



IN (ACCURATE) DATA WE TRUST.

How to leverage construction
data analytics with confidence.

ACCURACY MATTERS

Many construction companies use drones to collect aerial images and data of their construction sites – and for good reason! Drone surveying and data collection are faster, cheaper, and safer than traditional methods.

Yet despite photogrammetry's rapid adoption in the construction industry, doubts linger. Questions regarding how accurate digital models are and the trustworthiness of the calculations and measurements derived from them are inevitable and of utmost importance.

Digital surveys, maps, terrain models, and construction data that lack accuracy are not only useless; they are potentially dangerous.

This e-book addresses common accuracy issues and describes how the DatuBIM Construction Data Analytics platform overcomes them, so you and your team can confidently base decisions on analytics and insights derived from 3D site models.

Read On!

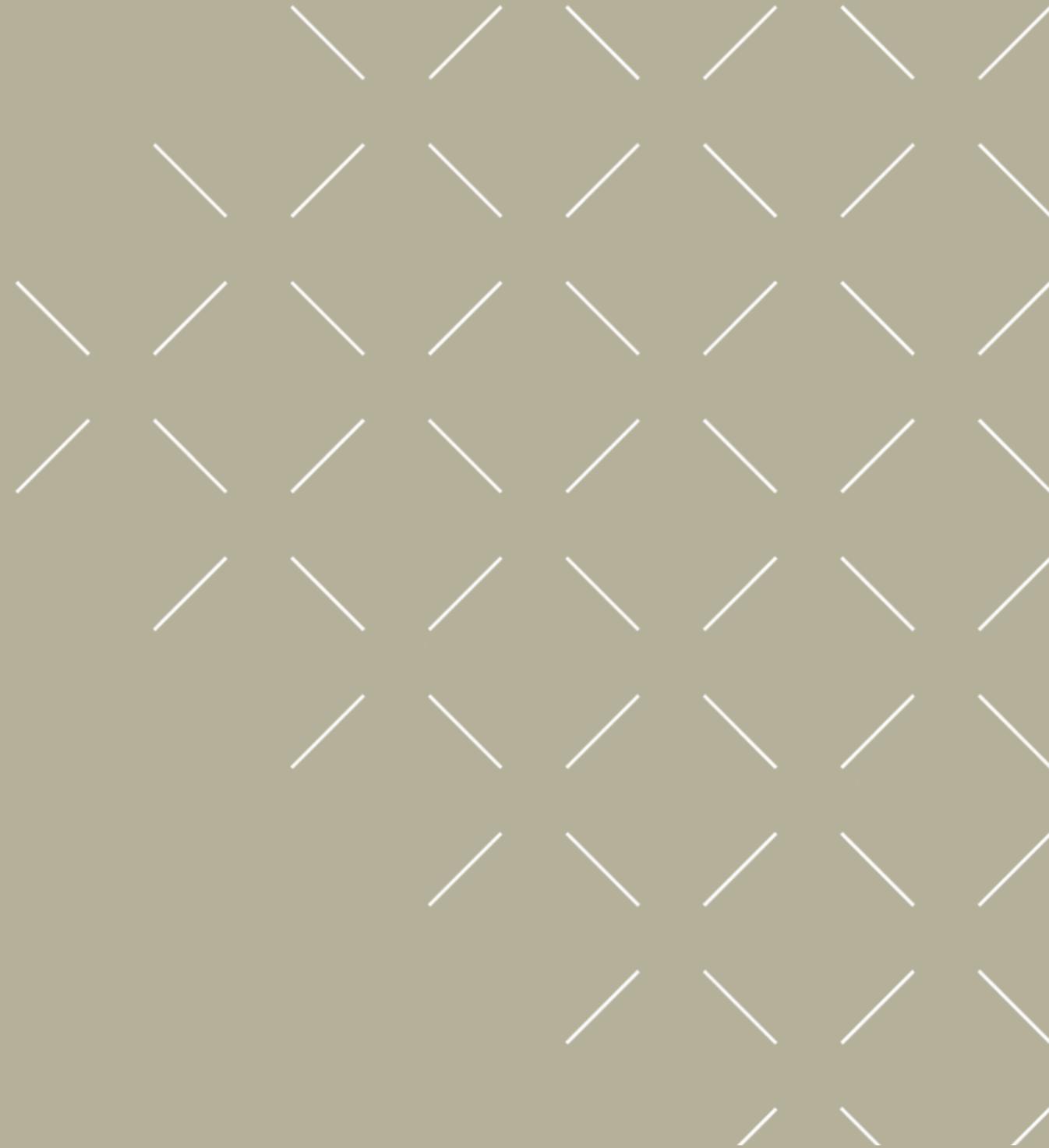


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01

DIGITAL CONSTRUCTION NEEDS RELIABLE INSIGHTS AND OUTPUTS

The ability of digital transformation and data-driven insights to address stalled productivity in the construction industry is evident: Digital technologies can improve planning and scheduling, accelerate decisions and project delivery, improve team efficiency, and reduce costs.

Whether part of a comprehensive digital strategy or to address specific pain points, new layers of information must never be added merely as "data for data's sake."

Construction companies require that actionable insights be derived from data and need software solutions that are innovative without disrupting complex business processes.

Now that digital solutions like Building Information Modeling (BIM) have been widely adopted in the planning phase, project owners, construction management firms, and construction companies are ready to bring digital to the construction and operational phases as well.

Benefits like positive ROI, delay prevention, and safety improvements make the addition of digital solutions attractive.

But before you can rely on new technologies and embrace a data-driven culture, you first must be confident that your new data layer is accurate.

02

MOVING FROM REALITY CAPTURE TO DIGITAL CONSTRUCTION DATA ANALYTICS

For some companies, drones are simply tools to shoot videos of construction sites for marketing purposes or quick status updates to owners. But they can – and should be – used for much more.

Drone-based imagery and photogrammetry provide visibility into constantly reshaped environments and ever-changing construction sites.

These technologies are the starting point for as-built 3D models of construction sites that can serve as a data pool for engineering reports, calculations, progress tracking, and quality assurance.

