AutoCAD File Types and Their Application in Civil Engineering

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Abstract This article discusses the main AutoCAD file formats and their role in modern engineering, construction and manufacturing processes. There are presented working, standardization, data exchange ,documentation, recovery file formats. Special attention is paid to the discussion of the CAD–CAM–CNC work cycle, which combines computer-aided design and real production into a single technological process.

The purpose of the work is promoting the thoughtful use of AutoCAD files for students and novice engineers and preparing them in accordance with the requirements of the modern professional environment.

Key words: AutoCAD, CAD, CAM, CNC, DWG, DXF, DWS, DWF, PDF, file formats, drawing standards, data exchange.

Introduction

In modern engineering and construction activities, special importance is attached to maximum data accuracy, standardization, and efficient use of time in work processes. Thus, the processes of design, planning, documentation, and production are today closely related to the use of computer programs. In this regard, AutoCAD remains one of the leaders in this direction, both in professional and educational environments.

Such a wide distribution and success of AutoCAD, among other factors, is due to a diverse system of file formats. Different types of files serve different tasks, such as creating working drawings, standardization, quality control, printing and sharing, data recovery. Especially important is the use of AutoCAD files in the integration with the production process, where the AutoCAD file is the first link in the CAD–CAM–CNC technological chain.

Part I. Conditional classification ofAutoCAD file formats

The file types used in AutoCAD are diverse, and each of them performs a specific function at different stages of the workflow For better understand it is possible to conditionally classify files according to their purpose. This will simplify both the learning process and the selection of the right file in professional practice.

1. Working and design files

The purpose of this type of file is to create, edit, update and save a project in the AutoCAD environment.
File tipe - **DWG** file

2.Template and standardization files

This group includes files that ensure a uniform style and compliance with standards for drawings.
File types:
DWT — Template file(purpose-Correct start of the drawing
DWS — Standards File(purpose- control of compliance with established or corporate standards)

3.Sharing and Documentation Files

This category includes files, the purpose of which is the presentation,transmission or archiving drawings, but this file are non-editable
File types:
PDF file-Portable Document Format
DWF -Design Web Format
DWFx-Design Web Format (XPS-based)
DWF, DWFx, and PDF are not working design files, but they play a critical role in engineering communication. These formats provide a secure, standardized, and easily accessible representation of drawings that is an integral part of the modern design process.

4. Data exchange and production files

This file transfer geometry created in a CAD system to CAM programs and CNC machines.
File type: **DXF** (Data exchange and production files)
The main advantages of DXF file are
containing clean geometry, maximum compatibility with other systems, possibility of

its use in CAM and CNC environments.
This file is the first and most important link in the CAD-CAD-CAD system.

5. Data protection and recovery files

Files of this category ensure information security and data recovery in case of emergency situations.

BAK — Backup file

SV$ — Autosave file

These files are created automatically and are rarely edited by the user

Used to restore a previous version of a drawing or unsaved data.

Part II. Drawing an standardization file formats(DWG,DWT,DWS)

1)DWG (Drawing) file

DWG (Drawing) is the main file format of AutoCAD, which is used in engineering, architectural and construction design. This format was created by Autodesk and is the environment where the complete technical and graphic information of the drawing is stored.

The drawing is created, edited and updated in the DWG file at all stages of the project.

This filr is widely used in civil engineering.

In particular, for construction plans (floor plans, sections, facades), structural drawings (beams, columns, nodes), engineering networks (water, sewage, electricity) as well as for creating working documentation,

for detailing and processing of nodes and others.

The advantages of the DWG format are high geometric accuracy, the ability to store complete information in one file, integration with BIM and CAM processes, wide support by various CAD systems

It is worth noting that other types of files can be developed around the DWG format

$DWG \rightarrow PDF$ — documentation and printing

$DWG \rightarrow DWF/DWFx$ — sharing

$DWG \rightarrow DXF$ — CAM and CNC production

$DWG \rightarrow DWT/DWS$ — standardization

Thus, the DWG file is the basis of the AutoCAD workflow

2) DWT (Drawing templates) file.

DWT(Drawing templates) file is a drawing template, a pre-configured DWG file, which is then saved with the .dwt extension. This file is used to start a new drawing in AutoCAD, a prepared workspace; that allows all new drawings to start with a well-defined set of parameters.

A DWT file may contain units, drawing limits, layers, Text and Dimension styles, Page setups, also some geometry in form of Frames, Stamps, Title blocks, Company logos etc.

