A PHOTOGRAMMETRIC SURVEY OF A DRILLING PLATFORM

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Abstract

Terrestrial photogrammetry for engineering survey has been used for many years. The analytical approach has given new possibilities.

This paper gives a description of an adaption of a bundle adjustment programme to suit a very free choice of camera stations. In this case the method is used to control the dimensions of a drilling platform under construction. A total of 16 photos was taken. Three from each of the four sides, and one diagonal from each corner. The block is adjusted, using only 2 control points in "xy" and 3 in "z".

The paper also tells about the thrilling experience of photographing from a crane in a light snow storm.

Introduction

Photogrammetrists mostly consider terrestrial photogrammetry just as a "special" case of aerial photogrammetry, and so do we. Still, it is very often more difficult and thrilling to find an optimal solution, because of the wider ranges, especially when applying analytical methods. It is very popular at universities, and most people cannot explain, why it finds relatively little use in practice. In our opinion it must be due to too little knowledge of the method. Therefore this practical experience.

Problem

Control survey or "as built" survey is getting more common on large construction works, because of the large sums of money involved.
In this case a private photogrammetric firm, LLO, Copenhagen, was asked to make such a survey on the "underwater" part of a drilling platform as it stood at the construction site in Aalborg. As we were near, at the Photogrammetric Laboratory of the University of Aalborg (AUC), we joined the mission with instruments and system solution. Also a student could participate, making his own project on the job.

The task was to coordinate the nodal points of the large steel construction as a check of the straightness of the legs and of the dimensions in general.

The accuracy specification for the check was not very clear. As good as possible, or maybe better than 1 cm !?

Mission

The platform has the shape of a cone with a base of 20 by 25 meters and 50 meters high. The construction site was near the quay of a little harbour from which the platform should be towed to the North Sea on a barge.

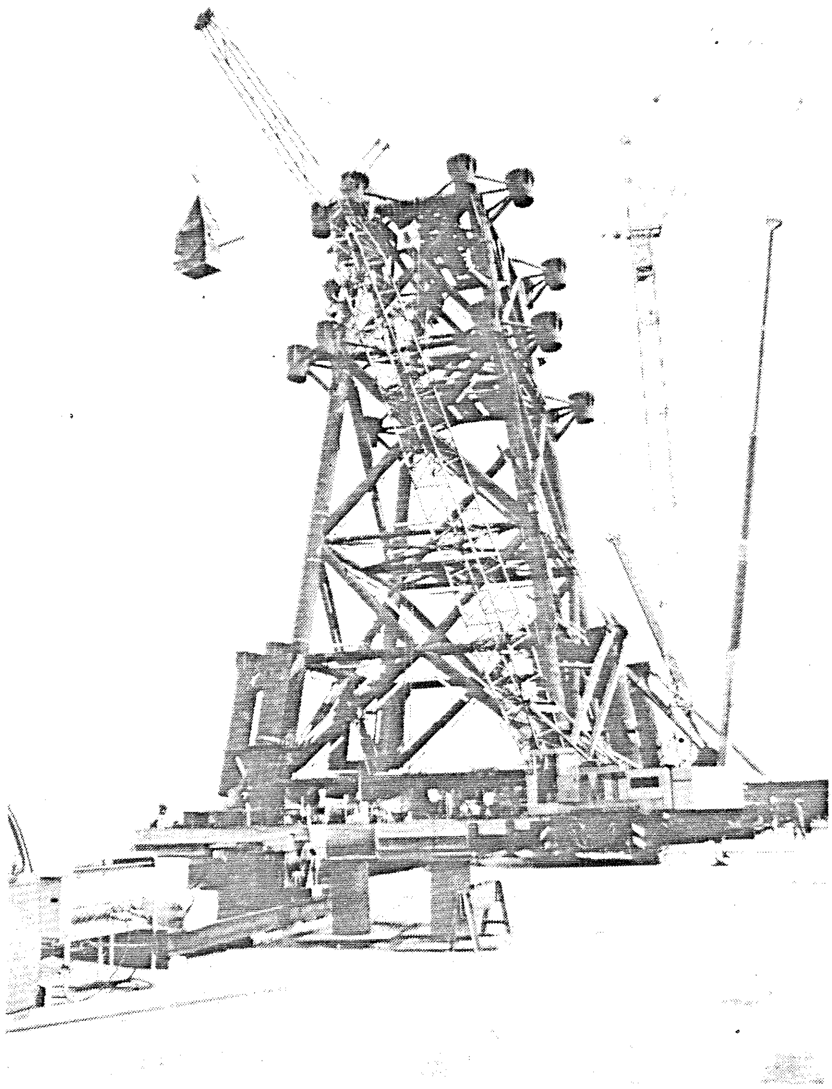
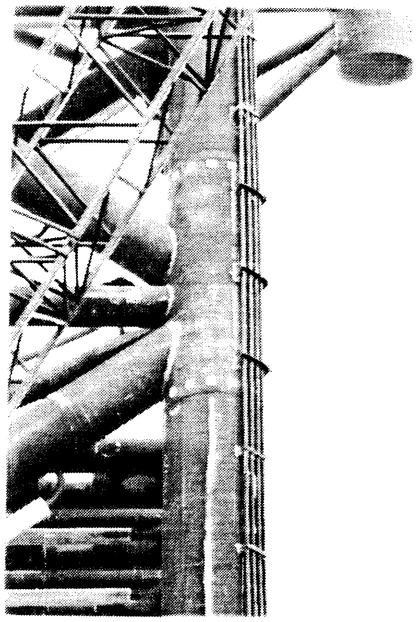


Photo: Palle Juul Jensen

It would have been very difficult to create and maintain stations for ordinary landsurvey, e.g. by intersection, at the busy site. Luckily we did not choose that solution, because - what we did not know in advance - the platform had moved during the mission. At the beginning it stood about 75 m from the quay. Later it was direct on the quay, and at last it was on a barge and had turned 100 gon.
We had decided to use photogrammetry. As only few photos had been taken before the first move, we had to hope that the constructor's word that the platform was stable in itself, was true.