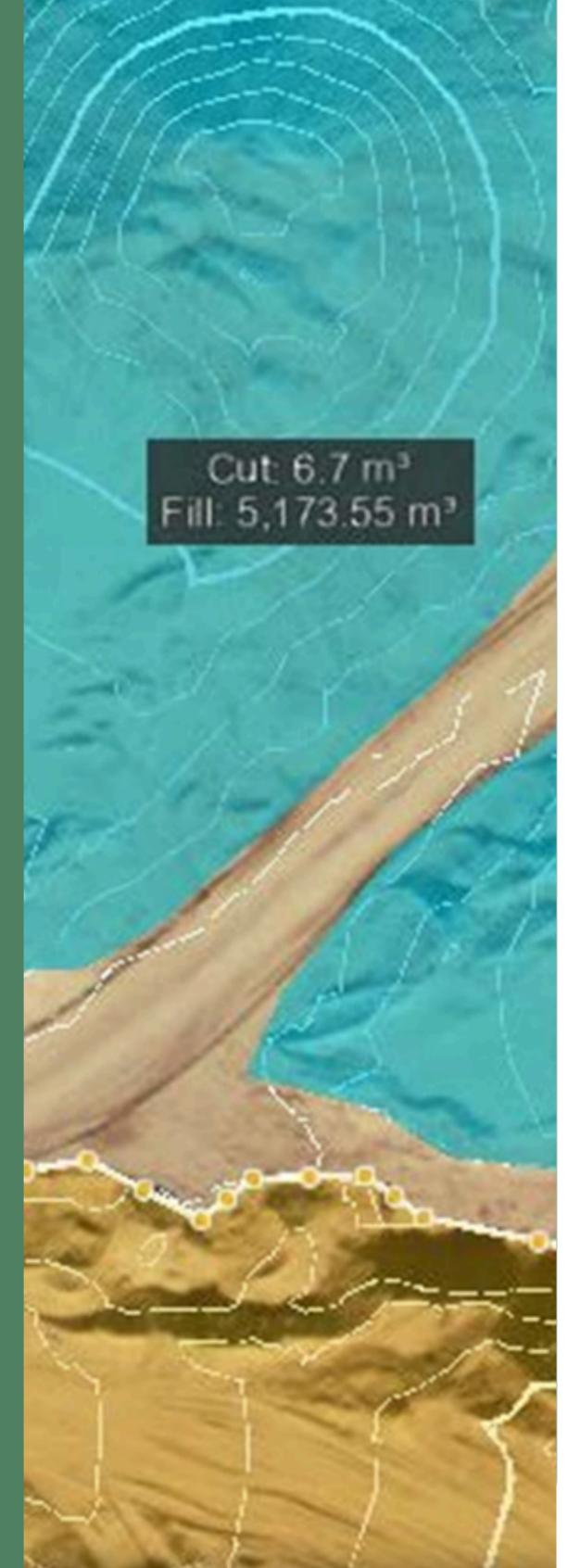
Digital construction data analysis

provides a system for monitoring construction progress and optimizing project management from preliminary planning to delivery. Leveraging 3D models, it delivers thought-out and practical digital analysis of the most diverse construction and management processes.

Multidimensional analyses provide

valuable insights and engineering outputs for optimizing, controlling, and documenting project delivery.

Assessing conditions on the site and **supporting remote monitoring** digital construction data analytics helps owners, designers, planners, schedulers, general contractors, and operators to become more efficient.



03

THE THREE PILLARS OF ACCURACY

Different geo-referencing methods may be applied to 3D model generation depending on your specific accuracy needs: GPS data from drones, with or without RTK (real-time kinematic) positioning, might be sufficient in some cases. To reach survey-grade accuracy, ground control points (GCPs) are essential.

In general, the accuracy of 3D site models depends on three crucial factors: the quality of the ground control points (GCPs), the integrity and quality of the image dataset, and the photogrammetric engine.

1. Quality of Ground Control Points

A GCP is any point on the ground with known coordinates and whose mark can be unequivocally identified in drone images. GCPs measured and marked by professional surveyors using precision tools are required to generate an accurate digital model of your construction site.

The quality of GCPs is determined by:

- **Precision** – GCPs are measurements of positions by the surveyor, who has to ensure that no human or instrumental error impacts the results.
- **Density** – The GCP density is calculated from the number of GCPs used to build the 3D model DSM, divided by the area of interest.
- **The distribution of GCPs in three dimensions** – GCPs at different elevations enable greater 3D model accuracy.

2. Quality of the Image Dataset

In addition to drone pilots who are experienced in construction and earthmoving surveying and an advanced flight program software, the integrity and quality of the dataset depend on:

- Use of a professional, high-stability drone and a high-resolution camera with shutter options
- Ground resolution and inherent image quality
- Overlap between images
- Atmospheric conditions (position of the sun, haze, clouds, etc.)
- Site conditions: For example, dense foliage, snow, and water adversely affect the ability of any photogrammetric engine to create a good model.

3. The Photogrammetric Engine

Photogrammetry is, by now, a well-researched science and technology. With the mathematics well established, the differences between various vendors' engines are relatively small.

Today, the focus is on the ease with which datasets are preprocessed and post-processed for validation, image processing, GCP marking, and performance considerations.

04

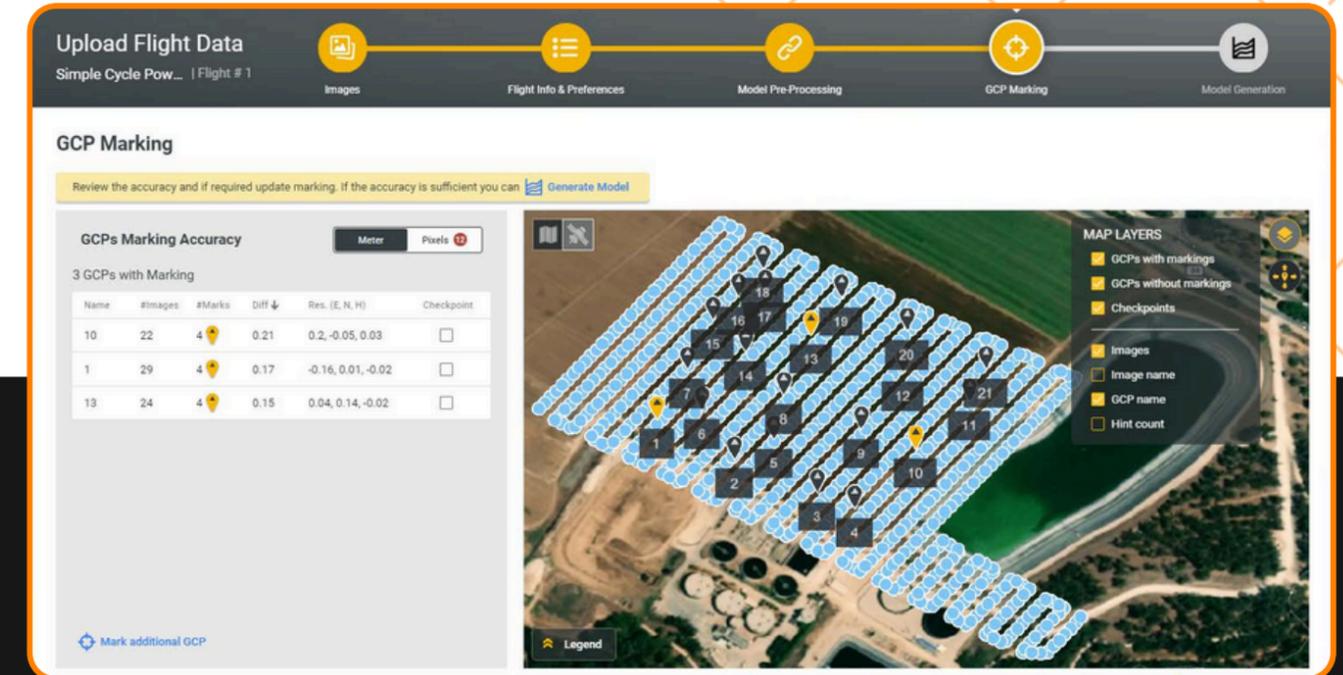
ACHIEVING SURVEY- GRADE ACCURACY WITH DATUBIM

Drone-based image acquisition and photogrammetry are in Datumate's DNA. This expertise translates into DatuBIM capabilities, automation, and unique features for supporting accurate model generation.