When a user creates a new drawing using a DWT file, all the necessary settings and basic geometry are already ready.Changes made to the DWT file do not affect existing drawings—they will be applied only to future drawings, which are created using that template.

The DWT file is opened using the New command.

Stages for creatin DWT file:

Stage I – Preparing the Initial DWG File

Open a blank DWG file or an existing DWT template

Stage II – Creating Standard Settings

Create Layers ,Text Styles, Dimension Styles, page settings etc.

Stage III – Adding Geometry (if needed)

Add Frames, Title Blocks, Stamps and Other Standard Elements (company logo etc)

Stage IV – Save as DWT File

Save the file in the template format with (*.dwt) extension.

File → Save As

File Type: *AutoCAD Drawing Template (*.dwt)*

3) DWS (Drawing standards) file.

The DWS file contains a set of standards and styles and is used to verify compliance between the established standards and design drawing settings.

This file uses the check standards tool and controls

a) Layer standards

b) Text styles (font type, text size, title size, etc.)

c) Dimension styles

d) Line types etc.

A certain company may have its own standards (for example, a load-bearing wall on a plan should be made in a red continuous line of 0.5 thickness). The company project manager creates a DWS file, where all the styles are predefined according to the company standards. The user engineer scans the

working drawing during work using the STANDARDS command and compares it with the standards defined by DWS.

Here are the stages for creating a DWS file.

Stage I — Preparing a Standard DWG File
This includes opening a DWG file (empty DWG file or DWT template),
creating Layers, Dimension Text Styles, creating of Standard Hatches and Blocks (if the company uses them).

Stage II Creating a DWS File
Save file in*. dws format

File → *Save As*

File type: *Drawing Standards (*.dws)*

Stage III - Using a DWS File
Open the DWG file to be checked.
Attach an existing standard file to this file.

Manage → CAD Standards → Configure

After that, let's check the compliance of the settings of the file to be checked with the standards of the DWS file

Check Standards

AutoCAD will check: Layer names, colors, Lineweights, Dimension Style, Text Style, and etc..

If something does not match → *it gives us a message.*

The example: Let's we have a layer named DIMLINE in the DWG file, and we do not have such a layer in the DWS file. Then the program will prompt us with a message

***!** Non-standard layer detected*

after which it is possible to delete the file or replace it with a standard Layer.

It is important not to be confused with DWT and DWS files. At first we may think that DWT and DWS files are similar to each other, but in fact they have completely different purposes.

The DWT file is used to start a new drawing. Changes to the DWT file do not affect older drawings. It contains certain geometry in the form of frames and stamps. The DWT file is opened using the New command.

The DWS file is used to control standards in an existing drawing,changes to a DWS file may affect an existing drawing (with user approval), it does not contain geometry. The DWS file is opened using the STANDARDS command.

The best option is the combination of **DWS +**

DWT both in the professional and learning process, because this provides both a correct start of the drawing and constant control of standards during the work process.

Part III. Data Sharing Files in AutoCAD (PDF, DWF,DWFx)

1)PDF file

PDF (Portable Document Format) is an universal document format that is not tied to a specific CAD system. This file does not require a special viewer . The PDF format is characterized by cross-platform compatibility, high print quality, and the official appearance of the document. Therefore PDF is mainly used for the final, official presentation of drawings.

There are two main ways to convert a drawing to PDF in AutoCAD:

PLOT (by printing to PDF)

EXPORT / PUBLISH PDF (direct export)

Both methods are widely used, and the choice depends on the type and purpose of the drawing.

Creating a PDF using the PLOT command is the most common and controllable method, especially when precise scale is required.

Steps for printing drawing in PDF are following:

Execute the command:*PLOT*

In the Printer/Plotter section, select:

DWG To PDF.pc3

Specify the paper size *(A4, A3, A1, A0, etc.)*

In the Plot Area, select:

Layout (if you are printing from a sheet)

Window (if you only want to move a part)

Specify the scale:

1:100, 1:50, 1:1, etc.

Click *Preview*

If everything is correct — *OK*

Specify the name and location of the PDF file

There are common errors when transferring PDF, such as incorrect scale, too thin or thick lines, Incorrect paper format, poor text readability, print directly from model Space

In professional practice, PDF is almost always created from Layout because the scale is correct, the frame and title block are visible, the printing standard is maintained.

