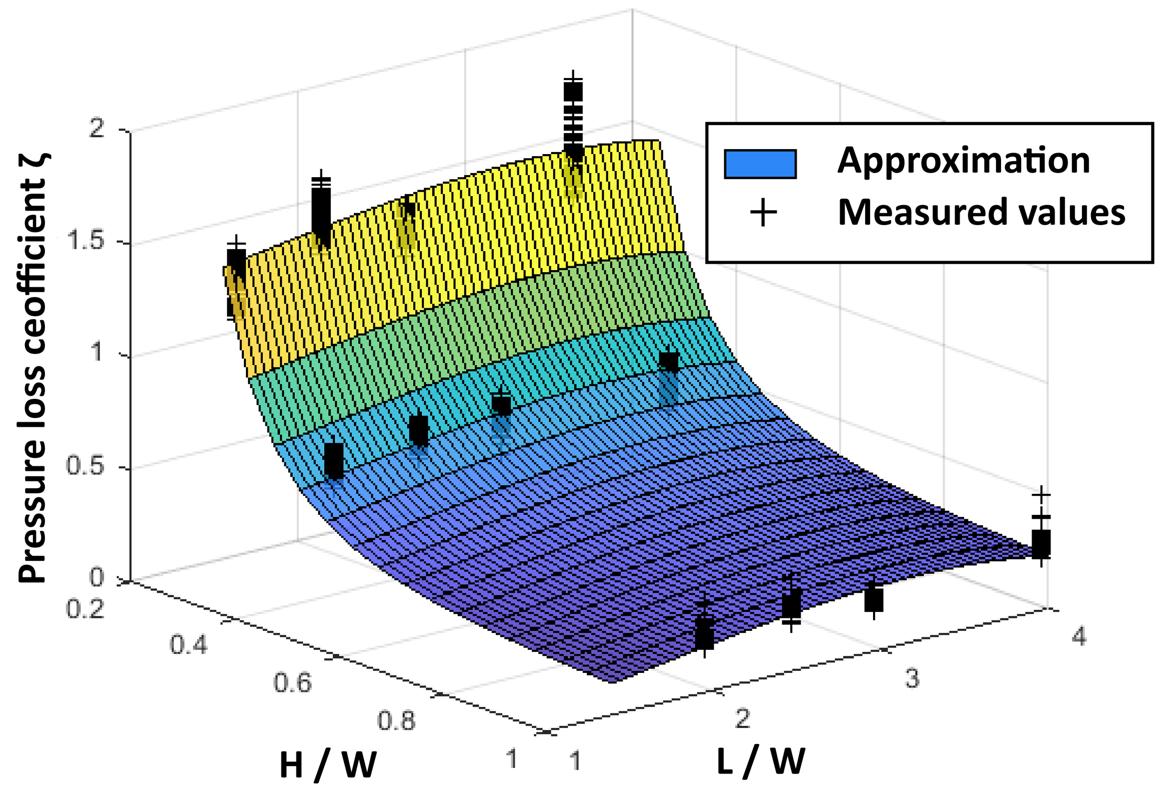
Elbow 1 × 90°

$$\zeta = -5{,}606\left(\frac{W}{R}\right)^2 + 14{,}210\frac{W}{R} - 8{,}470$$



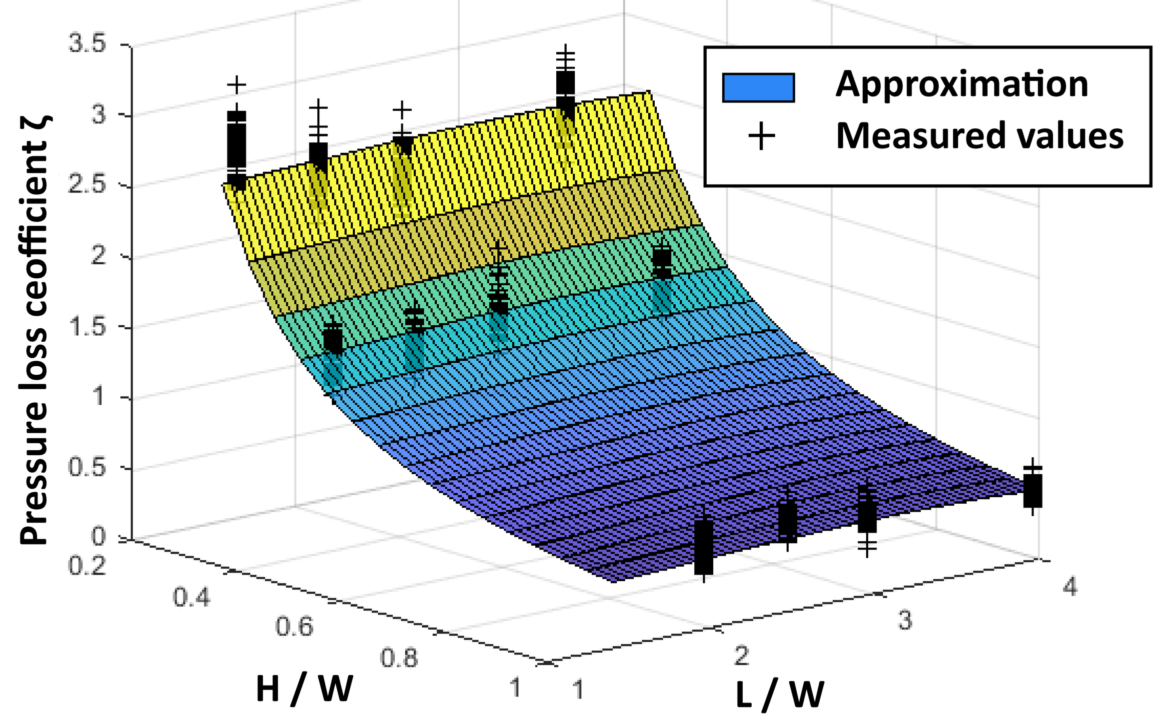
Elbows 2 × 45°

$$\zeta = 0{,}043\left(\frac{H}{W}\right)^{-2{,}441} - 0{,}015\left(\frac{L}{W}\right)^3 + 0{,}072\left(\frac{L}{W}\right)^2$$



Elbows 2 × 90°

$$\zeta = 0{,}432\left(\frac{H}{W}\right)^{-1{,}248} - 0{,}007\left(\frac{L}{W}\right)^3 + 0{,}032\left(\frac{L}{W}\right)^2$$



CONCLUSION

The research determines physical dependencies of pressure loss values on geometrical parameters of individual elbows, subsequent pairs of elbows. The relations are implemented in the additional Revit application used for determination of pressure loss in ductwork. This application is free to download. The analysis, which is processed by the application, uses for the losses calculation physical relations and coefficient table, which can be edited. Initial values contained in the table represent coefficients based on ASHRAE Association.

The main aim of the research is to determine relations for broad spectrum of basic fittings and make the use of gained knowledge in application into digital building modelling process. The target is to optimize and automate the design of ductwork and air-handling unit. Modelled addition reacts to building industry requirements, as for example it is possible to utilize information contained in the digital model also for engineering tasks connected with the design.