1. Quality of Ground Control Points

The DatuBIM platform provides an automated workflow for importing GCPs for easy model generation.

Once GCPs are imported, the system automatically identifies those GCPs and generates hints on the images to make marking them quick and effortless. Once each point is marked, DatuBIM instantly calculates its accuracy and presents it to the user to either approve or adjust the mark to be more accurate before initiating the model generation.



DATUBIM AUTOMATIC GEO-REFERENCING. SAVE TIME AND MONEY.

In addition to geo-referencing based on GCP import and RealTime Kinematic (RTK) drone data, DatuBIM also **performs automatic geo-referencing** of the 2nd model and onwards based on the 1st model.

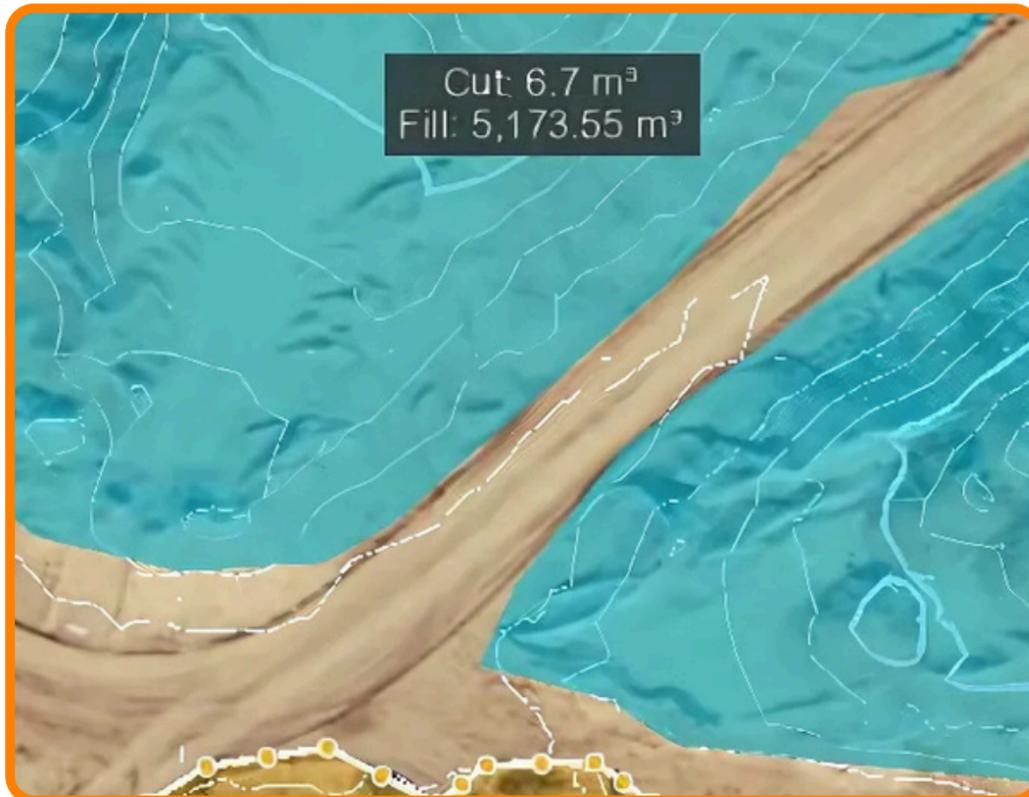
This **patented automated process** is unique and designed specifically for the construction industry, to enable continuous progress monitoring by comparing several models and plans.

DatuBIM automatic geo-referencing eliminates the need to repeatedly place and measure GCPs in the field and mark them on the model in the office. This exclusive feature **saves hundreds of working hours** throughout the project lifecycle.

04

ACHIEVING SURVEY- GRADE ACCURACY WITH DATUBIM

(CONTINUED)



2. Integrity and Quality of the Image Dataset

The DatuBIM platform includes **DatuFly Professional**, a mission planning and execution app for drones. DatuFly automates the data acquisition process to help ensure the quality of the image dataset. Using DatuFly, you can specify the accuracy required for a defined project area, and the app automatically generates and executes drone flight and image capture.

On uploading images to DatuBIM, the platform verifies the integrity of the dataset and issues alerts regarding integrity matters such as missing coverage, duplications, elevation problems, etc.

As a genuinely flexible platform, DatuBIM does not require the use of DatuFly. Customers may use any other drone flight app as long as best practices are observed.

3. Photogrammetric Engine and Resulting Accuracy

Datamate's photogrammetric engine implements a rich set of proprietary pre- and post-processing algorithms to deliver best-in-class maps and models. The engine supports a wide range of rotary and fixed-wing drones and is agnostic to the camera type.

DatuBIM translates pixels to either centimeters or inches. Given a quality image dataset*, the average offset between coordinates measured by the Total Station or RTK GPS and **coordinates calculated by DatuBIM is 1.5 cm (0.59 inch) in X/Y and 4 cm (1.5 inches) in Z coordinates.**

The statistical accuracy of newly generated points is at a **95% confidence level** calculated per the **2.0 σ standard deviation.**

* = Images taken from a distance that produces less than 2 cm per pixel (equivalent to 50m or 16ft elevation with a 20 mpx camera).

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DATUBIM ACCURACY. A SMART ORCHESTRATED PROCESS.

In the field, Datumate supports you with best practices and DatuFly automated flight planning. In the office, DatuBIM offers an intuitive interface, automation features that prevent human error, and quick 3D-model turnaround. Accuracy is easily achieved, and automated reports make tolerances transparent.



1. GROUND CONTROL POINTS

A professional surveyor measures accurate and sufficient GCPs according to best practices.



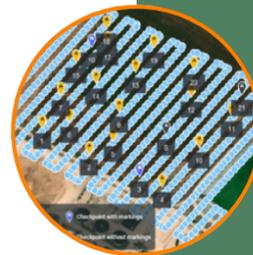
2. DATA ACQUISITION

A pilot flies a suitable drone, may use DatuFly, and collects imagery based on best practices.



3. GCP MARKING IN DATUBIM

After image upload, the Model Generation Wizard makes marking GCPs easy, incl. automated hints on GCP density and quality.



4. CHECKPOINTS IN DATUBIM

Mark checkpoints in DatuBIM's wizard so you can evaluate the accuracy of the 3D model.

