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Sewer Network Design Using Urbano Canalis Version 7 Release 2010

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Abstract – The paper presents an advanced modeling and design software application for sewage networks - Urbano Canalis version 7, which allows projects to be accomplished in a short time, with high efficiency and low costs. The software application calculates the storm water flow, using rational method based on IDF curves or constant intensity approach and perform all the necessary calculations related to a sewage project. The hydraulic design consists in the computation of the transit and total flow and hydraulic modeling for network pipes diameters or slopes. The application provides reports, layouts, longitudinal or transversal cross sections of the pipe network, displayed in an advanced graphic system based on AutoCAD technology.

Keywords: sewage design, hydraulic computation, Computer aided design

1. INTRODUCTION

As a member state, Romania has to observe the development program and comply with European Directives set by European Union.

European Directive on water quality requires to Romania to build water and sewer infrastructure for 263 cities with over 10,000 users, until 31 December 2013.

It is estimated that 9.5 billion euro are needed to implement the European Directive regarding waste water treatment, of which 5.7 billion for wastewater treatment plants and 3.8 billion for the construction of sewage networks. The necessary funds for this investment are going to be financed from three sources: state budget (196 million lei), external sources (460 million) and Environmental Fund (130 million).

During a meeting organized by the Romanian Raw Water National Administration, celebrating World Water Day (March 22, 2010), our authorities concluded that Romania will not be able to achieve in time the European Water Directive targets on the implementation of a sewerage and water treatment at European standards.

It is up to each of us to bring the contribution to this activity, in order to reduce the delays in implementing the European Directive.

As part of this effort, we present in this paper an advanced modeling and design software application for sewage networks - Urbano Canalis version 7, which allows projects to be accomplished in a short time, with

high efficiency and low costs. The program has been developed by StudioARS Company, in Croatia and fully adapted to Romanian legislation, as regards sewage networks design.

The base of all StudioARS' activities is Autodesk technology. StudioARS is the only Croatian company which has the status as Autodesk Gold partner and can offer high quality support and expertise together with the implementation of their technology. StudioARS has been developing software solutions in infrastructure area for more than 20 years. Well known software products such as Urbano Canalis and Urbano Hydra have been effectively used throughout Europe. More than 1000 users use these products for sewage and water distribution system design.

2. GENERAL DATA ABOUT THE SOFTWARE

Urbano Canalis is a software package for the sewage water system design which works within any Autodesk platform [1]. The software runs within AutoCAD, AutoCAD MAP or AutoCAD Civil 3D and can easily interchange the network data with AutoCAD Civil 3D and can be used in complex projects for infrastructure project.

Digital Terrain Models developed in AutoCAD Civil 3D can be the base of terrain elevations calculation within Urbano Canalis. All AutoCAD based products from the version 2007 and upwards are supported [2].

The main package consists in several modules such as [3]:

- **Network Layout Module** which is able to create sewage networks interactively or by conversion from AutoCAD elements.
- **Longitudinal Sections Module** which can define any kind of table layout with different parameters. Virtually, any kind of table bands can be added to longitudinal section. Pipe inverts can be interactively created and edited.
- **Terraform Module** is a built-in digital terrain modeling software which support Civil 3D's Digital Terrain Models and is optimal to be used for any pipe network systems design.

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- **Sewage Hydraulics Module** which is able to deal with catchment areas creation, rain and sanitary flow calculation. Hydraulic calculation is included. Besides the main modules, a few optional modules are delivered by the developing company.
- **Database Extension.** It allows connection to any external data sources such a database (Esri SHP and cross sections drawing with the volume calculation are supported).
- **Polygon Manager** for polygon topology creation from AutoCAD elements. Options to label, query and export topology element. Very valuable functions like topology analysis (buffer and overlay) are included in this module.
- **Raster Module** offers the possibility to connect a

Map Info files are supported). Communication is bidirectional.

- **Geo Extension** for surveying data management. It can deal (import/export) with any points type from external text files. Special linetypes according to surveying regulations, 2D to 3D conversion and

large number of raster images from within AutoCAD. Raster images are organized in an advanced manner according to spatial criteria.

