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COMPUTER AIDED SEWER DESIGN

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Abstract

This paper describes the development of a sewer design system capable producing up to working plan level documentations. This system was built on personal computer as a hardware device. The design is supported by the most modern devices. In the following we detail the design steps from entering of data through horizontal-vertical placing the sewers and hydrologic-hydraulic checking up to graphical displaying of plans. Parallel with the results we touch also upon the possibilities and limitations of computerization.

Keywords: sewer design, computer aided design (CAD).

Introduction

Recently, the computer technics almost in every scope of engineering design has been introduced. The speedy development of the hardware side of the computer technics made it possible. Parallel with that process, first of all due to the spreading of personal computers, the possibilities of working on computer have improved significantly. Therefore, in the process of engineering design have got the machines, which can give a considerable help in solving problems. Of course the decision, which jobs are worth to proceed with computers, which ones with traditional methods needs thorough considerations. It depends both on the actual state of development of the computer technics and on the possibilities of getting computer to work on. On the other hand, the choice between the possible methods is determined by the type of the job. The more repeatable, exactly formable, algorithmic jobs are to fulfil, and the more data and computation they need, the more worth applying computer for it. After due deliberation in our field we qualified the design of sewer and drainage system into that group.

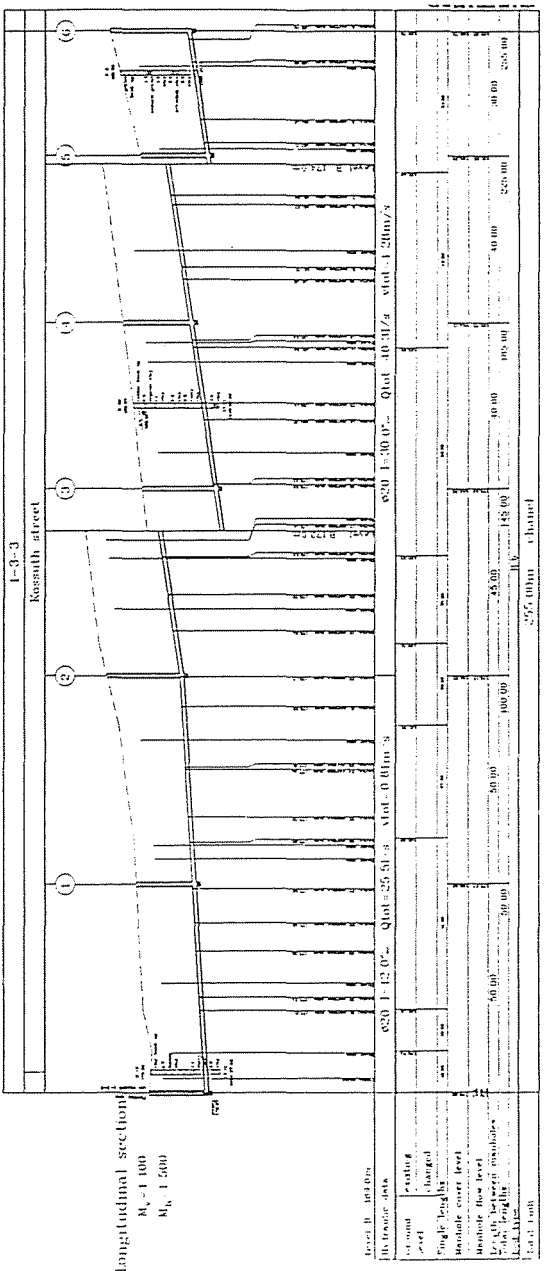

Fig. 1. Longitudinal section

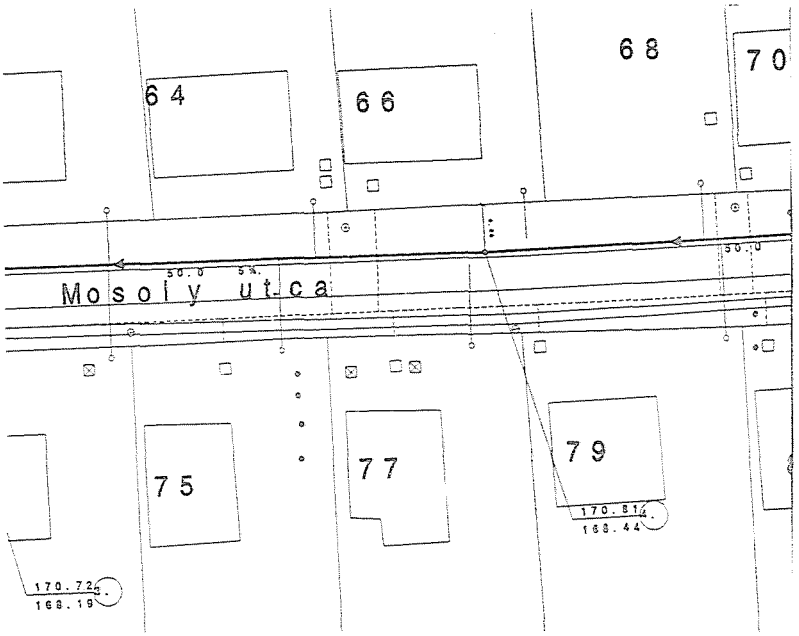

Fig. 2. Layout plain

Design Process

The 'full' solution of the sewer design problem would mean that on the basis of all needed data, applicable methods, and operative regulations the computer has to produce the optimal version of the possible plans. More detailed description about that can be gained e.g. from the paper (BUZÁS, 1991). The solution outlined this way is strongly limited by the hardware and software conditions.