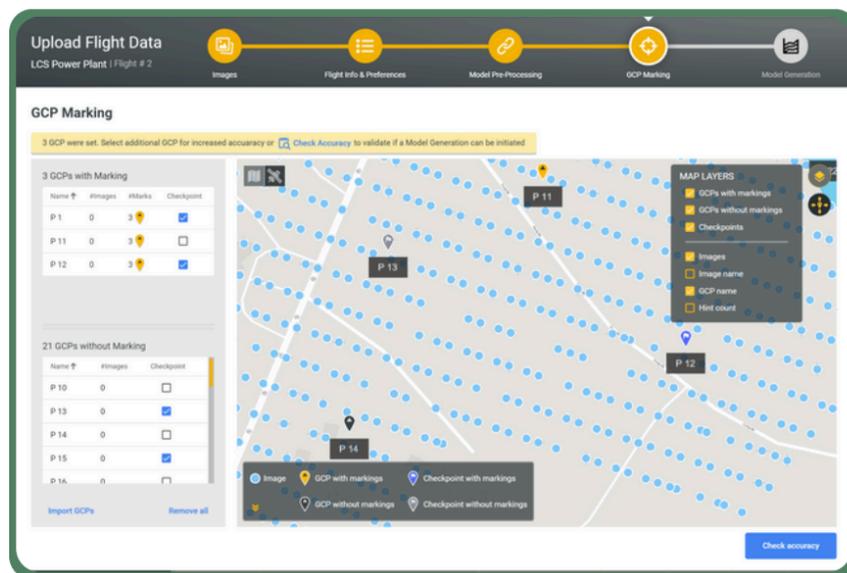


5. MODEL GENERATION AND ACCURACY REPORTS

Run the model generation and receive a detailed accuracy report for GCPs and checkpoints.

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DATUBIM: ACCURACY CHECKS AND TRANSPARENCY ARE BUILT-IN



Why guess or accept average accuracy values provided by software vendors? Don't base your success on general statements. When it comes to your construction site, trust only project-specific accuracy.

With DatuBIM, you can effectively and quickly determine your model's accuracy with an **automated accuracy report**. For every new model created in DatuBIM, you'll know exact accuracy values and residuals.

The importance of GCPs for generating models was covered above. GCPs not used to generate models can serve as **valuable checkpoints** to ensure that your model is as accurate as you need it to be.

TIP:

DON'T MISTAKE GCPS FOR CHECKPOINTS

The most common mistake in checking the accuracy of a 3D Model is using GCPs as checkpoints. A checkpoint must be a **measured point that has not been used** for the model generation. Otherwise, the accuracy check is simply a self-fulfilling prophecy.

DatuBIM safeguards against this error: Once a measured point has been marked as a GCP in the Model Generation wizard, it cannot be chosen as a checkpoint and vice versa.

In addition, DatuBIM provides a dedicated accuracy report on your checkpoints.

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DATUBIM IN ACTION: ACCURACY REALIZED IN POWER PLANT CONSTRUCTION PROJECT

Here is an example of model accuracy realized in the construction project of DatuBIM customer [Energy Services](#), a comprehensive engineering and construction firm in Connecticut, USA, specializing in gas and steam turbine power generation.

Energy Services runs projects worldwide and is also the general contractor for the Zomet Energy Power Plant in Israel. During high demand, this peaking power plant will supply 396 MW generated by gas turbines.

Why Energy Services Choose DatuBIM



The COVID-19 crisis challenged all construction firms that operate globally. With strict travel restrictions keeping its project manager grounded, Energy Services sought to control the project's progress remotely. DatuBIM Construction Data Analytics answered all their demands

With DatuBIM, Energy Services can now:

- View and track project status from US headquarters
- Monitor and validate accuracy of on-site work
- Compare work done to design plans
- Deliver construction data and insights to project managers, execution engineers, and supervisors at the local management company
- Enrich meetings with the developer by presenting the project phase, progress visualizations, and analytics in the DatuBIM platform

Project Details

Duration: 30 months

Location: Israel, South

Area: 100,000 m²

Flight Frequency: 16 flights in the first year, with two flights in the first couple of months.

Drone Services: Datumate flew the first couple of times. Energy Services subsequently purchased drones and is training its team.

Accuracy Realized with DatuBIM: under 3 cm

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ZOMET ENERGY POWER PLANT'S ACCURACY REPORT

The accuracy report run after the first 3D model generation of the Zomet Energy Plant project showed an accuracy of under 3 cm.

The report starts by depicting the GCPs that were used and listing their coordinates.

GROUND CONTROL POINTS

Name	E [m]	N [m]	Elv. [m]	Marked / Detected
1	175455.79	615208.329	95.581	May-30
2	175542.27	615155.947	96.688	Apr-24
4	175676.32	615091.563	96.176	Apr-25
5	175586.31	615182.282	96.713	Apr-26
6	175506.1	615220.452	96.021	Apr-25
7	175490.18	615273.07	96.355	Apr-25
8	175597.65	615239.625	96.831	Apr-23
10	175745.08	615168.759	96.629	Apr-22
11	175805.66	615230.518	96.647	Apr-27
12	175731.21	615268.917	96.276	Apr-25
13	175628.46	615317.657	96.883	Apr-24
14	175555.41	615295.988	96.511	Apr-25
15	175519	615337.43	96.353	Apr-22
17	175577.49	615372.481	96.632	Apr-25
18	175575.23	615404.575	96.556	Apr-25
19	175662.7	615366.418	97.406	Apr-26

GCP ACCURACY

The GCP Accuracy table compares measured GCPs to calculated model points and calculates the residuals. While you can check each point, the report summarizes the overall accuracy by three values: Mean, σ – Sigma (Standard Deviation), and RMSE (Root Mean Squared Error).

GCP Name	Measured (1) [m]			Photo Model Calcs (2) [m]			Residuals (1) - (2) [m]			
	Name	East	North	Elevation	East	North	Elevation	DE	DN	DElv.
1	175455.79	615208.329	95.581	175455.792	615208.33	95.58	0.002	0.004	0.001	
2	175542.27	615155.947	96.688	175542.262	615155.94	96.713	0.012	0.005	-0.025	
4	175676.32	615091.563	96.176	175676.304	615091.56	96.155	0.012	0	0.021	
5	175586.31	615182.282	96.713	175586.304	615182.29	96.729	0.002	-0.004	-0.016	
6	175506.1	615220.452	96.021	175506.097	615220.45	96.041	-0.002	0.001	-0.020	
7	175490.18	615273.07	96.355	175490.172	615273.06	96.386	0.008	0.009	-0.031	
8	175597.65	615239.625	96.831	175597.642	615239.63	96.851	0.005	0	-0.020	
10	175745.08	615168.759	96.629	175745.081	615168.76	96.628	0.002	-0.004	0.001	
11	175805.66	615230.518	96.647	175805.667	615230.52	96.669	-0.008	-0.005	-0.022	
12	175731.21	615268.917	96.276	175731.211	615268.92	96.294	-0.006	-0.001	-0.018	
13	175628.46	615317.657	96.883	175628.467	615317.65	96.913	-0.012	0.008	-0.042	
14	175555.41	615295.988	96.511	175555.41	615295.98	96.524	-0.003	0.009	-0.013	
15	175519	615337.43	96.353	175519	615337.42	96.381	-0.004	0.013	-0.028	
17	175577.49	615372.481	96.632	175577.498	615372.48	96.622	-0.004	0.003	0.010	
18	175575.23	615404.575	96.556	175575.229	615404.57	96.554	0.001	0.005	0.002	
19	175662.7	615366.418	97.406	175662.713	615366.43	97.459	-0.017	-0.008	-0.053	
							Mean	0.006	0.005	0.02
							σ Sigma	0.005	0.004	0.014
							RMSE	0.009	0.007	0.028

Finally, the report provides checkpoint accuracy results.