2) DWF file

DWF (Design Web Format) is a compressed

file format created by Autodesk for quick sharing and visual inspection of AutoCAD drawings. DWF files maintain graphical accuracy, but limit editing capabilities, which makes them secure for data transfer.

The advantage of a DWF file is possibility of quickly sharing a drawing with colleagues or a client, very small file size, protected visual information from editing.The disadvantages of a DWF file are the need for a special viewer and the low print quality.

3) DWFx file

DWFx (Design Web Format, XPS-based) is an extended version of the DWF format, based on Microsoft's XPS technology. The main advantage is that DWFx files can be opened using standard Windows tools without installing an additional Viewer.

Part IV.Data exchange and production files(DXF)

DXF (Drawing Exchange Format) is a data exchange format developed by Autodesk, the main purpose of which is transfering geometric information between CAD systems.

DXF is not the main working format of AutoCAD, but it represents a transmission link between different systems and working stages.

In modern production, DXF files play an important role in the CAD–CAM–CNC workflow.

Let's recall the meaning of these terms.

CAD (Computer Aided Design) is a set of computer systems and software used for creating, editing and analyzing engineering objects, details and technical drawings. In the CAD environment, geometric models are created, that are the initial data for farther manufacturing processes.

CAM (Computer Aided Manufacturing) is the use of computer systems to plan and control manufacturing processes. CAM programs take the geometry created in a CAD system and convert it into technological instructions that determine the movement of the cutting tool, cutting speed, depth, and sequence of operations.

In other words, CAM is a transitional stage between design and actual manufacturing.

CNC (Computer Numerical Control) is a control system for production machines that operates on the basis of a numerical program.

CNC machines receive commands (G-code) generated by a CAM program and automatically perform material processing with high accuracy and repeatability.

In conclusion, CAD–CAM–CNC represents a unified technological chain, where CAD provides the creation of geometry, CAM transforms this geometry into production instructions and CNC performs physical processing. This interconnection is the basis of modern manufacturing systems.

What role does a DXF file play in the CAD–CAM–CNC workflow?

At the CAD stage (for example, in AutoCAD), the exact geometry of the part is created. This geometry is stored in DXF format

In the CAM system, DXF is used to plan cutting paths, while the CNC machine takes the program generated by CAM and performs the actual machining.

In other words, DXF is a bridge between digital design and physical production.

Therefore, a DXF file, as a rule, only requires a geometric description of the drawing. It should include lines and polylines, arcs and circles, closed contours, coordinate data

Thus, the information in the DXF format is represented by a relatively simple structure, which ensures its high level of compatibility with various CAD and CAM systems. DXF can exist in both ASCII and Binary formats, although in manufacturing practice the most common is the DXF R12 ASCII format, which is considered an industry standard.

The DXF format is widely used in manufacturing processes such as laser cutting, plasma cutting, CNC milling, engraving, sheet metal processing, and more. For manufacturing, only the necessary geometry is usually retained in the DXF file, while text, dimensions, blocks, and other auxiliary elements are removed. This reduces the risk of errors and simplifies the work of the CAM program.
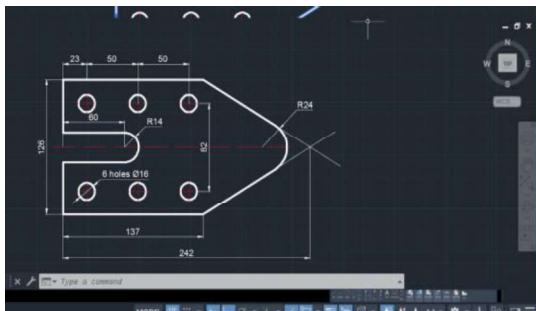
When preparing a DXF file for production stage, it is essential to follow the following rules

✓ All contours must be closed and continuous

✓ All elements must be in the same plane (Z = 0)

✓ There should be no duplicated or overlapping lines

✓ Simple geometric objects should be used

✓ The units (mm)should be defined clearly

Following these rules, the correct reading of the DXF file in CAM and CNC systems will be provided.

Let's consider the simplest example of creating a DXF file

The pict. 1 shows a working drawing of a plate made in dwg format. The drawing is built in compliance with standards, the appropriate layers are created, dimensions, axis lines are indicated.

Pic. 1

At the next stage, the drawing should be prepared for conservation to DXF format.