Regarding the mentioned viewpoints our design method has been developed for personal computer. Our system is strongly based on the traditional well-developed design method — as detailed in design study-aid (SALI, 1990) — and we tried to utilize the present technics. The following is the review of the working steps with our design system, especially for the computer aided sewer design possibilities.

The first design step is the collection of data, and entering the requried ones for the computer based design. In the case of the 'full' solution all the data inevitable must be entered into the computer. That means existing features like ground surface, groundwater surface, geotechnics, structures, etc., but also demands for sewer (e.g. capacity), developing concepts and

many others. That would mean entering and processing a large amount of data, and storing these data. It is mostly difficult in such form, from which they are easily retrievable during the design process. Applying our methods, data must be given in the following forms.

A uniform alphanumerical database — of which comfortable processing is supported by modern computer technical services — contains all existing data needed to the longitudinal and cross-sections:

cross-section
- existing features
- electric distribution network poles, trees etc.
- existing pipes

longitudinal section
- existing features
- gas connections
- service pipe connections
- existing drain traps
- other crossings
- drilling data
- street names

Rigorously well-ordered computer digitizing of graphical data is needed first of all to draft the layout plan. This graphical database is also suitable to the longitudinal and cross-section drafting.

The next design step is the locational assignment of the sewers and the structures joint them, both horizontally and vertically. In case of the 'full' solution that would mean a three-dimensional computer based design. As a consequence of the large amount and complicated data, restrictions and methods constitute the less easily soluble part of the design process. Until now, we have it not undertaken but developed the computer aided method of the traditional design. That means the two-dimensional drafting of the horizontal location of the sewers in the graphical editor based on the engineering considerations, in two dimensions. The vertical data of sewers and the other data needed to the design process must enter into the alphanumerical database. Those kinds of designed data are the followings:

cross-section
- designed features
- sewer
- drafting data (titles, street names, etc.)