CHECKPOINTS ACCURACY

Checkpoint Name	Measured (1) [m]			Photo Model Calcs (2) [m]			Residuals (1) - (2) [m]		
	Name	East	North	Elevation	East	North	Elevation	DE	DN
3	175634.7	615112.422	95.76	175634.699	615112.42	95.747	0.004	0.006	0.001
16	175547.67	615367.947	96.416	175547.684	615367.93	96.403	-0.016	0.016	-0.025
						Mean	0.01	0.011	0.013
						σ Sigma	0.006	0.005	0
						RMSE	0.013	0.013	0.013

Green: $R < 0.050$ [m]

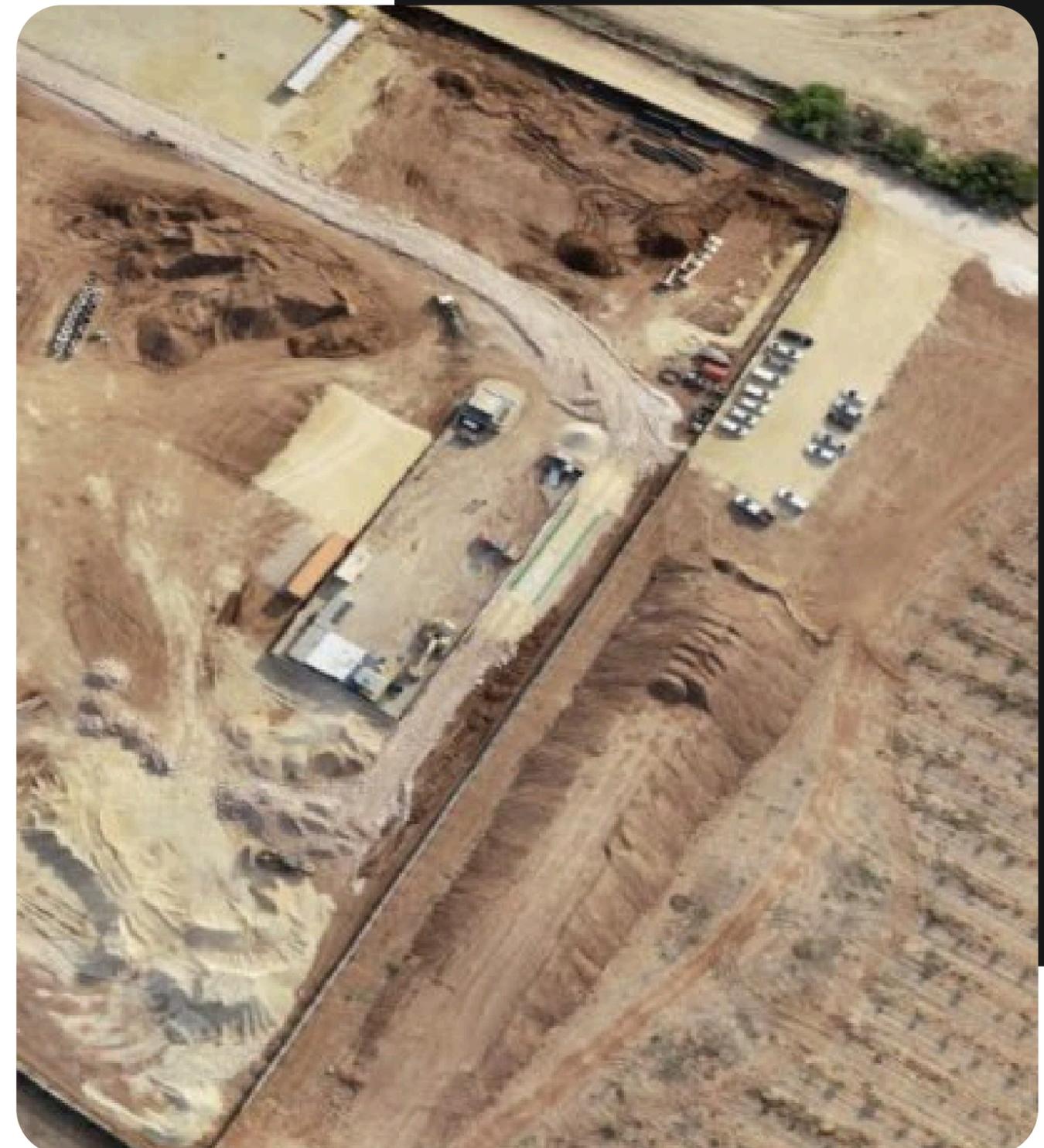
Yellow: $0.050 \leq R < 0.100$ [m]

Red: $0.100 \leq R$ [m]

All values are rounded to three decimal places

Legend

- **Photo Model Calc** - The calculated coordinates according to the model
- **Residuals** - The difference between the measured coordinates provided by the user, and the 'Photo Model Calc' coordinates
- **Mean** - The average of the absolute values of the Residuals
- **σ** (Standard Deviation) - Standard deviation of the errors (square root of $\Sigma(\text{Residual} - \text{MeanOfResiduals})^2 / N$)
- **RMSE** - Root Mean Squared Error (square root of $\Sigma(\text{Residual}^2) / N$)



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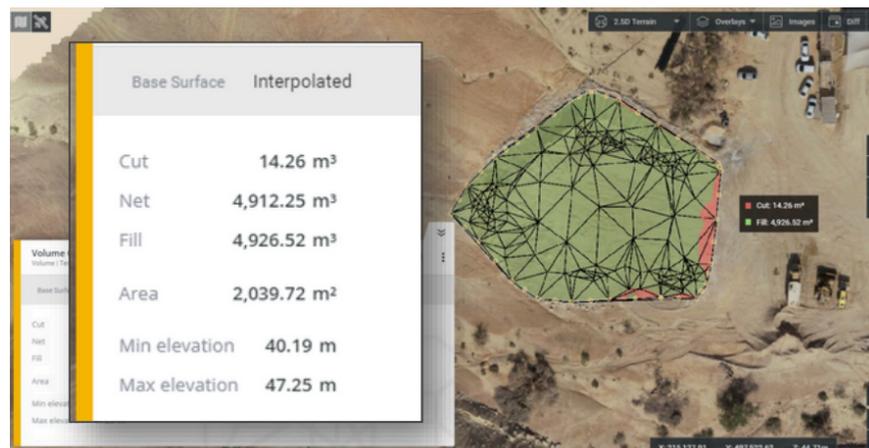
ACCURACY COUNTERCHECK. SENDING OUT THE SURVEYOR.

As already emphasized, the generation of an accurate 3D model depends on using GCPs. In this sense, the model generation starts with the surveyor. For ultimate proof of the accuracy that DatuBIM delivers, we present here a countercheck by a surveyor.

For this check, we took measurements on a 3D Model generated by DatuBIM and had the same area, distance, and elevation rechecked by the surveyor.

1 . Volume and Area Countercheck

	DatuBIM	Surveyor	Difference
Volume	4926.52	4925.26	0.02% (1.26m ³)
Area	2039.72	2036.68	0.15% (3.04 m ²)



MODEL EDITS & TERRAIN FILTERING FOR HIGHEST PRECISION WITH DATUBIM

DatuBIM allows you to edit a Digital Terrain Model (DTM) for even higher precision and flexibility. With **Model Edits**, you can filter out noise, surfaces, objects like site equipment, and other elements for even more **accurate measurements and analytics**.

