Platform Sync in MCIntegrator: The Explanation and Benchmark

Civil 3D · https://mes100.com/docs/platform-sync-in-mcintegrator-the-explanation-and-benchmark/

Introduction

In Malaysia, the government has set a goal to widely adopt the Building Information Modelling (BIM) system in the construction industry by 2025. With BIM, information sharing is more efficient among all the parties involved in a project, from planning to maintenance and demolition. With such aim, engineers (mostly involving large or medium scale projects) will need to transform their design at the end of the day into 3D models and this can be achieved with the help of one of the Autodesk engineering software, Civil 3D.

While Civil 3D and AutoCAD may appear similar at first glance, Civil 3D is specifically designed for civil engineering tasks and has a wealth of specialized tools, including for sharing information. The downside is it’s not intuitive to engineers who are not already soaked in the AutoCAD nomenclatures. . With the large number of features and icons, it takes a significant amount of time to learn the software just to be able to create a single surface. Of course training classes are available online and offline, but then they can be costly; Another cons of Civil 3D.

These challenges with Civil 3D definitely open the doors for alternative software options, like MiTS. Our software offers ease-of-use, allowing engineers to complete their design within a single program without the need to navigate through hundreds of icons – something Civil 3D won’t or can’t do. Additionally, we have also taken the steps to promote interoperability and BIM in MiTS by developing a specific plugin called MCIntegrator, which enables back-and-forth synchronization between MiTS and Civil 3D.

Engaged users of MiTS may have come across or had the opportunity to experience this plugin before, where only utility networks and survey points groups are able to be synchronized between the

two softwares. But in the latest releases, MCIntegrator has been upgraded to **allow for the synchronization of platforms at two different levels, be it as surfaces (Civil Sync mode) or CAD objects (CAD Sync mode**); greatly simplifies the conversion of platforms to TIN Surfaces in Civil 3D.

How does MCIntegrator simplify things?

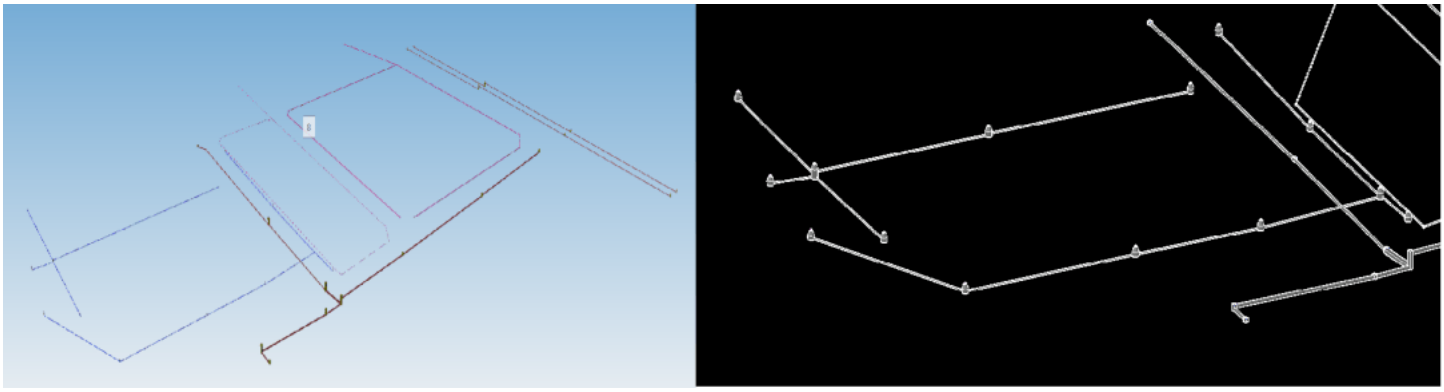
The Civil 3D design requires you to know about **Surface**, **breaklines**, **boundaries**, **3D points**, **3D polylines**, **3D faces**... It's quite a mouthful! With the MCIntegrator plugin, it eliminates all those steps, and all you need to do is define the parameters for your design in MiTS and click 'OK' – the rest will be handled by the software. As simple as that, and you can have the work-life balance that you have always wanted.

Defining parameters will let the software know which information needs to be written from MiTS to Civil 3D or the other way round. The parameters are listed below.

1. **Surface feature** – for survey points groups in MiTS, and is available for two-way synchronizations
2. **Platforms feature** – for conversion into surfaces in Civil 3D, which is recommended for one-way sync (from MiTS to Civil 3D) to prevent unwanted changes to your designed platforms. That is, unless you are synchronizing the surfaces in Civil 3D to a blank MiTS project file.
3. **Road feature** – for the conversion of a complete road design in MiTS (horizontal and vertical alignments, road offsets, and superelevation) into native Civil 3D objects, such as assemblies (road cross-sections), corridors, and surfaces. Do note, this feature is only available for a one-way sync from MiTS to Civil 3D
4. **Utility features (Sewerage, Drainage, Water Reticulation)** – to convert a network of polylines (in MiTS) into gravity or pressure pipes (in Civil 3D), and vice versa.
5. **CAD settings** – this feature is for a project that involves a CAD sync level, requiring users to define the 3D View exported from MiTS

Embedded media:
https://www.youtube.com/embed/hu9vlyIla14?version=3&rel=1&showsearch=0&showinfo=1&iv_load_policy=1&fs=1&hl=en-US&autohide=2&wmode=transparent&enablejsapi=1

Parameter for the MCIntegrator plugin



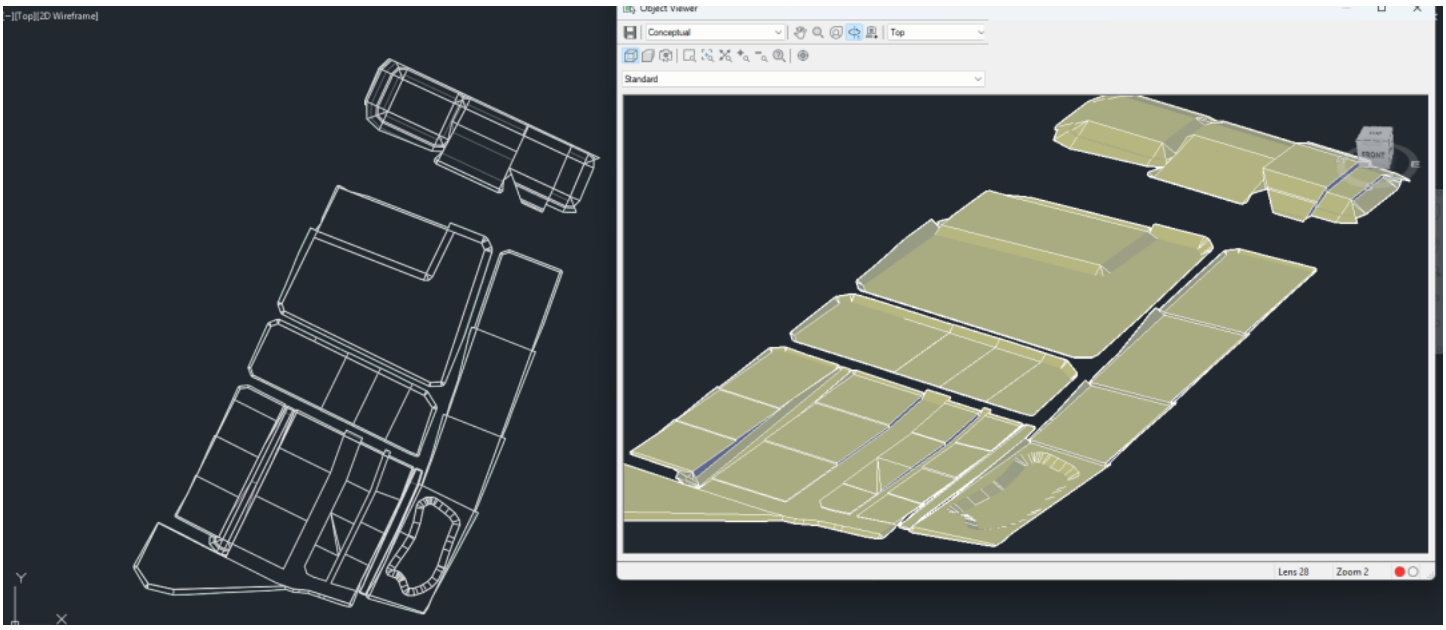
Utility pipes synchronized into CV3D as gravity pipes and pressure pipes

MiTS to Civil 3D: Platform Synchronization

Civil Sync: Breaklines Surface

Polymesh TIN Surfaces are just CAD objects that don't have civil meanings like Surface. The most proper way to synchronize platforms and surfaces is via **breaklines** and **boundaries**, the two entities that are only available in Civil 3D. Whenever possible, you should always opt for this mode of sync for Platforms, as properly utilizing these tools can help in representing drops for human-altered terrains and *less headaches* for users.

Adding this feature as part of the synchronization process effectively overcomes the limitations of the polymesh when it comes to triangulations for sharp drops between edges and missing surface areas, successfully reducing the discrepancies in earthwork volumes between the two programs.



Platforms with slopes as Breaklines Surface

Result Comparison:

Sample project file **here**

	MiTS	Breaklines Surface in Civil 3D	Discrepancy (%)
Cut (m^3)	115184.15	115200.71	0.014
Fill (m^3)	71558.39	71570.93	0.018
Area (m^3)	85060.32	85060.80	0.001

Discussion:

Based on the results tabulated above, the variations in cut and fill volumes between MiTS and Civil 3D have been *minimized to less than 0.5%* with the **introduction of the Breakline Surface synchronization method** for platforms. This method utilizes two helpful tools of Civil 3D, ***breaklines*** and ***boundaries,*** in refining the TIN Surface triangulations (polymesh) to accurately represent the sharp edges or drops of the manmade terrains.