To do this, it is need to clean the drawing from unnecessary information, remove Dimensions Text, Center lines, hatching lines, and so on.
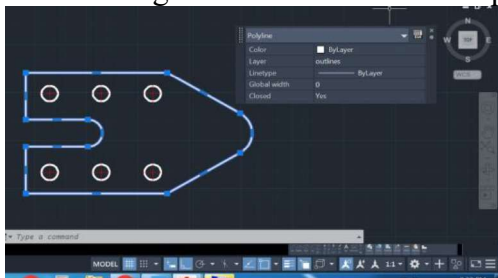
Next stage is executing the commands

OVERKILL (delete double lines)

FLATTEN (Z=0)

PEDIT → JOIN (unite all contours)

The drawing looks like the one in the pic.2.

Pic.2

On final stage of creating DXF is

SAVE AS

File type: DXF

Version: AutoCAD R12 ASCII

Part V. Data protection and recovery files (BAK , SV$)

AutoCAD uses two different types of files for data protection: BAK and SV$. Both serve to reduce the risk of drawing loss, but the mechanism and purpose of their creation are different.

1) BAK file

BAK file is a backup copy that AutoCAD creates every time you manually save (SAVE). It represents a previous version of a DWG file, automatically updates every time you save and is saved in the same folder as the DWG

This process of restoring working file is performed by renaming the BAK file to DWG format and is an effective data protection mechanism.There are two methods to convert a backup file to a working file.

First method — by renaming the BAK file (the simplest and most effective)

Steps are the followings- open the folder where the working DWG file is saved, find the corresponding file with the .bak extension , suppose *Plan01.bak*

Select the file and rename it to *Plan01.dwg*

In this way we will get the previous version of the DWG file, the state that was before the last SAVE

Second method-Method II — Open from AutoCAD (Open Dialog)

If extensions are not visible in Windows,

Open AutoCAD, click *Open*

In the File type list, select:

All Files (.*)*

Select the .bak file and click Open

After opening the file, *SAVE AS → DWG*

If the BAK file does not exist, this means thatthe file has not been saved yet

or BAK is disabled in AutoCAD settings

To do this, go to

OPTIONS → Open and Save

"Create backup copy with each save" — must be checked by ✓

2) SV$ file

In case of an unexpected shutdown of AutoCAD or the system, it is possible to recover the working drawing using the automatic save file (SV$), which temporarily stores unsaved data.This file is created by the AutoSave mechanism, and is stored in a temporary folder. For restoring of working file the steps are following:

Step I — Finding of the SV$ file

SV$ files are usually not stored in the `

Its most common locations are

Windows:

C:\Users\<UserName>\AppData\Local\Temp

or a folder specified by AutoCAD
From AutoCAD, the address can be accessed in this way

   OPTIONS → Files → Automatic Save File Location

Stage II — Identify the corresponding SV$ file

Sort the SV$ files by *Date Modified*
Select the most recent SV$ file

Stage III — *Rename the SV$ file*
Copy the selected .sv$ file to a safe folder
Change the extension:

   .sv$ → .dwg

   and confirm the extension change

Stage IV — Open the file in AutoCAD

Open the renamed DWG file in AutoCAD if the file opened correctly — save it immediately:

   With *SAVE AS*

Conclusion

This article discusses AutoCAD file types and their role in civil engineering design, documentation, and production processes. It shows that in modern engineering practice, each file format has a clear functional purpose and a specific context of use.

The comparative table (pic.3) of AutoCAD files summarizes the material discussed in this article.

File type	Name	Purpose	Edit file	Usage stage	Main feature
DWG	Drawing	Main working file	yes	Design	Stores the complete drawing (geometry, layers, styles)
DWT	Drawing Template	Template	yes	Starting	Standardized drawing source file
DWS	Drawing Standards File	Drawing control	no	Control	Checks Layer, Text, Dim standards
DWF	Design Web Format	Sharing	no	presentation	Lightweight, protected viewing format
DWFx	Design Web Format (XPS-based)	Sharing	no	presentation	Opens in Windows without Viewer
PDF	Portable Document Format	Documentation	no	print/archive	Official, cross-platform format
DXF	Drawing Exchange Format	Data exchange	limited	exchange/man ufacture	CAD–CAM–CNC universal format
BAK	Backup File	backup	no	safety	Automatic copy of the previous version of DWG
SV$	AutoSave File	Autosave	no	restoring	Recovery after program shutdown

The comparison presented in the table clearly shows that the correct and targeted selection of file formats is an important component of professional work and a necessary prerequisite for ensuring the quality and efficiency of the project.

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