As a whole, Urbano Canalis application is a modern software tool for sewage systems design, focused on pipes networks design, with an easy to use interface and a dynamic approach (all changes are updated immediately in all designs instances) – Fig. 1.

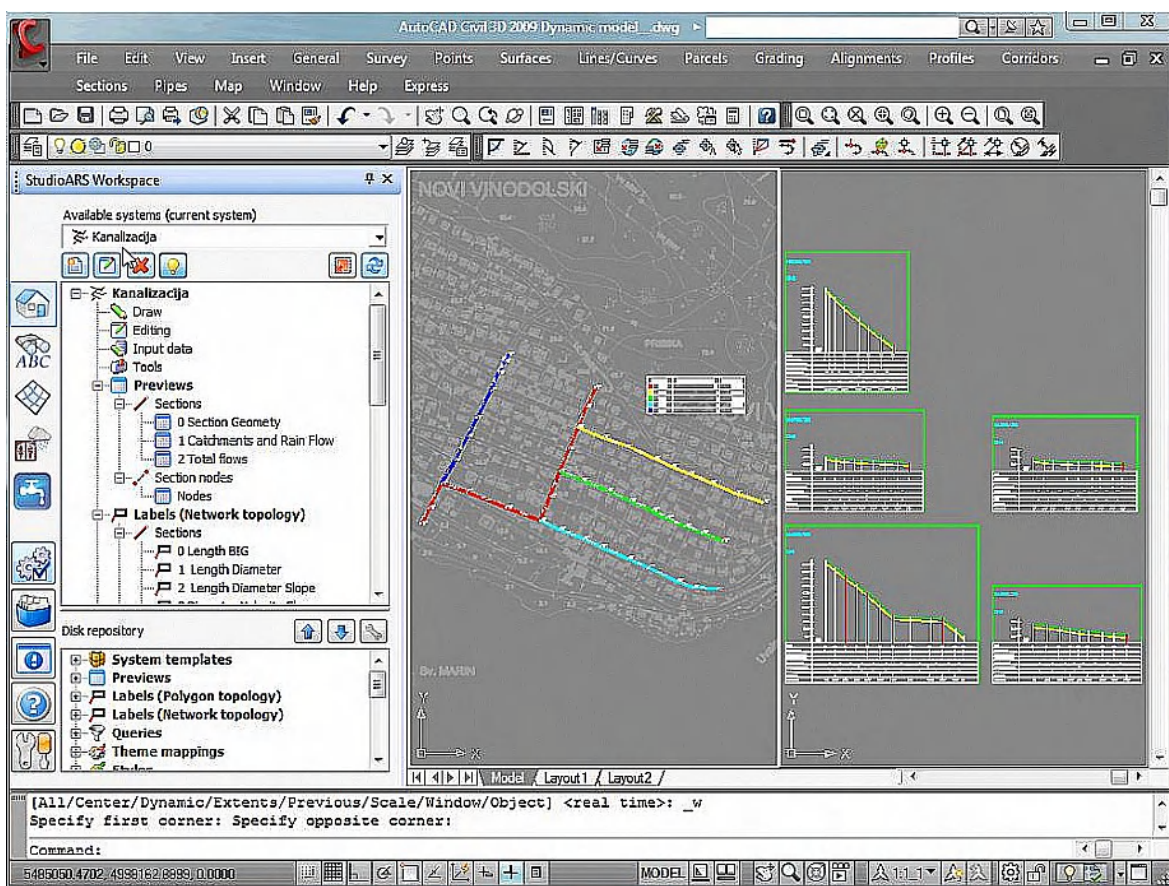


Fig. 1 - Urbano Canalis version 7 is based on dynamic modeling approach

3. STORM WATER NETWORK DESIGN

With Urbano Canalis software is very easy to define all the catchment areas within a project, to calculate the storm water flow using rational method based on IDF curves or constant intensity approach and perform all the necessary calculations related to a sewage project [1].