The minimal variations between the volumes computed are still expected, though the value should be very small to indicate a successful design preservation. This is because the two programs are using

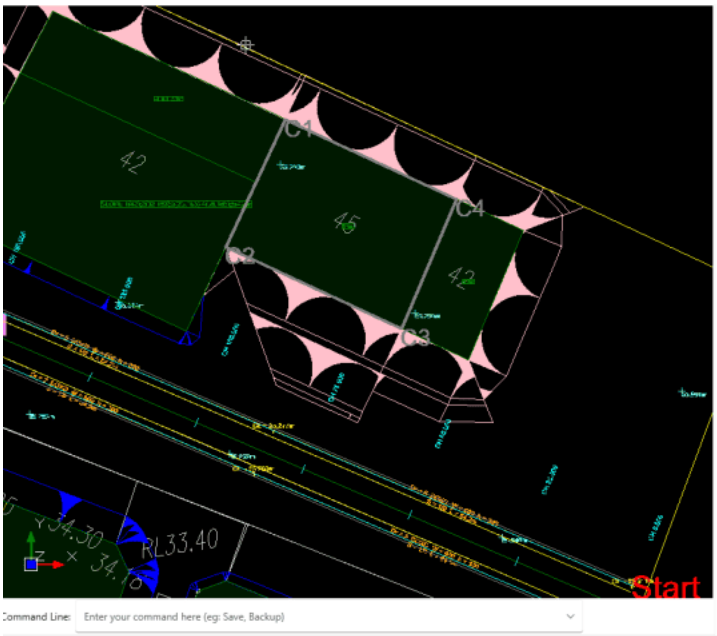
different algorithms in modeling manmade terrains, and as such, their output cannot be mathematically identical.

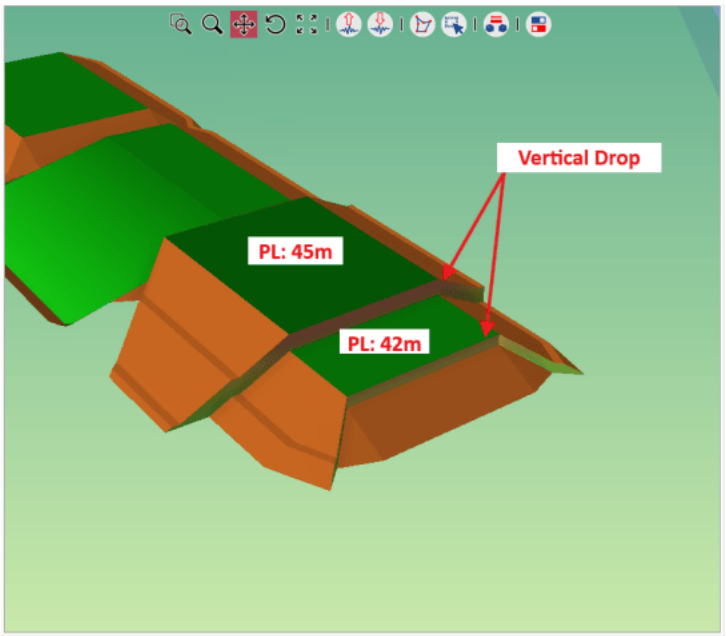
Wall Breaklines: Defining the shapes of platforms and slopes

The polymesh of a TIN Surface can be *reshaped* by adding breaklines to it.

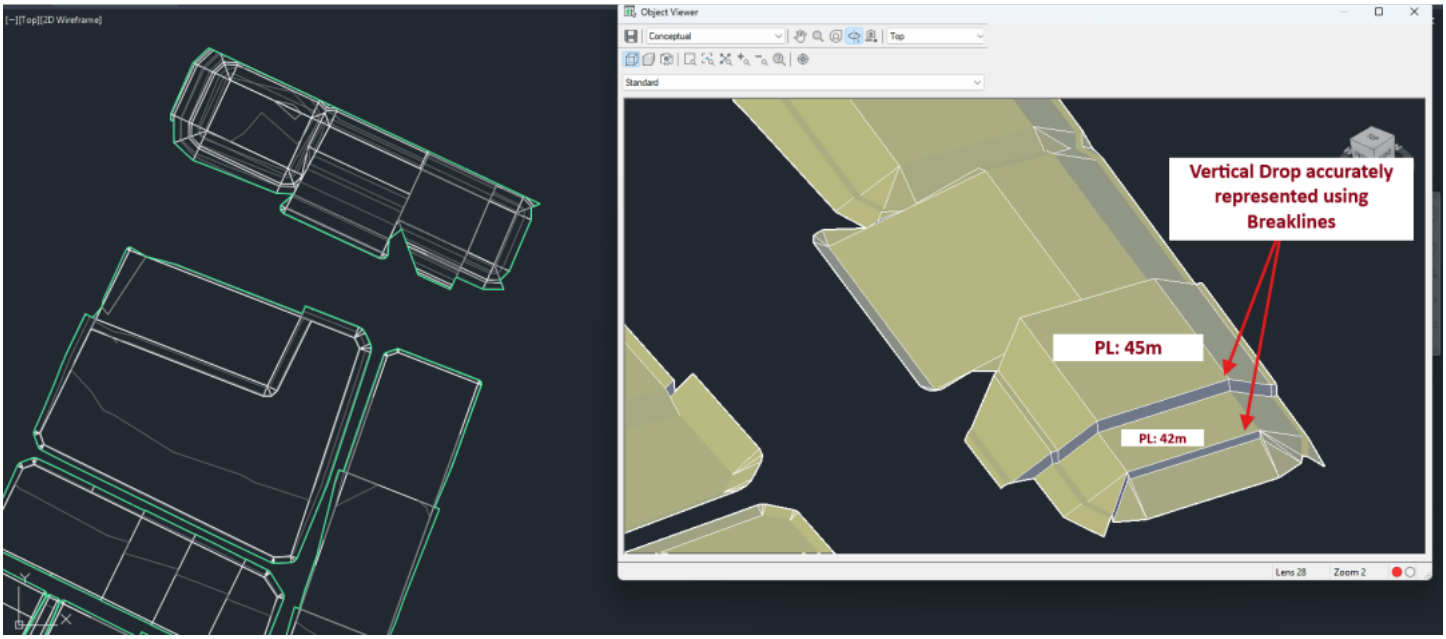
A breakline is a **Civil 3D polyline** that acts as a *hard edge*, **forcing the triangulations (polymesh) to ignore its default smoothing behavior** of connecting the nearest 3D Points and create the abrupt vertical drop between the surfaces. In simpler terms, the breaklines added instructions to the software to **continue the triangulation along the polylines,** and **no triangles are allowed to cross over them** (so, a perfect slanting slope can't be in between). This is what makes breaklines perfect for representing man-made terrain designed following various shapes (regular and irregular) and elevations.

There are *four types of breaklines*; One of them is the **Wall Breaklines**, specifically utilized by MCIntegrator, as it possesses the ability to model vertical drops in between platforms and slopes accurately. The Wall breaklines will have the parallel polylines for the edges – Base (Actual) polylines and Offsetted Polylines – which will replicate the elevation differences between the shared edges and create an *almost vertical drop*.





Vertical Drop created in MiTS



Vertical drop is accurately represented in Civil 3D using Breakline

In the synchronization method context, the breaklines are utilized to define the internal surface of the platforms and slopes according to their elevations, including the drops at the shared edges. The Wall breaklines will have the parallel polylines for the edges – *Base (Actual) polylines and Offsetted Polylines* – which will replicate the elevation differences between the shared edges and create an *almost vertical drop*.

Detailed explanations on how the breakline tool is applied in the platform method sync, *BreaklineSurface* can be **read here**.

Boundaries: Controlling the Surface's overall shape

In addition to the breaklines, another tool that can be utilized to ensure a highly accurate representation of the MiTS platforms in Civil 3D as TIN Surface is **Boundary**.

A boundary is added to the polymesh TIN Surface from a closed 2D polyline, which helps in controlling the triangulations done by the software. It defines the limits of a surface, dictating *how far the polymesh should extend* and *which portions of the surface should be visible*.

More than one boundary can be added to the surface, and they can be opted from the four types available in Civil 3D; *Outer*, *Show*, *Hide*, and *Data-clip*. Each boundary will affect differently on the surface, and the BreaklineSurface sync method mostly utilized the Outer Boundary and Show Boundary in defining the perimeter of the platforms and slopes.

Outer Boundary:

This is a commonly used boundary that removes any unwanted triangles defined beyond the platform or slope limits or shapes. The Outer Boundary helps to “clean up” the surface and ensure the earthworks volumes computed are exactly within our development area. To apply Outer Boundary, a polyline will be created to represent the perimeter of the slope and platforms as in below.