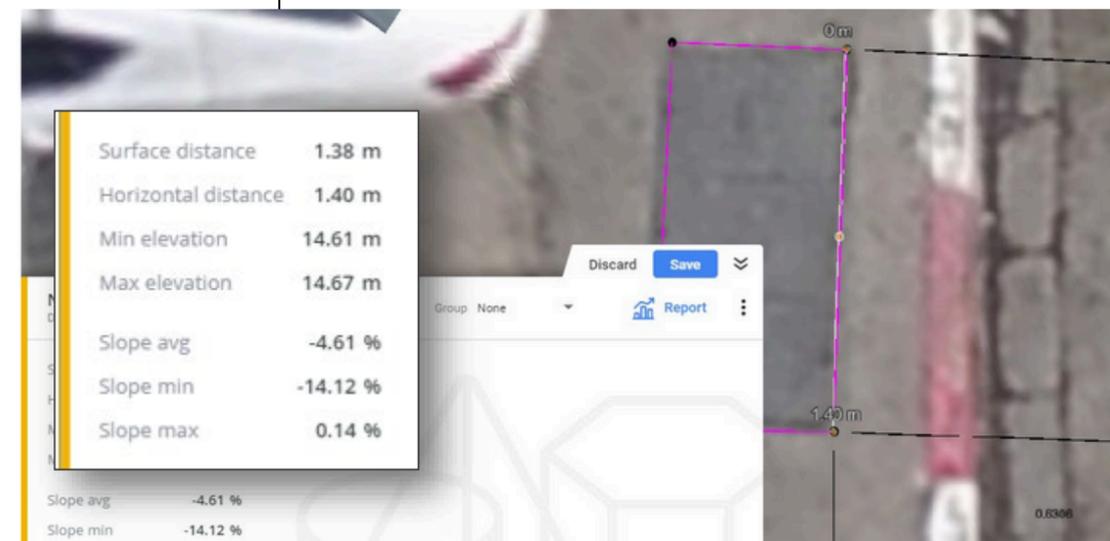
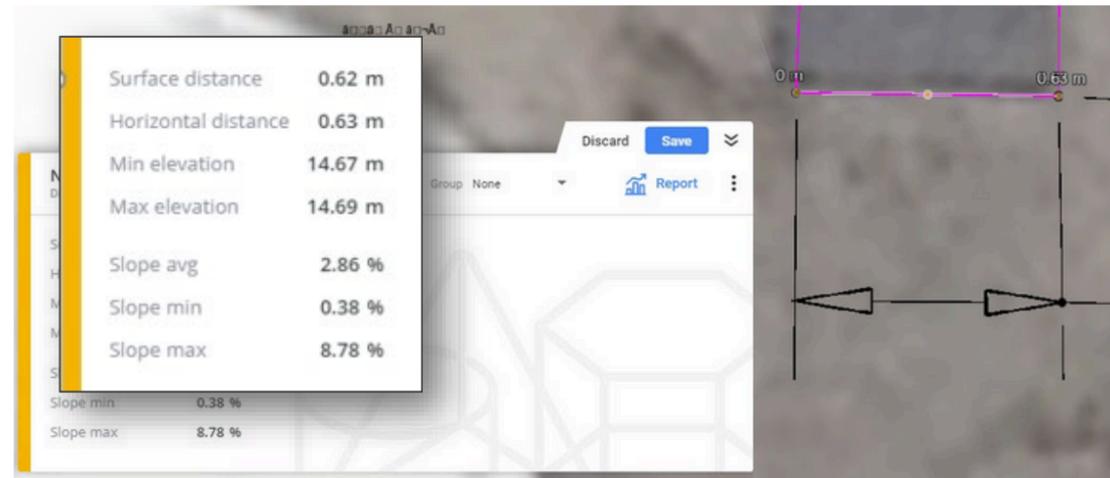
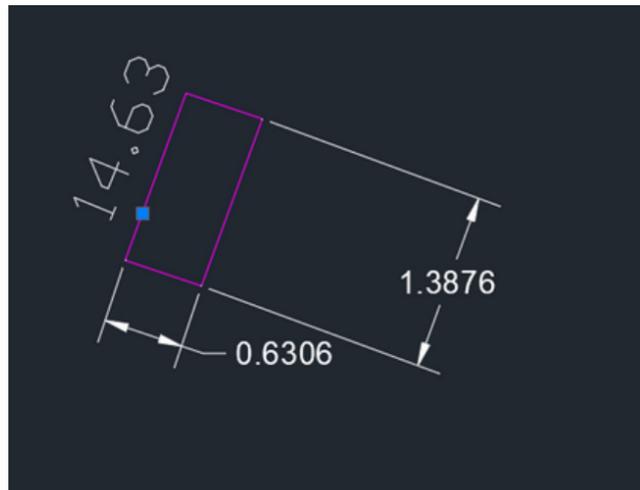
Clean up any area that might have been affected by photogrammetry issues or weather conditions, such as wind or rain-filled areas.

A bill of quantities or a new schedule needs to go out between two flights? Remove already invoiced earthwork to calculate the latest work and bill correctly or remove past movements to precisely calculate and plan forward.

Stay efficient with Model Edits and **apply edits with one mouse click to previous and future models**.

2. Distance Countercheck

	DatuBIM	Surveyor	Difference
Distance 1	0.63	0.63	0%
Distance 2	1.40	1.3876	0.88% (1.3 cm)



DATUBIM FROM A PROJECT MANAGER'S VIEWPOINT

"Without any tedious surveying work in the field, DatuBIM delivers us quantity reports and measurement analytics. These detailed, quickly generated reports enable me as the project manager to monitor the entire construction site in a comprehensive way.

It gives me the ability to zoom in to the smallest details on the ground. Comparing work executed to plans assists me in spotting deviations and errors before they occur.