longitudinal section
- designed features
- manholes
- diameters
- beds

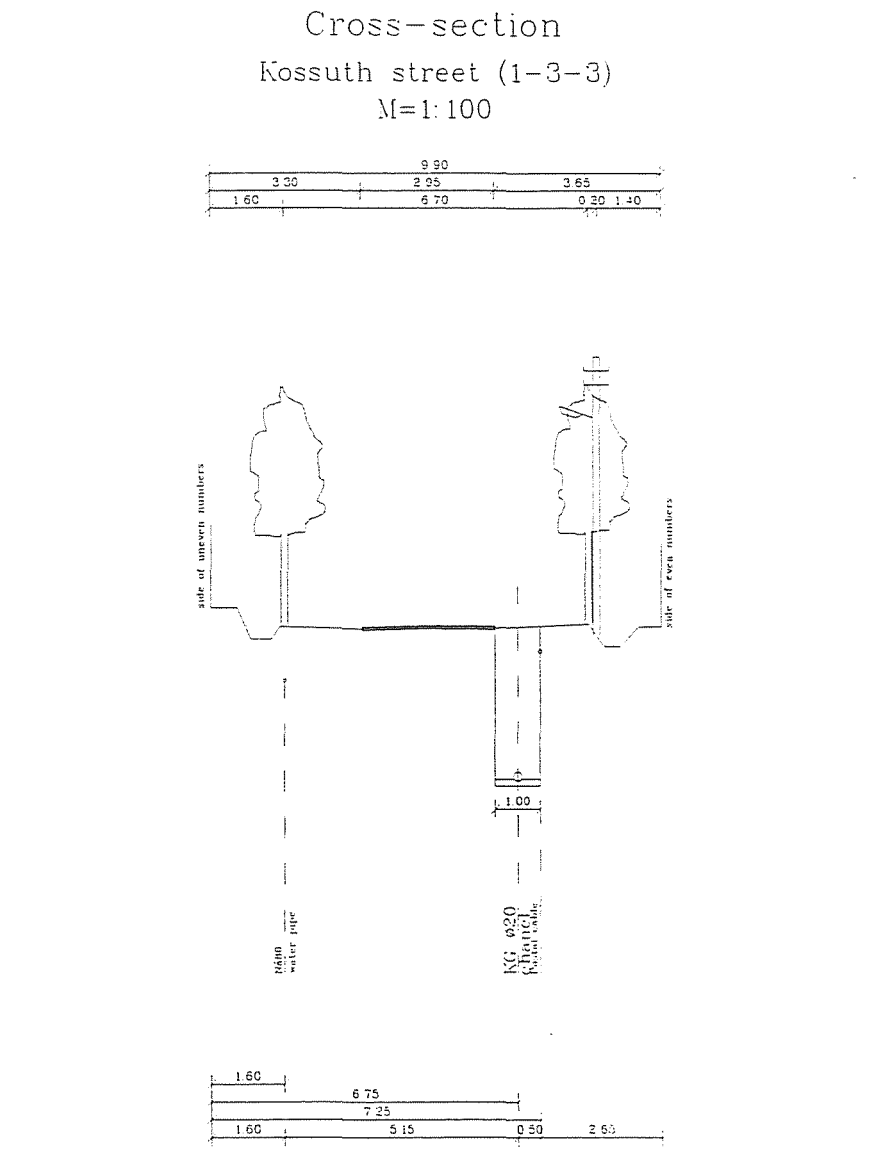

Fig. 3. Cross section

- spout materials
- starting levels of sewers
- sewer inlets
- house-drain connections
- designed drain traps
- drafting data

The three-dimensional design of the sewer system, storing their data in graphical database, their processing and displaying are possible in the computer technics. However, the demands on the applied computer increases suddenly (memory, storing, speed, etc.). Our system remained at the two dimensional graphical representation, as in the traditional design.

After entering the designed data the longitudinal and cross-section plans can be swiftly and simply produced. They can be displayed on the computer without printing. These plans may show that the designed sewers' location is wrong or for the design engineer somehow is not appropriate. Then the data on which the design is based can be simply modified and the new plans can be displayed again. This procedure makes more comfortable and simple the design process than the 'paper and pencil' method.

The hydrologic-hydraulic measuring or checking of the sewer system is closely connected with the design of their location (e.g. slope). In case of computerised design problems do not emerge if the hydrologic-hydraulic checking necessitate the modification of the sewers' location. The numerical and graphical data are simply modifiable and the checking could be proceed again. There are well-developed models for measuring and checking a sewer system. Their different levels correspond to the capacity of simulating degree of the real (surface and in-sewer flow) conditions. A highly detailed review in (ÖLLŐS, 1990) deals with these models. Our design system knows at the present state only a simply hydraulic checking method. It is based on the Prandtl–Kármán–Colebrook equation as published in (MARKÓ, 1989), describing the full capacity of a sewer section. Joining the mentioned models our system does not mean particular problem.