The runoff component operates on a collection of

sub-catchment areas that receive precipitation and generate runoff and pollutant loads. The routing module of the software application transports this runoff through a system of pipes, channels, storage/treatment devices, pumps, and regulators. It tracks the quantity and quality of runoff generated within each sub-catchment, and the flow rate, flow depth, and quality of water in each pipe and channel during a simulation period comprised of multiple time steps.

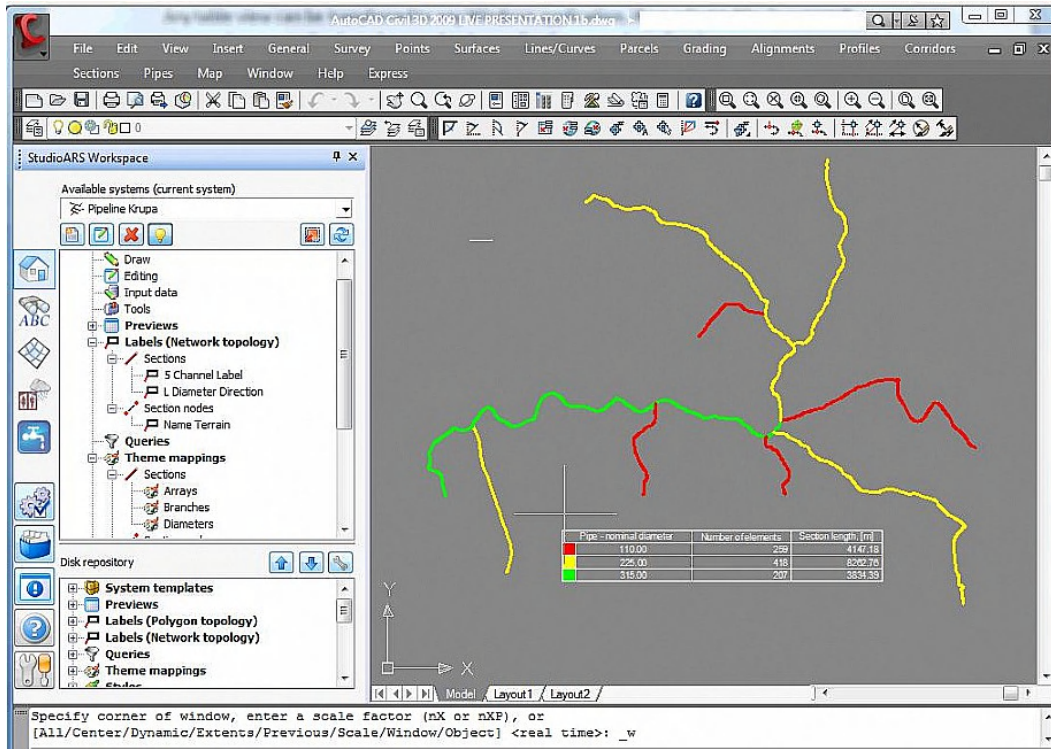


Fig. 2 - Catchment definition and design scheme in Urbano Canalis version 7

4. SEWAGE NETWORK DESIGN

There are two steps for hydraulic computing:

1. Transit and total flow calculation
2. Hydraulic modeling for network pipes diameters or slopes

Transit and total flow calculation

For the sanitary system flow calculation, Urbano Canalis software offers two methods:

- The percent calculation method
- The influence area calculation

The most common method is the percent calculation. For this method, it is necessary to enter the number of inhabitants, the water consumption per inhabitant, the annual population growth, the design period, the coefficients variation per day and per hour and also some specific coefficients for water losses in

the system and for the system maintenance (Fig. 3). It is also possible to define some additional flows like foreign water, additional rain flow or point flows discharged by the local industries.