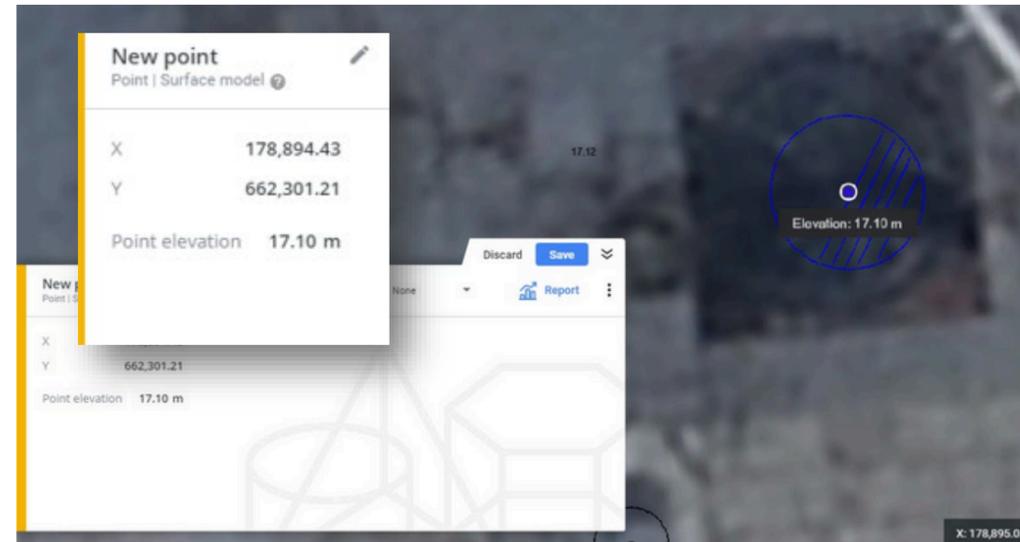
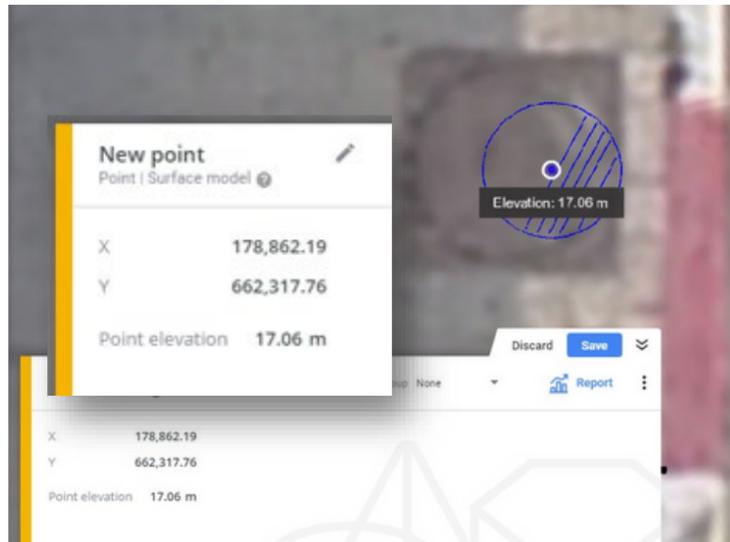
By serving a wide range of essential data, DatuBIM allows me to effectively monitor the progress of the construction project in order to meet deadlines and to stay on budget."

**YANIV SHARABI,
PROJECT MANAGER,
MEKOROT**

[READ THE CASE STUDY](#)

3. . Elevation Countercheck

	DatuBIM	Surveyor	Difference
Point 1	17.06	17.09	0.0017% (3 cm)
Point 2	17.10	17.12	0.0012% (2 cm)



DatuBIM changed the way our business works. We can now deliver maps, groundzero surveys, and engineering reports much faster than we could before. What took us weeks in the past is now a matter of days.

I know I can trust DatuBIM models to be at survey-grade accuracy, sometimes even better! We also found DatuBIM superior to other solutions we tested. It is faster, more precise, and easier to use.

We work a lot for general constructors of infrastructure projects. With accuracy reports documenting the models' quality, we can quickly sign off the calculations, measurements, and engineering reports for our customers.

DatuBIM has made our work as surveyors safer, and improved the pace at which our customers can make informed decisions based on our reports.

**EMAD HAKIM,
LICENSED SURVEYOR,
GEOPOINT**

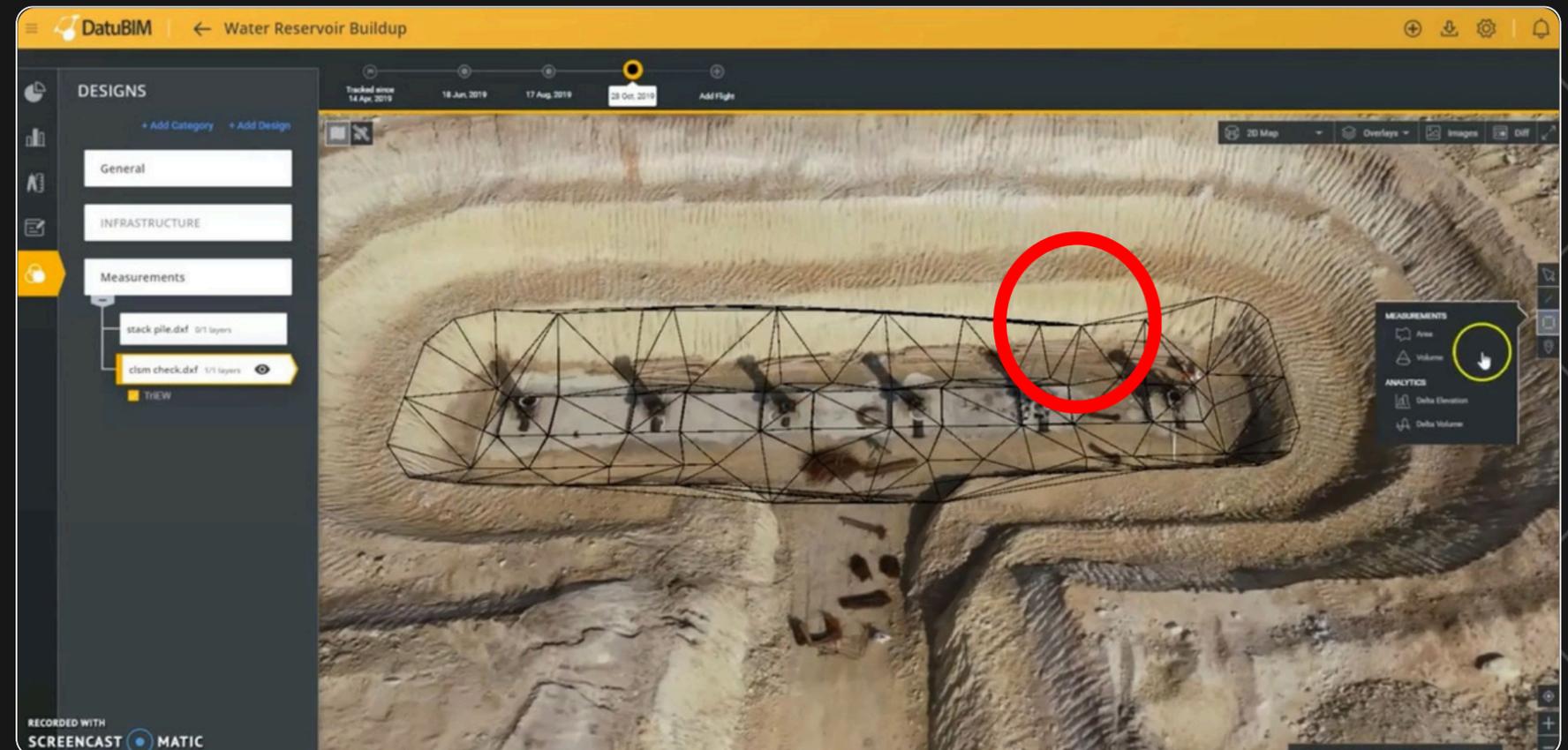
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SUPERVISING SURVEYORS WITH DATUBIM

Throughout many project phases of infrastructure construction, surveyors are needed, but double-checking their deliverables can be sensitive. Unless you deploy a quality control surveyor, you must trust what surveyors deliver and rely on your own experience to detect any errors. And while to err is human, it is also often costly. Consider, for example, mistakes in earthwork bills.

Our customers know that they can trust the DatuBIM models. They are in the position to supervise and double-check deliveries of surveyors with the DatuBIM platform.