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Show Boundary:

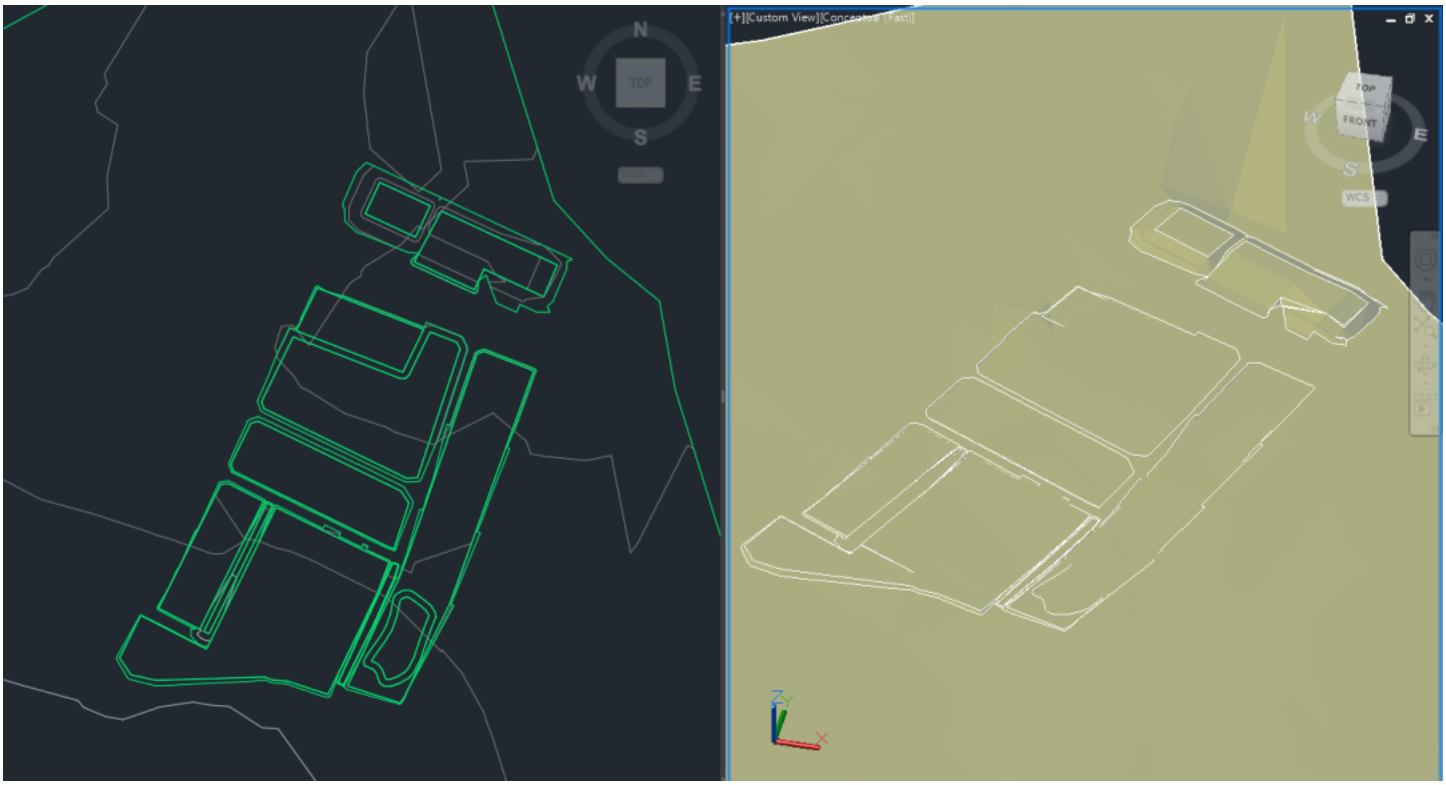
This type of boundary reverses the effect of **Hide Boundary**, where it makes the “hidden” triangles reappear.

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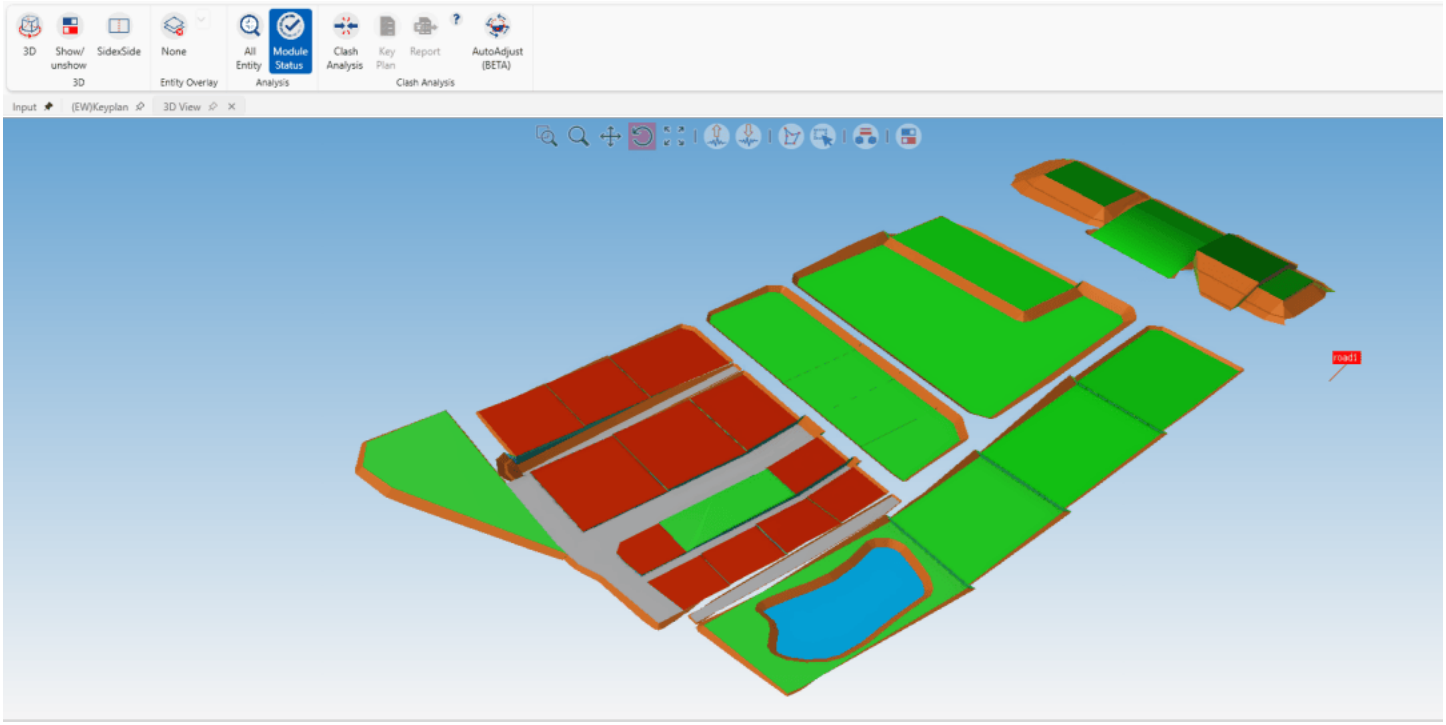
CAD Sync: IndividualSurface & AllSurface

In the MCIntegrator plugin of MiTS, we have introduced the two methods above, ***IndividualSurface*** and ***AllSurface***, for a seamless integration of platforms and slopes. Applying either one of these methods in the design integration process will convert the MiTS platform to a Civil 3D TIN Surface, in which the surface will be defined and represented as ***a polymesh***.

In the example below, we have synchronized the platforms together with the slope using the ***AllSurface method*** for Civil Sync.



Platform and slope surfaces represented by polymesh



Platforms with slopes generated in MiTS

Results comparison:

Sample project file **here**

	MiTS	Civil 3D Polymesh TIN Surface	Discrepancy
Cut (m^3)	115184.51	117866.98	2.33
Fill (m^3)	71558.39	69912.73	2.30
Area (m^2)	85060.32	83824.55	1.45

Discussion:

As shown by the results, the variations in cut and fill volumes between the two software programs fall within the standard industry range of less than 10%. While the outcome is considered satisfactory, our team's innate curiosity prompts us to further investigate the cause of the discrepancy, despite the identical physical appearance of the TIN Surfaces in Civil 3D to the platforms and slopes in MiTS. The answer lies in the way **Civil 3D Polymesh and MiTS Platform treat abrupt changes in the elevations or walls on altered terrains**.