The software calculates specific flow taking into consideration a coefficient for density of population (k_i) that is defined for each section of the system or for the entire system at once. This coefficient, multiplied with the real length of the section, will give a virtual length (l_i) which is used by the software for calculating the specific flow (q_{sp}) and the sections for one flow (Q_{own}).

$$q_{sp} = Qt / (\sum l_i * k_i) \quad (l/sm) \quad (1)$$

$$Q_{own} = q_{sp} * l_i \quad (l/s) \quad (2)$$

Data	Value
Planned number of inhabitants	1684.8111
Average demand per day [l/day]	194595.6872
Average demand per hour [l/hour]	8108.1536
Max. demand per day [l/day]	291893.5307
Max. demand per hour [l/hour]	18243.3457
Total length of section [m]	3422.7633
Total corrected length of section [m]	3422.7633
Specific demand [l/(s m ³)]	0.0015

Fig. 3 – Input data for the percent calculation method

Hydraulic modeling and computing for pipe diameters and slopes

Before running the dialog for hydraulic modeling it is necessary to define the pipe roughness according to the material used. The software offers the possibility to define as many pipe catalogs as we need according to the materials and diameters that are available on the market.

The pipe diameter for both of the systems (the sanitary system and the stormwater system) is calculated either for each section or for the group of sections at once.

Hydraulic calculation is based on Darcy-Weisbach's and Colebrook-White's equation for flow in

totally filled pipe. For the partially filled pipes, the relations for velocity and for the flow quantity are taken into consideration.

The diameter can be determined according to the slopes defined in the longitudinal profile and to the section flows. Some conditions for the maximum filling of the pipe and the minimum diameter that must be taken into account can be settled (Fig 4).

The application offers the possibility to determine also the slopes using the values for diameters from the previously defined longitudinal profile and the sections flow. The conditions for maximum filling and for minimum velocity can be set for this situation.

Sec...	D [mm]	I [%]	h/D...	v [m/s]	Note
P1	299.60	3.2319	39.21...	1.0051	ok
P2	299.60	3.2319	69.57...	1.2006	ok
P3	299.60	3.2319	73.42...	1.2006	ok
P4	299.60	3.2319	79.92...	1.1892	ok
P5	299.60	3.2319	88.56...	1.1583	ok
P6	587.20	2.0000	62.81...	1.4139	ok
P7	587.20	2.0000	63.38...	1.4161	ok
P8	587.20	2.0000	63.81...	1.4176	ok
P9	587.20	2.0000	64.31...	1.4192	ok
P10	587.20	2.0000	64.46...	1.4197	ok
P11	299.60	4.3248	33.95...	1.0998	ok
P12	299.60	4.3248	52.37...	1.3300	ok
P13	299.60	4.3248	73.18...	1.4083	ok
P14	380.40	2.0000	72.09...	1.0796	ok
P15	475.40	2.0000	56.07...	1.2023	ok
P16	475.40	2.0000	61.61...	1.2293	ok
P17	475.40	2.0000	67.66...	1.2455	ok
P18	475.40	2.0000	75.96...	1.2445	ok
P19	299.60	4.0001	22.10...	0.8413	ok
P20	299.60	4.0001	29.13...	0.9752	ok
P21	299.60	4.0001	35.68...	1.0799	ok
P22	299.60	4.0001	44.93...	1.2010	ok

Fig. 4 - Pipe report in Urbano Canalis software

Within the software there is complete hydraulic package for stationary flow. It is possible to define constraints such as minimum diameter, minimum velocity or maximum fulfillment of several criteria.

For more advanced calculation it is possible to export the whole project in EPA SWMM format, widely accepted by many other powerful software applications like BOSS' StormNET or Bentley's CivilStorm. Using the software engine for SWMM (Storm Water Management Model) developed by EPA (Environmental Protection Agency) from United States, these applications are able to perform advanced hydraulic calculations for a large variety of pipes (circular cross section pipes, elliptical, oval, flattened or rectangle pipes) as part of any storm or sewage systems.

SWMM is a dynamic rainfall-runoff simulation model, for urban and small rural areas, for single-event or long-term (continuous) simulation. Flow routing is performed for surface and sub-surface conveyance and groundwater systems, including the option of fully dynamic hydraulic routing. Nonpoint source runoff quality and routing may also be simulated, as well as storage, treatment and other water management practices.

With an advanced graphical engine based on AutoCAD technology, the results are easily displayed in many forms (tables, reports, layouts, longitudinal or transversal cross sections) with any scale, content and amount of annotation [1].