Surveyors generally present their measurements in a report based on a model generated within a CAD environment. This means that the measurements are shown in a cleansed environment, where everything looks just right. But did you get the insights you needed?



DatuBIM gives you a fast, convenient way to supervise the execution of survey requests. Upload the surveyor's measurement layer and anchor it to the orthophoto model in DatuBIM. Now you can visualize and determine precisely what the surveyor measured and if the surveyor calculated measurements correctly.

Here's an example of how DatuBIM helped the construction manager of one of our customers discover a surveyor's error. One single point taken incorrectly at one side of a pit caused the entire calculation to be wrong.

Watch this [short video](#) to see how easy it was to discover this mistake using DatuBIM.

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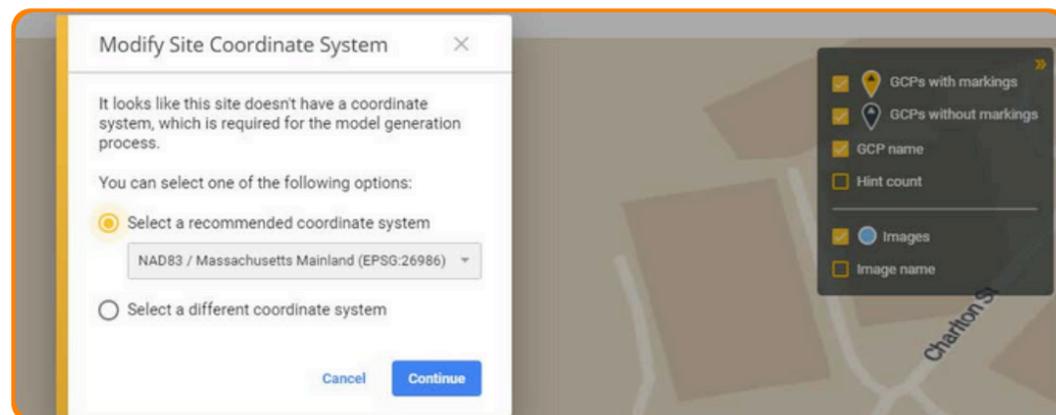
SURVEY-GRADE ACCURACY. IN SEARCH OF A DEFINITION.

Despite the importance of accuracy, there is no one universally accepted definition of survey-grade accuracy. In December 2015, the Wisconsin County Surveyor's Association (WCSA) formulated a by now prevalent definition for survey-grade coordinates:

"Coordinates collected under the direction of a Professional Land Surveyor, in a coordinate system allowed by 236.18(2), and obtained by means, methods, and equipment capable of **repeatable 2 centimeter or better precision.**"

As WCSA mentions, it depends on the surveying project to define the needed accuracy, which can vary from survey-grade, to sub-meter and approximate.

For infrastructure construction projects, a centimeter-level accuracy below 3 cm allows for best-in-class calculations and measurements.



Relative and absolute accuracies are yet another crucial factor concerning 3D models of construction sites and work environments. Relative accuracy is the measurement of two points relative to each other on 3D model counts. Depending on your application of the data, this accuracy might be sufficient.

But when it comes to construction sites, you need the model to be referenced to the actual location. This is absolute accuracy which is measured against a global coordinate system.

With **various coordinate systems in use by different countries, regions, or organizations**, confusion can be high, and mistakes can occur. Choosing the wrong coordinate system or map projection can "move" your construction site to a wrong physical location.

To help you choose the most suitable coordinate system, **DatuBIM automatically calculates the geo-location of the images based on X, Y, and Z data**, and recommends you the most relevant coordinate system in this region. You can **accept this recommendation or select a different coordinate system** you are sure to use for your job

LOCAL COORDINATE SYSTEMS. THE DATUBIM WAY

For projects that use a local coordinate system (LCS), DatuBIM provides automated, generic, and independent support.

DatuBIM's LCS feature is entirely self-sufficient. It ends customer dependency on any Global Navigation Satellite System (GNSS) or expensive hardware.

When a site is identified as using LCS, DatuBIM's patent-pending technology automatically places the ground control points on the flights' image set and aligns them with the images.

Once GCPs have been marked, DatuBIM detects the local coordinate transformation automatically with a proprietary algorithm and applies it to each survey flight that is processed.

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TAKEAWAYS

Checking accuracy doesn't have to be hard

Maybe you're currently considering drones and construction technology for remote site management and progress tracking. Or you are seeking team buy-in and want to give your colleagues confidence in a digital solution you are about to introduce.

Make sure to choose a solution that not only delivers the accuracy you need but also lets you easily check its accuracy for each of your projects and datasets.

Takealook beyond accuracy

While we dedicated this e-book to the accuracy of 3D models, this is not where all data considerations end.

Besides the accuracy, you should also take **data relevancy** into account. The most accurate data that doesn't bring you valuable insight is only a nice-to-have or, at worst, a distraction.

The data in the system needs to work for you, your teams, and your processes.

Speed matters

As construction projects evolve and change over time, the **data at hand needs to be up-to-date.**

Of course, flight intervals have the largest impact. Nevertheless, check carefully that your vendor enables a **fast turnaround** from drone imagery to 3D model and engineering reports.

Innovation is a process, not a software program

Your 3D models' accuracy is crucial but depends on getting suitable ground control points and drone imagery. These activities occur before any software solution comes into play.

If your company is new to drone-based data collection, make sure you choose a vendor who helps you get familiar with the process. There will still be a learning curve, but it will be faster and easier to navigate with an experienced account manager at your side.

Pay attention to a solution's automation features. Automation will reduce potential sources of error by your team. Finally, check what managed services your vendor offers to support you during your on-boarding time.

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BENEFIT FROM NEW TECHNOLOGIES IN CONSTRUCTION WITH DATUBIM

DatuBIM improves project management and accelerates infrastructure construction project delivery through continuously updated, drone-based 3D models of construction sites and changing environments.

Automated model generation and insightful analytics increase transparency, accountability, and efficiency of all teams involved.

DatuBIM fosters faster, more data-driven, and more collaborative decision-making. It enables tracking of project progress and optimized project management.

Delivered as a cloud-based platform, DatuBIM gives teams remote access to insights when and where they are needed, reduces the time on the site, and keeps workers safe.

Key Benefits

- Visualization and remote monitoring of project progress
- Comparisons against design or previous as-builts 3D modules
- Automated engineering reports and insights
- State-of-the-art turnaround of models; available within 24 hours
- Survey-grade accuracy, documented by detailed accuracy reports
- Automatic geo-referencing for time and cost savings
- Automated and independent local coordinate system support
- Supervise teams, assure quality, and control bills
- Monitor earthwork, improve scheduling, detect deviations fast
- Professional account managers; optional managed services

About Datumate

We here at Datumate focus on serving construction companies, general contractors, developers, and project management companies with a clear focus on large, complex infrastructure construction, especially in Highway & Roads, Railways, and Utilities.

We are committed to the digital transformation of infrastructure construction projects, and our core competencies are rooted in a dedicated team of construction and high-tech professionals.

We work with companies that want to empower their teams to make data-driven decisions with confidence. That's why we develop technology that turns data into insights.

To learn more about us visit www.datumate.com or call us at USA Toll-Free: +1-240-326-7787