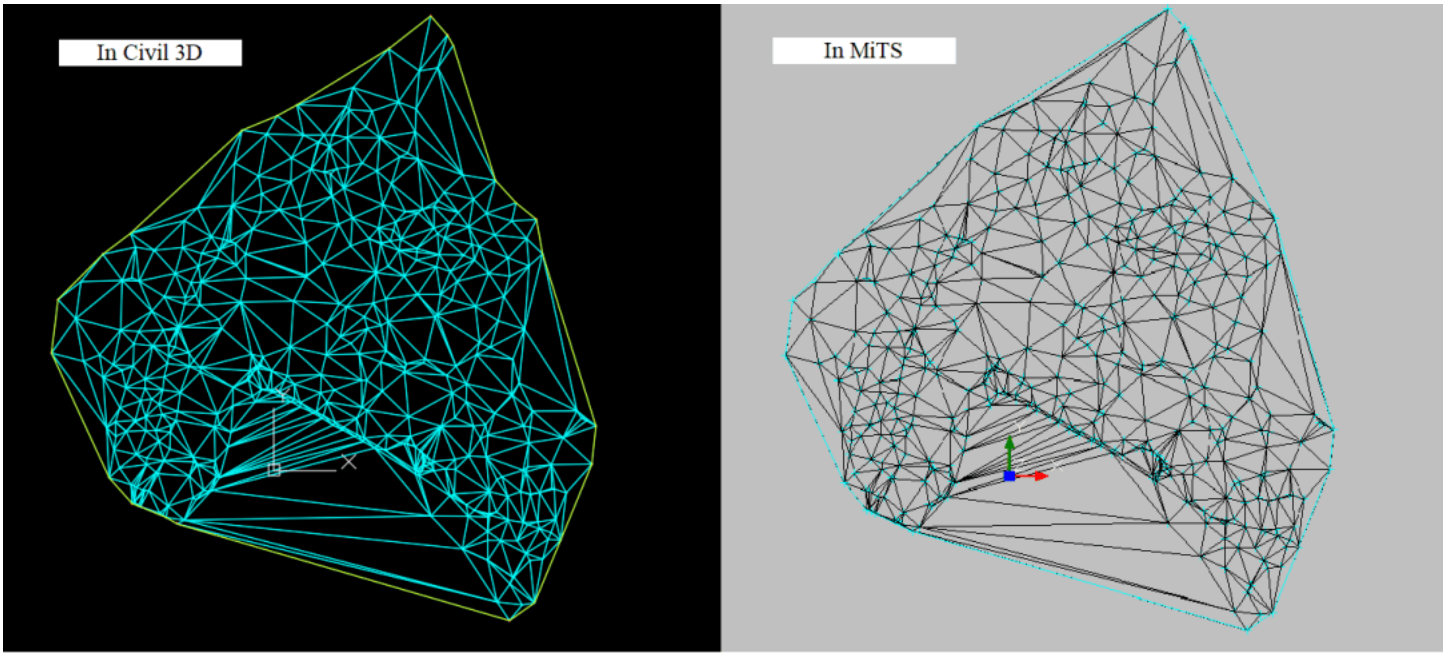
TIN Surface for human-altered terrain

Many modeling software, including Civil 3D and MiTS, create TIN Surfaces with polymeshes to represent the surface morphology. The surfaces will be created from the *connection of irregularly spaced 3D points* (with x, y, and z coordinates) by a series of edges to create a network of triangles to represent the land's terrain.

To obtain an accurate representation of a land's terrain, denser triangles are the best option, hence why it's highly recommended to have more scattered 3D points across your project. However, there's a catch to this; *A high density of points will create too complex surfaces* that might not be useful for the computation.

For natural terrain, yes, the job can be done easily and quickly with TIN Surface. All you must do is create a surface, followed by selecting all the 3D points – there you have a good 3D model representing the terrain. With minimal elevation variations and the use of survey points, users will have more control over the triangulation.

Clearly, the TIN Surface algorithm is geared towards these kinds of landscapes.



Existing terrain in MiTS and Civil 3D using TIN Surface

However, when dealing with manmade terrains, the polymesh TIN Surface can prove to be quite challenging to work with. Altered terrains often feature *complex topography of flat or near-flat areas with abrupt vertical drops or walls in between shared edges*. With the terrains designed as closed polygons instead of points, the complexity ***is not something that polymesh can handle*** with its triangulation nature. Instead of presenting a vertical drop, it connects the vertices of the closed polygons and displays a smooth transition in between. When the **TIN Surface and TIN Volume Surface heavily rely on the polymesh of the 3D points**, the earthwork quantities, cut and fill, are anticipated to have differences, as the surface area involved also has quite a difference.

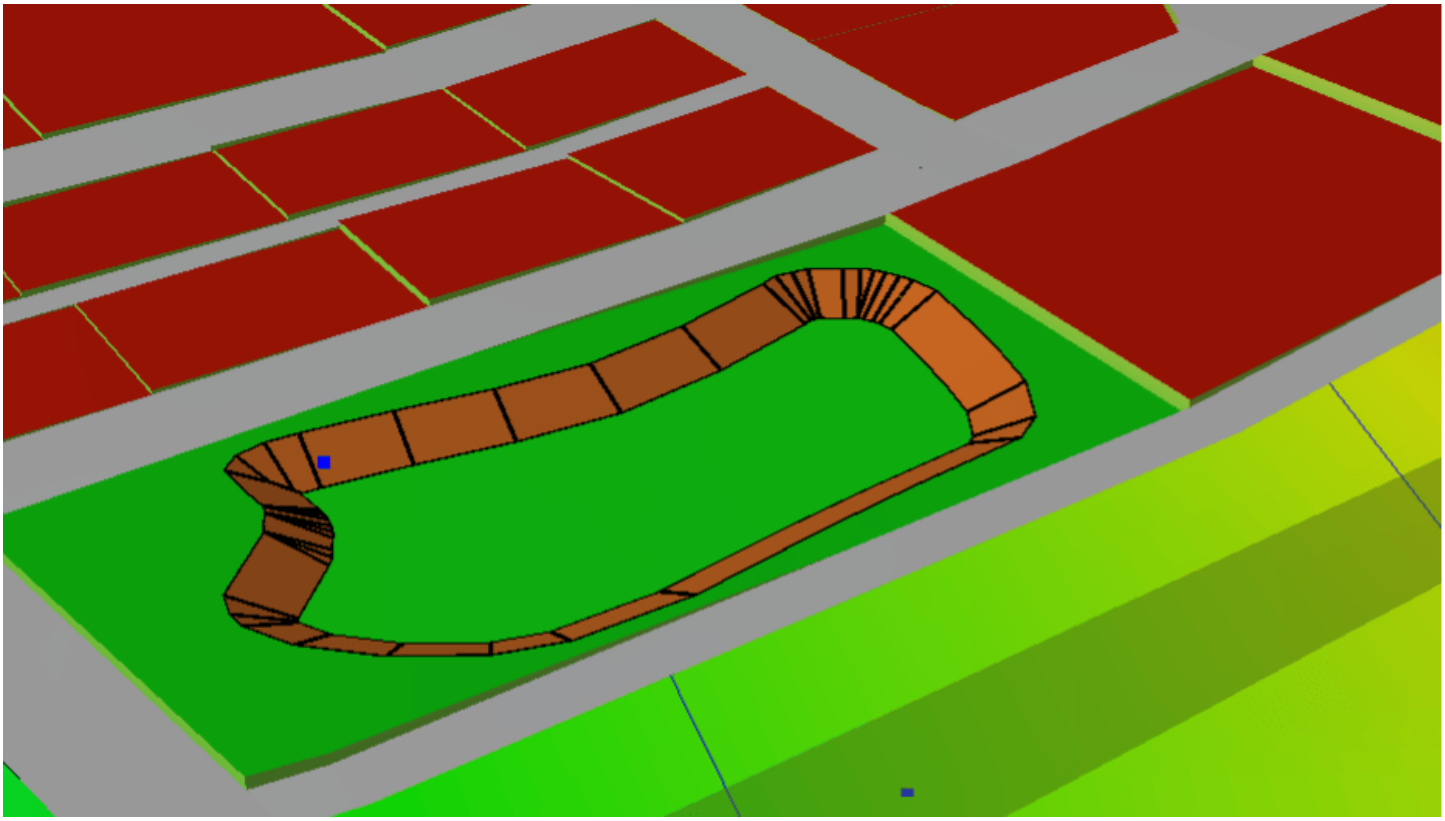
Well, this is how the algorithm is built for the polymesh TIN Surface, where it is more of a static graphical representation of the surface; The surface will be similar to a *fixed sculpture* where abrupt changes are not expected. So, we cannot simply convert the polylines with defined elevations to a surface and have the software represent the drops right away – It just doesn't work that way!

This demonstrates why a polymesh is not a great idea in representing a complex human-altered terrain, as it can lead to significant inaccuracies and increased manual work.

Platform for human-altered terrain in MiTS

With the aforementioned limitation of polymesh, MiTS is designed to utilize the polymesh Tin Surface method exclusively during the pre-development state, which involves survey points for representing the existing terrain.

For post-development (altered) landscapes, we offer a less complicated concept – *Platform*. The platform method allows users to design or alter the landscape as they imagine – whether it is regular or irregularly shaped polygons – MiTS can handle them well.



Irregular and regular shaped polygons created in MiTS for platforms

With MiTS, users do not need to be concerned with earthworks volume computation for vertical drops between platforms, as the software handles all of this automatically. All that is required from the user is to define the platform's level and sloping direction (in, out, or none), and the software will generate the slope and compute the cut and fill quantities. Hence, users can simply create the polygons with the levels and sloping directions defined, and your job for the day is done