5. POWERFUL GRAPHICAL USER INTERFACE

The graphical user interface provides maximum flexibility and the best user experience (Fig. 5). The

workspace can be customized by dragging and resizing windows or by docking them to the main display. You can also define and save a named view, so that you can quickly and easily return to that same area of interest at any time [3].

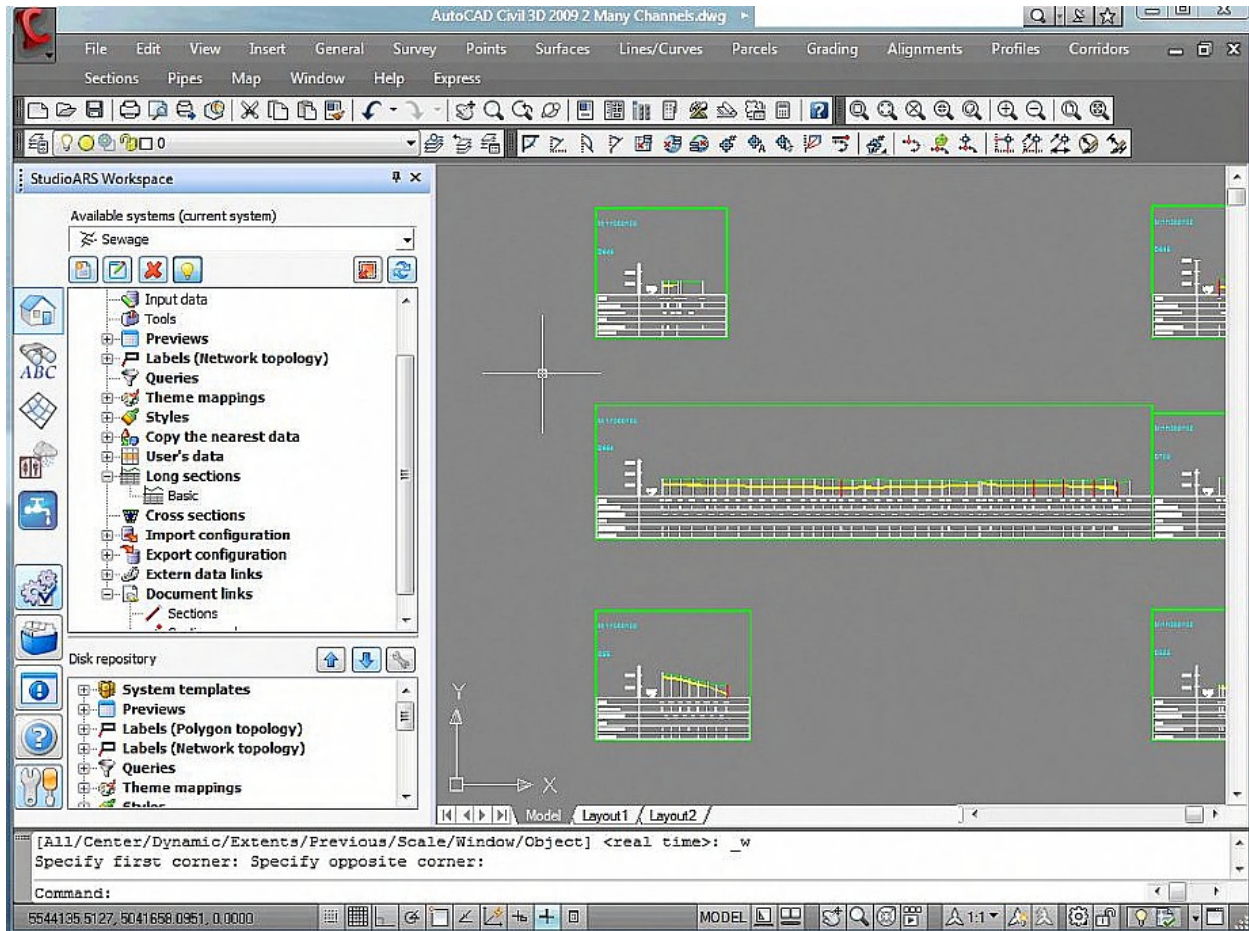


Fig. 5 - Longitudinal and transversal cross sections in Urbano Canalis version 7

6. STRUCTURES DESIGN

Structures can be added from a library and easily included in the project. In addition to convert AutoCAD Civil 3D pipe networks and structures to Urbano Canalis version 7 network and vice versa. The conversion is very simple, all elements can be converted using one command. Conversion respects

all elements which can be found in AutoCAD Civil 3D part list and Urbano Canalis version 7 catalogues (Fig. 6).