The documentation is the highly labour-consuming part of the design process. Working with our system the following plans can be produced by the computer:

- working map (*Fig. 2*)
- longitudinal section (*Fig 1*)
- cross-section (*Fig. 3*)
- schedule of quantities
- tables, accounts

The graphical documentations can be produced regarding the type of the plan in the appropriate size and details. The versions before the last one, due to the computerized method can be swiftly and at economically pro-

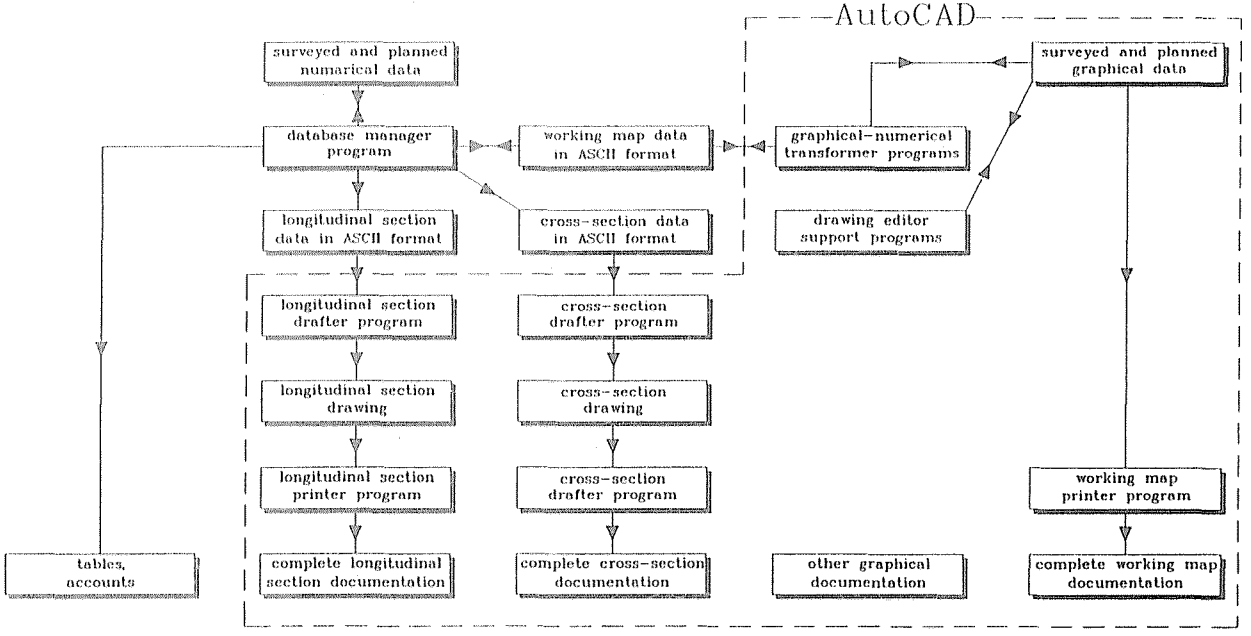

Fig. 4. Structure of the Design System

duced. After viewing them, they can be modified. The quality of the documentation made this way satisfies every demand.

Conclusions

The advantages of the computer aided sewer design are already significant in case of a few hundred meters long sewer system. The longer the designed network is the more considerable results can be achieved. The total duration of the design process is decreasing strongly, and the engineer is work-absorption also becomes less. The labour-consumption of draughtsmen'work is can be eliminated. At least so high-quality plans can be produced as with the traditional method. The plans can be stored on computer and later can be displayed again if demanding necessary. The graphical and numerical data entered into the computer are available for later use of other purposes. On the other hand, if these data have been already entered before the sewer design, they can be used for it. That means the open structure of our system toward the computerized inventory of public works. The structure of our design system, its connections are displayed on the *Fig. 4*.

Applying our system its advantages have already proved in practice. The results obtained so far urge us to continue developing our system based on the practical experiences and optimally utilizing the advantages of the computer.

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