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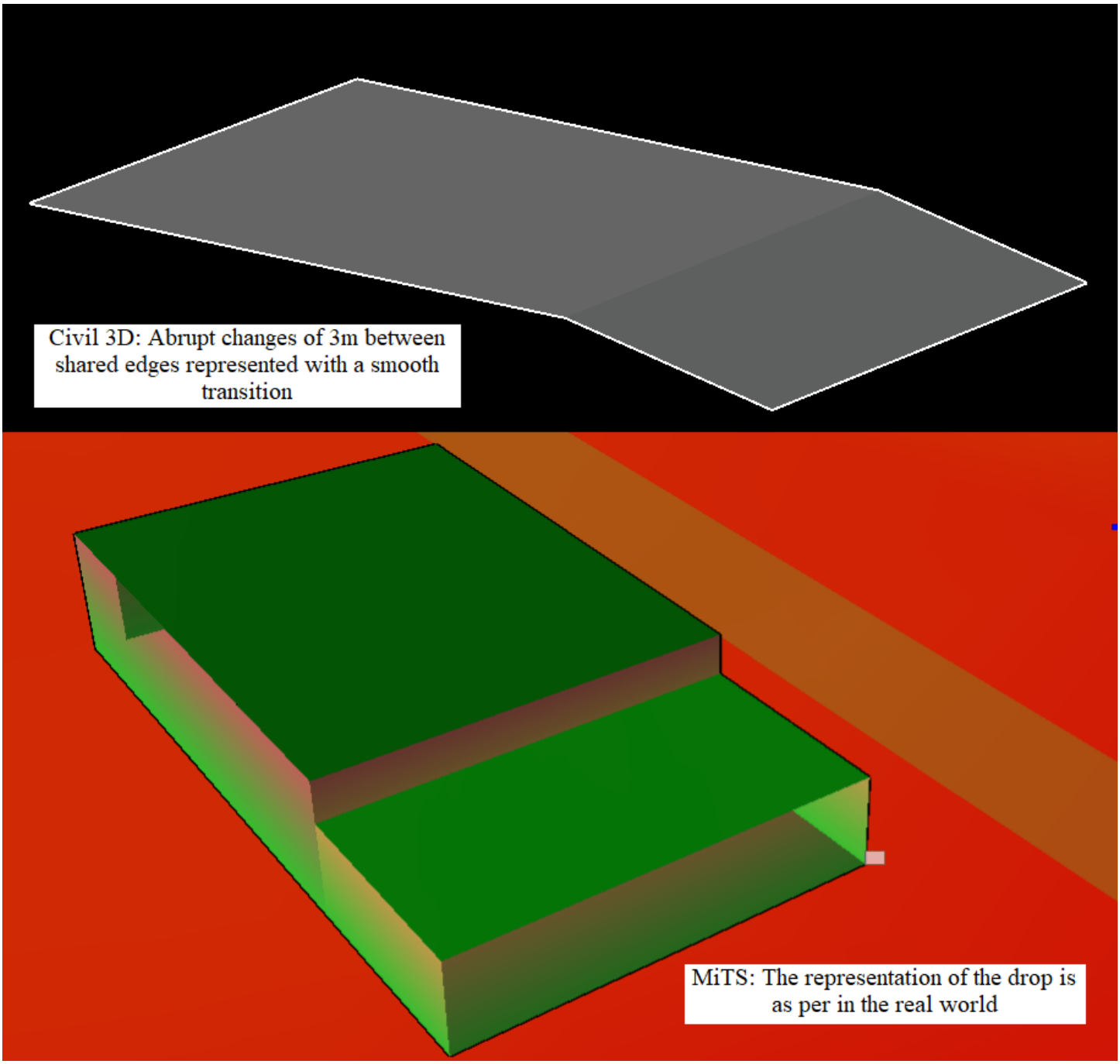
The mismatch between the polymesh TIN Surface and the Platform

Transforming platforms into polymesh TIN Surfaces is not a straightforward task, as the two entities are not the same. Attempting to fit platforms into TIN Surfaces can be achieved, but *only with an alteration to the platforms*. There are certain mismatches and limitations that we need to be mindful of, as they might impact the cut and fill results.

Polymesh TIN Surface doesn’t support an abrupt drop naturally

As an example, imagine two platforms side by side with a 3m height difference at the shared edge. Once the platforms have been synced over to Civil 3D and **defined with polymesh**, they will be *truncated in a way that the vertical drop in between is simply ignored* by the software when creating a network of triangles – Instead of showing the drop, it is *forced* to create a slanting surface, having smooth transition from a higher to a lower level, following the scattered 3D points available.

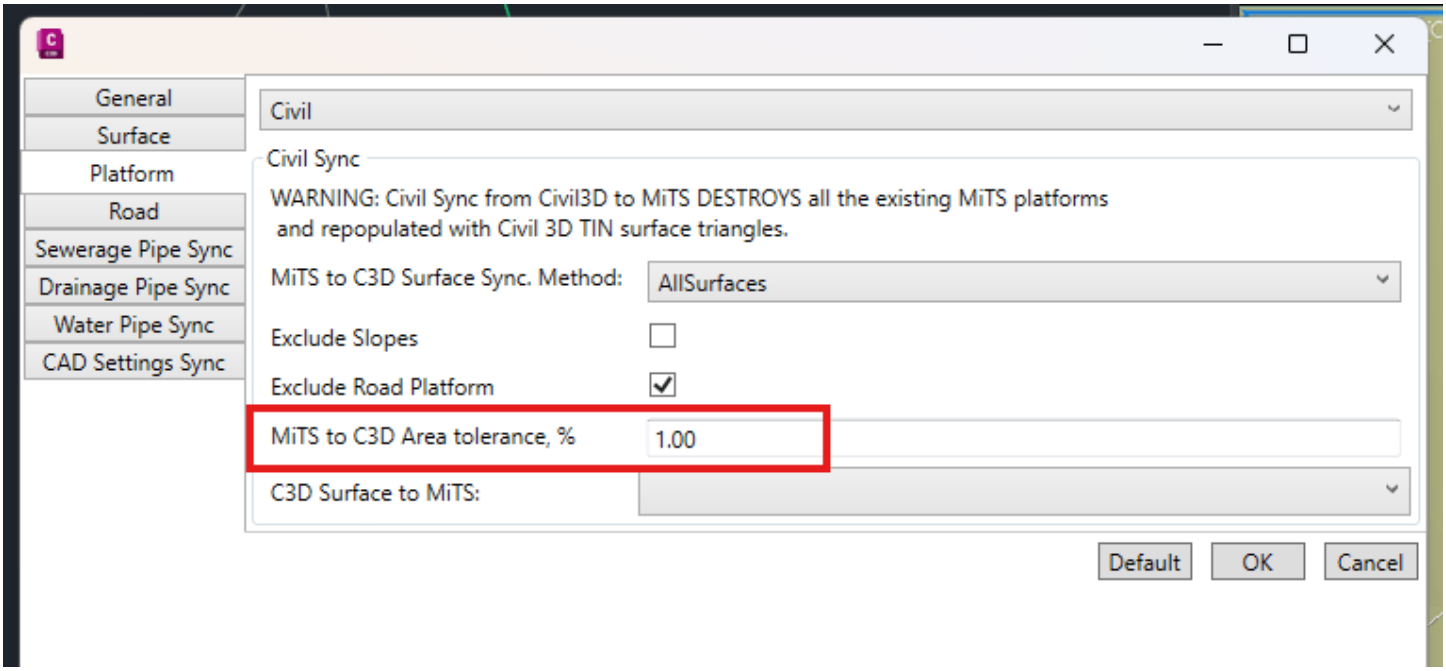
By failing to represent the true vertical drop between the shared edges, the volume computation will certainly be impacted as the *surface area involved will also be different*, leading to a mismatch between the quantities reported in MiTS and Civil 3D.



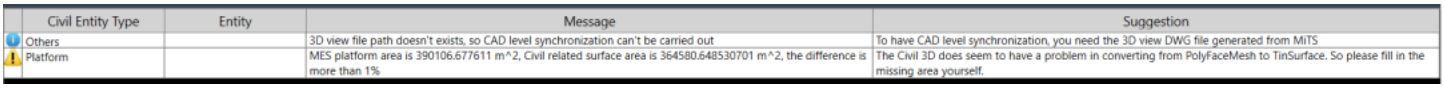
Missing area

There are times when areas are not properly converted from MiTS Platform to TIN Surfaces, due to an inherent limitation of the polymesh in Civil 3D.

To aid users in identifying the issue in their project, we have added a feature called **‘MiTS to Civil 3D Area Tolerance (%)’** in the Platform Civil Sync Parameters. This allows users to set a tolerance threshold and receive a warning message under the Action Panel if the percentage differences exceed the threshold value.



The parameter for the threshold value on the platform and the TIN Surfaces discrepancies