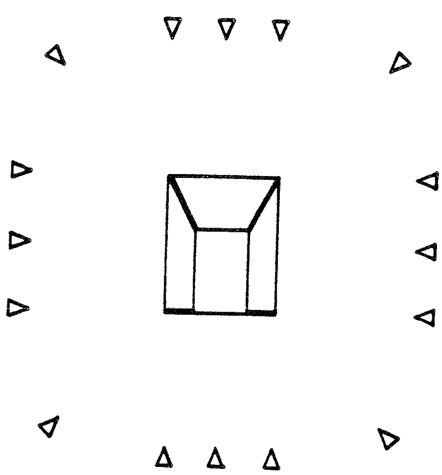


Targets

To define the lines, we were interested in, we had to target some points. To define the center lines of the legs we put up to 10 targets round the leg at a welding seam over and under each nodal point. As a vertical plane one of the sides was taken as a reference; the girders of the cutting planes were targeted only on the facade, using a right angle and a level.

It showed later that this did not succeed entirely, and it would probably have been better to define the axis as for the legs.
Instead of using single targets it would have been easier to use bands of targets on adhesive tape all round the leg.
Also extra marking to help identification and numbering would have been helpful.
A generous number of points was targeted to be able to select points later and to make sure of good connection.

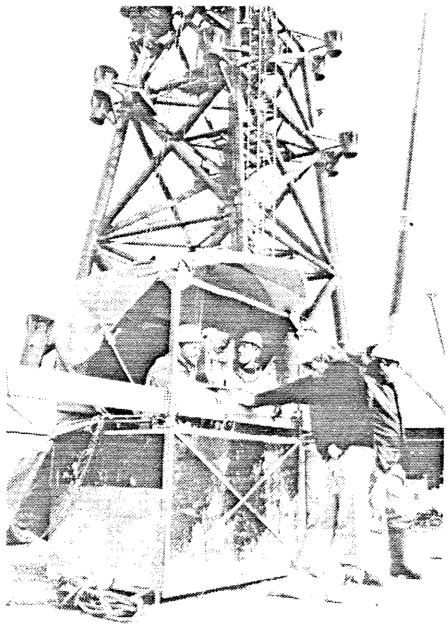
We wanted to use "aerial" triangulation to determine the points wished, and as the check was relative, no control points were measured. During the computation only two points and a plane were kept constant.



Camera stations

The Zeiss Jena UMK 10/13x18 camera was used. To be able to make a strong connection between the camera stations we decided to take in all 16 photos around the platform. Another reason for the many photos was that changing parts of the construction were always covered, as welding was still going on. By taking photos at different times we covered nearly all points wished.
The distance of 30-40 m was chosen to cover the whole platform in one photo, giving a scale of 1:300 to 1:400. For the same reason the camera was lifted to a height of 25 m above the ground (sometimes the water!).

The conditions for photography were difficult. Covered parts of the construction, different positions of the platform, snowy weather with little light and a strong wind.



The camera was placed in a box hanging from a crane. To prevent it from swinging in the wind we had to stabilize it with ropes from the ground. Still, we had a little image-movement in some of the photos.

Measurements and Computations

The measurements were made on the Zeiss Jena Stecometer comparator, used in mono. Some of the computations were done on-line, checking the inner and relative orientation during the measurements.
One of the problems was numbering of the targets, where a special procedure had to be developed. The on-line procedure gives a good check on numbering errors.
The "corner" photos were not oriented, as at that time our on-line programme could not manage the large rotation. For this reason the sides were not joined during this phase, and preliminary values of the coordinates for the triangulation had to be generated manually.

After measurements with $\sigma \approx 2$ µm the data were put into an analytical bundle adjustment system called ANA.
In the ordinary ANA, when using the formulas for rotations about rotated axis, large rotations are only possible about the first and third axis, so we had to choose the axis system in an appropriate way to give possibilities for the rotations at the corners.

Results

σ_0 came out as 2.8 µm which can be considered very fine. Part of the normal equations was inverted, and the relative accuracy of points was found to be between 2 and 5 mm. We were satisfied !

From these coordinates the nodal points were computed. As there was good redundancy, we had a good check on the various lines and planes. The accuracy of the nodal points is expected to be in the order of 5 mm.
The final set of nodal points was transformed on the project coordinates, and the discrepancies were presented to the customer as a coordinate list, and in a graphical way.
The largest difference showed to be 37 mm. Quite impressive when you stand near to the imposing structure.
A few days after the last photo was taken, the platform was standing at the bottom of the North Sea. We wonder what would have happened, if the check had not been successful.

Conclusion

Even under extremely bad working conditions it is possible to obtain sufficiently good photography to solve a problem like this.

Although the construction firm was very helpful and understanding, it was not possible to find a period, where the platform was "ours". The money involved and the time limits were of such a character that the surveyor had to do his job without special attention.

As the situation developed, with the platform changing place, it seems difficult to propose other solutions than the one used.

References

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