Sometimes complex projects are made in AutoCAD Civil 3D. In such cases Urbano Canalis functions, concerning pipe and structure networks, can be easily used and can significantly speed-up the design process AutoCAD Civil 3D [2].

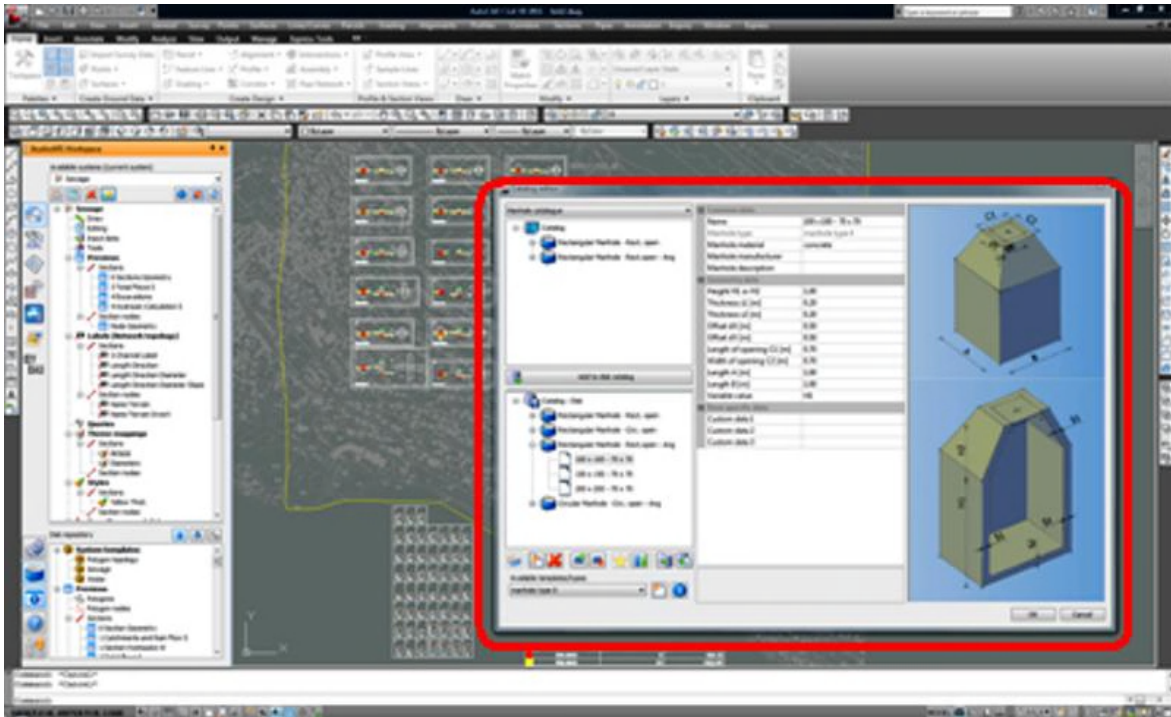


Fig. 6 - Structure insertion in Urbano Canalis version 7

7. CONCLUSIONS

The efficiency of using the Urbano Canalis software for storm water and sewage system design is given by:

- Less time spent to create the drawings by using the tools for labeling the system parts, updating data automatically for layout and longitudinal profile with the modifications you make along the designing process, calculating the pipe diameters automatically, using the features for creating the plotting drawings.
- Customized representation and information shown

both in the layout and longitudinal profile that can be used for any of your projects.

- Final drawings produced into a “.dwg” format which is the most generally accepted file format for civil engineers.

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