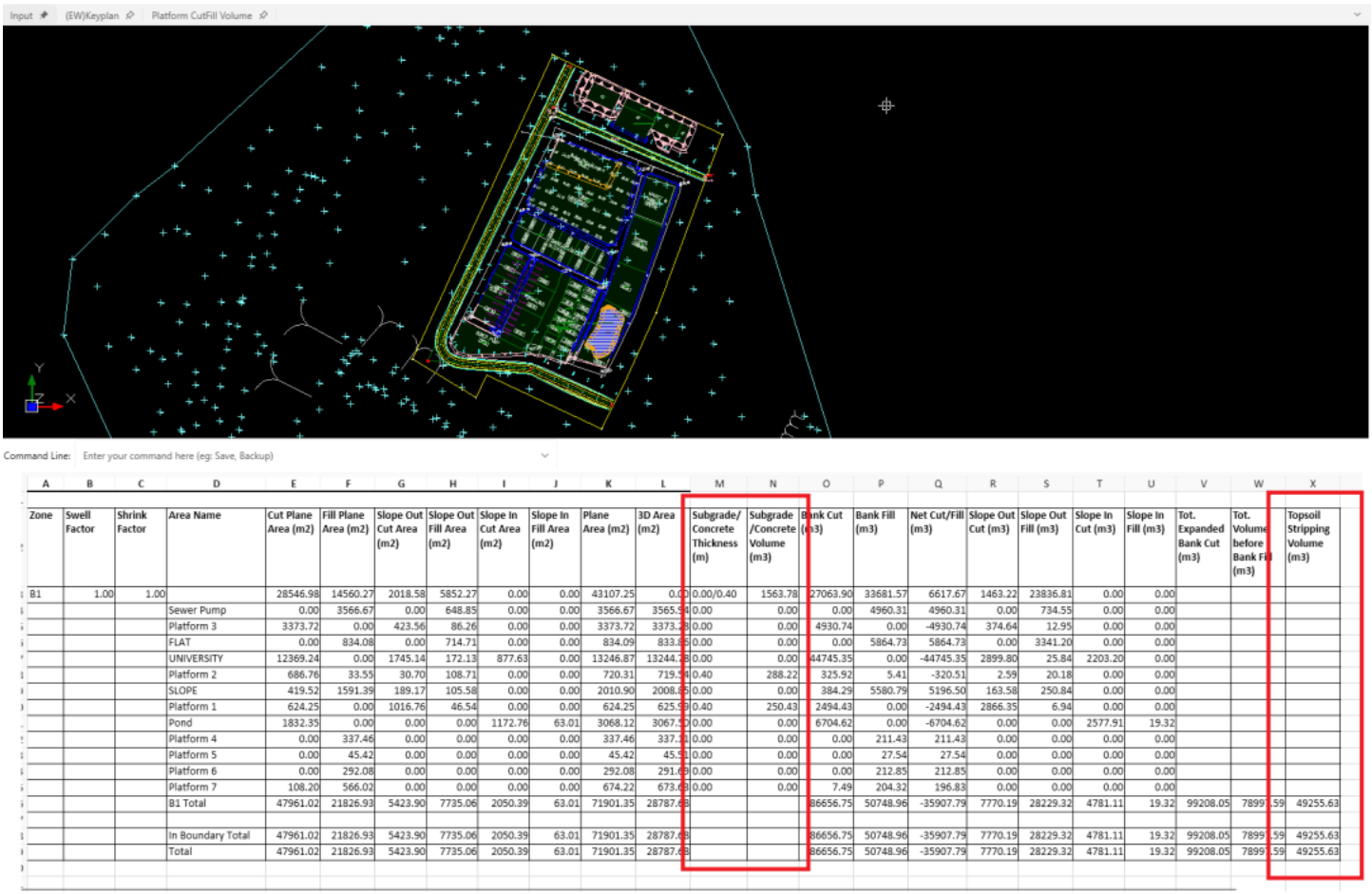
Civil Entity Type	Entity	Message	Suggestion
Others		3D view file path doesn't exists, so CAD level synchronization can't be carried out	To have CAD level synchronization, you need the 3D view DWG file generated from MiTS
Platform		MES platform area is 390106.677611 m^2, Civil related surface area is 364580.648530701 m^2, the difference is more than 1%	The Civil 3D does seem to have a problem in converting from PolyFaceMesh to TinSurface. So please fill in the missing area yourself.

The warning message under the Action Panel

Users should take heed of the message and add in the areas manually, so that the cut and fill volume is preserved with the polymesh TIN Surface.

Limitation: Soil Stripping and pavement thickness

Users may face significant discrepancies when it comes to the earthworks volume involving **soil stripping and pavement thickness**. This is a limitation/TODO on the synchronization, as we haven’t considered soil stripping and pavement thickness yet.



Zone	Swell Factor	Shrink Factor	Area Name	Cut Plane Area (m2)	Fill Plane Area (m2)	Slope Out Cut Area (m2)	Slope Out Fill Area (m2)	Slope In Cut Area (m2)	Slope In Fill Area (m2)	Plane Area (m2)	3D Area (m2)	Subgrade/ Concrete Thickness (m)	Subgrade /Concrete Volume (m3)	Bank Cut (m3)	Bank Fill (m3)	Net Cut/Fill (m3)	Slope Out Cut (m3)	Slope Out Fill (m3)	Slope In Cut (m3)	Slope In Fill (m3)	Tot. Expanded Bank Cut (m3)	Tot. Volume before Bank Fil (m3)	Topsoil Stripping Volume (m3)
B1	1.00	1.00		28546.98	14560.27	2018.58	5852.27	0.00	0.00	43107.25	0.0	0.00/0.40	1563.78	27063.90	33681.57	6617.67	1463.22	23836.81	0.00	0.00			
			Sewer Pump	0.00	3566.67	0.00	648.85	0.00	0.00	3566.67	3565.5	0.00	0.00	0.00	4960.31	4960.31	0.00	734.55	0.00	0.00			
			Platform 3	3373.72	0.00	423.56	86.26	0.00	0.00	3373.72	3373.2	0.00	0.00	4930.74	0.00	-4930.74	374.64	12.95	0.00	0.00			
			FLAT	0.00	834.08	0.00	714.71	0.00	0.00	834.09	833.8	0.00	0.00	0.00	5864.73	5864.73	0.00	3341.20	0.00	0.00			
			UNIVERSITY	12369.24	0.00	1745.14	172.13	877.63	0.00	13246.87	13244.2	0.00	0.00	44745.35	0.00	-44745.35	2899.80	25.84	2203.20	0.00			
			Platform 2	686.76	33.55	30.70	108.71	0.00	0.00	720.31	719.5	0.40	288.22	325.92	5.41	-320.51	2.59	20.18	0.00	0.00			
			SLOPE	419.52	1591.39	189.17	105.58	0.00	0.00	2010.90	2008.8	0.00	0.00	384.29	5580.79	5196.50	163.58	250.84	0.00	0.00			
			Platform 1	624.25	0.00	1016.76	46.54	0.00	0.00	624.25	625.5	0.40	250.43	2494.43	0.00	-2494.43	2866.35	6.94	0.00	0.00			
			Pond	1832.35	0.00	0.00	0.00	1172.76	63.01	3068.12	3067.5	0.00	0.00	6704.62	0.00	-6704.62	0.00	0.00	2577.91	19.32			
			Platform 4	0.00	337.46	0.00	0.00	0.00	0.00	337.46	337.1	0.00	0.00	0.00	211.43	211.43	0.00	0.00	0.00	0.00			
			Platform 5	0.00	45.42	0.00	0.00	0.00	0.00	45.42	45.5	0.00	0.00	0.00	27.54	27.54	0.00	0.00	0.00	0.00			
			Platform 6	0.00	292.08	0.00	0.00	0.00	0.00	292.08	291.6	0.00	0.00	0.00	212.85	212.85	0.00	0.00	0.00	0.00			
			Platform 7	108.20	566.02	0.00	0.00	0.00	0.00	674.22	673.6	0.00	0.00	7.49	204.32	196.83	0.00	0.00	0.00	0.00			
			B1 Total	47961.02	21826.93	5423.90	7735.06	2050.39	63.01	71901.35	28787.6			86656.75	50748.96	-35907.79	7770.19	28229.32	4781.11	19.32	99208.05	7899 .59	49255.63
			In Boundary Total	47961.02	21826.93	5423.90	7735.06	2050.39	63.01	71901.35	28787.6			86656.75	50748.96	-35907.79	7770.19	28229.32	4781.11	19.32	99208.05	7899 .59	49255.63
			Total	47961.02	21826.93	5423.90	7735.06	2050.39	63.01	71901.35	28787.6			86656.75	50748.96	-35907.79	7770.19	28229.32	4781.11	19.32	99208.05	7899 .59	49255.63

Result Comparison:

	MiTS	Civil 3D	Discrepancy (%)
Cut (m^3)	99208.05	114798.23	13.00
Fill (m^3)	78997.59	70292.71	12.00
Area (m^3)	85060.31	85060.80	0.00058

Users are advised to bear this in mind when doing the synchronization.

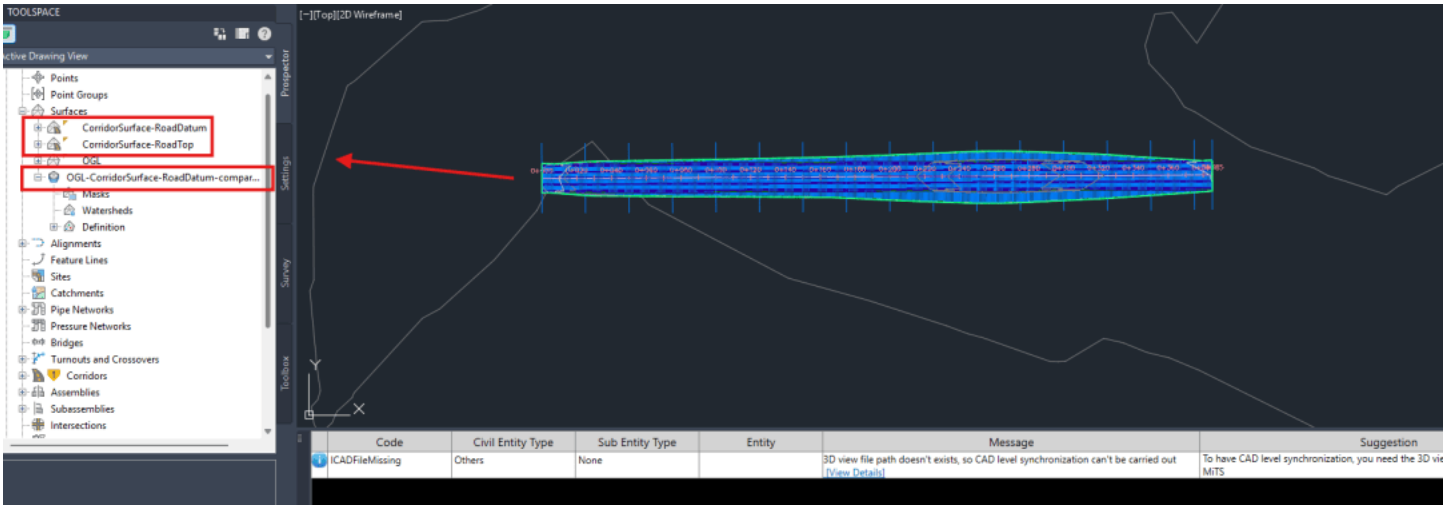
Discussion:

The volume discrepancies resulted from the different algorithms between MiTS and Civil 3D when it comes to earthworks modeling and computations.

In MiTS, the behavior of the algorithms is very much straightforward, in which it will consider the soil stripping and pavement thickness as the necessary “extra cut” to achieve the man-made terrain. This

means the overall volume can be computed without needing these components as separate surfaces.

However, Civil 3D requires a more explicit approach – Accurate volumes involving soil tripping and pavement thickness can only be achieved by making these components as **different surfaces** from the *normal platform and slope surfaces* (MESPltSlope). For **pavement thickness**, it must be defined as **Corridor Surfaces**, representing the layer of the road pavement. Similarly, the soil stripping will also need to be defined as a **distinct surface that represents the *soil volumes* that need to be stripped from the ground level**.



Example of how a road with pavement thickness should be designed as Corridor Surfaces

With the extra surfaces defined, only then can the TIN volumes be computed accurately by comparing the base surface (*the original terrain based on the survey data*) to the comparison surface (*surfaces representing our man-made terrain*).

Civil 3D to MiTS Platforms Synchronization

Under the Platform Civil Sync feature, users have the option to transfer TIN Surfaces from Civil 3D to MiTS by converting them into platforms. The conversion process will **overwrite the existing platforms with individual TIN Surface triangles**, resulting in a higher number of platforms that must be managed by users; However, the overall topology of the TIN surface will be preserved in MiTS

Does the conversion of the triangles affect the earthwork quantities between Civil 3D and MiTS? To determine this, it would be helpful to compare the results obtained.

Result comparison:

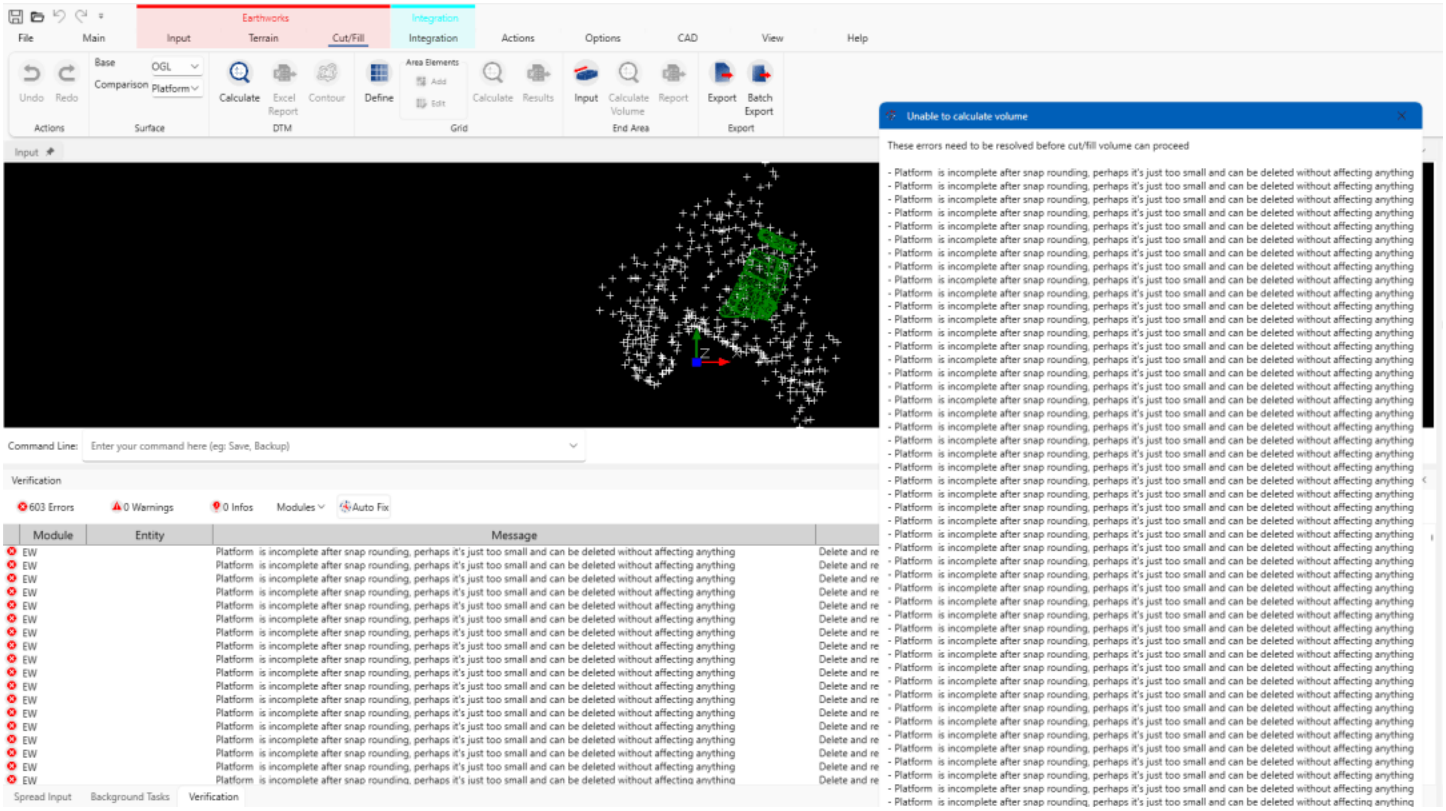
Sample project file **here**

	MiTS	Civil 3D	Discrepancy (%)
Cut (m^3)	114809.13	114798.23	0.009
Fill (m^3)	70277.23	70292.71	0.022
Area (m^3)	85062.89	85060.80	0.002

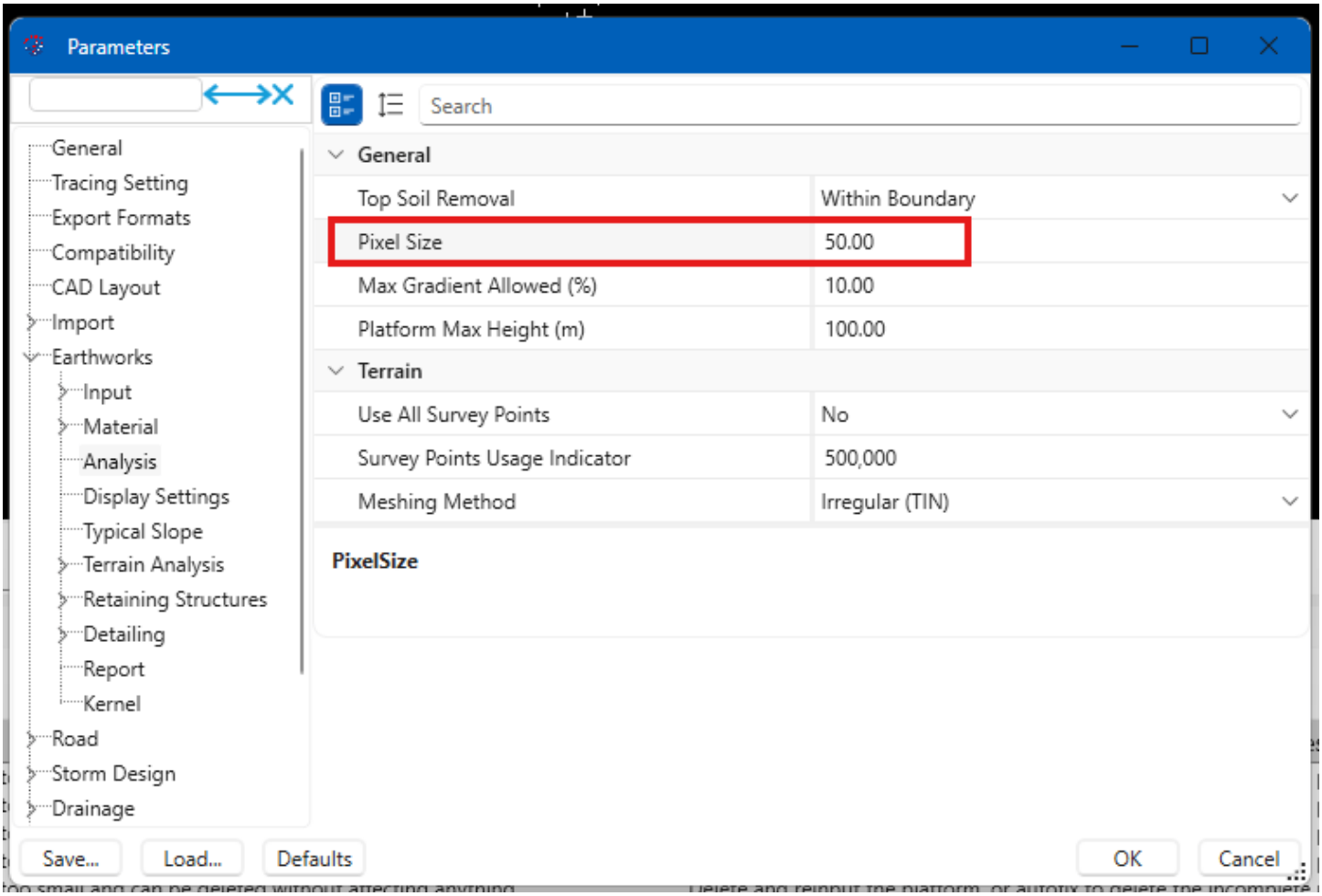
Discussion: Why is there a 0.01% discrepancy in my result?

The results shown with a discrepancy of only about 0.01% indicate that, with the way the Platform concept works in MiTS, in which users can throw in any shapes or vertical drops – the software will be able to handle the TIN Surfaces very well. Hence why the conversion is much easier compared to before.

The small and insignificant discrepancy in the earthwork quantities obtained in MiTS despite the identical physical appearance to the triangulation of the TIN Surfaces in Civil 3D might be **due to the snap rounding algorithm** for the platform input. The reason why you might also find verification errors – *Platform MarkX is incomplete after the snap rounding, perhaps it's just too small and can be deleted without affecting anything* – when proceeding to compute the cut and fill volume for the synchronized platforms.



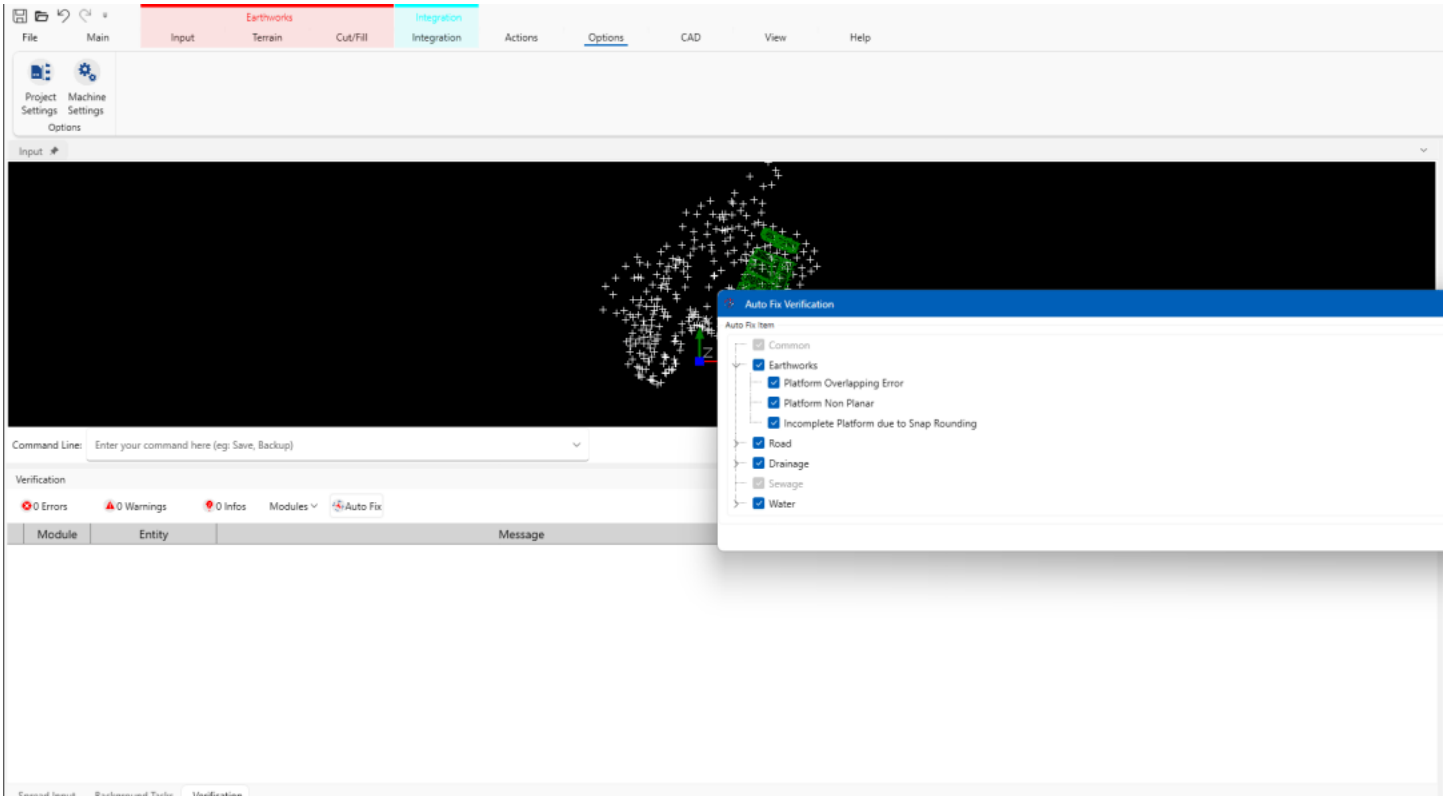
In MiTS, we implemented the snap rounding feature to increase the degree of accuracy for hand-drawn platforms by ensuring the edges are connected to one another to avoid inaccurate earthwork computations. This parameter was set with a default value of 50mm in the software –we think this is already quite a good accuracy, but this value can be overwritten by users.

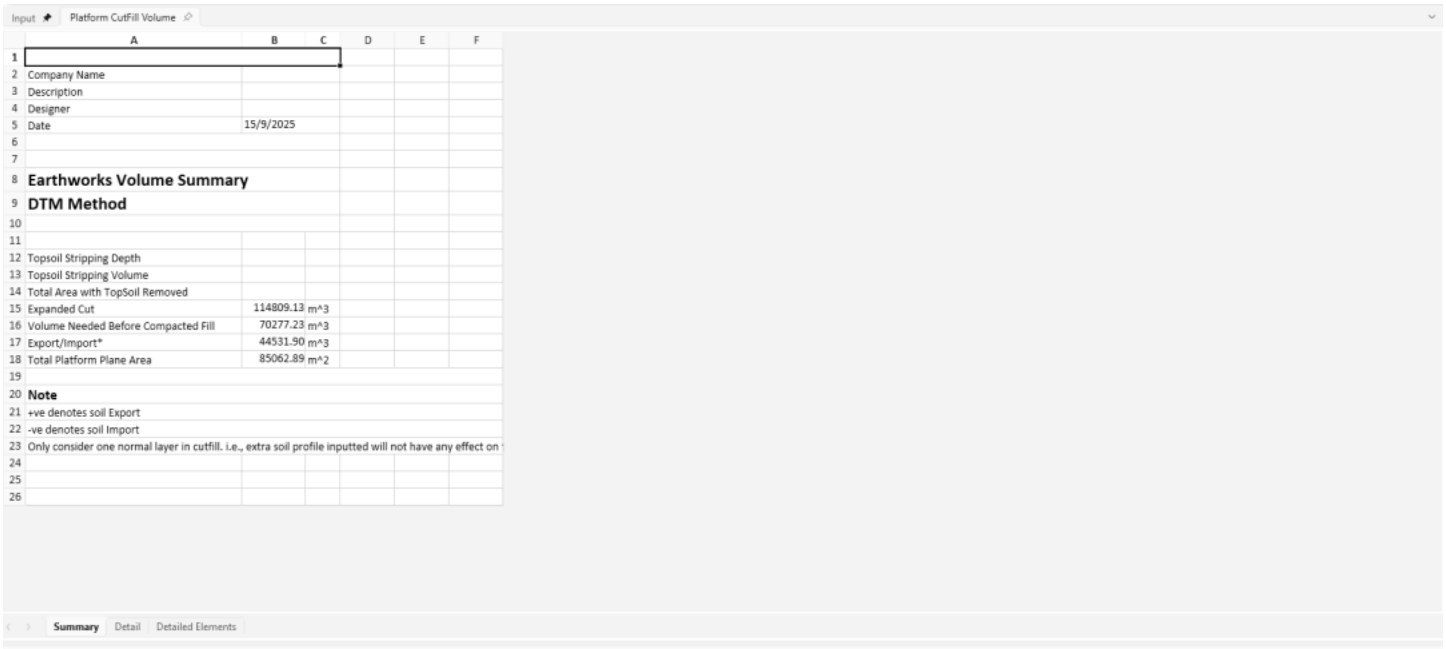


Overwriting to a small enough value, up to 1mm, will help in reducing the discrepancies in earthwork computation between MiTS and Civil 3D. This will also indirectly solve the verification errors obtained in your project file, though this may prolong the analysis process in your project file.

It is highly recommended for users to apply the ***platform AutoFix feature*** implemented in MiTS 3, which internally fixes the platforms with snap-rounding issues without overwriting the pixel size value. This not only resolves the error, but also allows users to proceed with the analysis without compromising the time.

You may refer **here** to understand more on the snap rounding and how it affects the volume computation.





Future Enhancement:

The synchronization from C3D to MiTS is still assuming CAD sync (from PolyMesh, the CAD object to MiTS platforms). Hence, there are limitations as detailed above.

With Breaklines and Boundaries, we can carry out the synchronization at the civil object levels. This means that we will be able to preserve the information better when the data goes from C3D to MiTS (eg, the slope information will be preserved for the platform undergoing two-way sync because it’s possible to maintain a one-to-one relationship between a breakline and a platform).

However, this is still a work in progress and is not implemented currently.

Conclusion

This article explains the concept of platform synchronization between MiTS and Civil 3D – via MCIntegrator– and demonstrates the accuracy of the transformation as well as the limitations

Related



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I’m the Benevolent Dictator for Life for MiTS Software cum Editor of this website. Read more here.

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