

# **Registration of 3D Situations in Land Administration in the Netherlands**

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**Key words:** 3D Registration, Land Registers, Multi-level Property

## **SUMMARY**

The rights of cadastral objects may relate to spaces above or below the earth surface. The fact that several legal spaces of objects can be located above or below the same surface parcel may cause confusion in practice. In the Netherlands the location of 3D objects are in fact only represented in the well known 2D cadastral map. Complex 3D situations causes Land registries worldwide to find solutions for a kind of 3D registration. This article discusses the current situation and recent developments in the Netherlands. This includes the development of a clear guideline for the registration of 3D property within the land administration in the Netherlands.

## **SAMENVATTING**

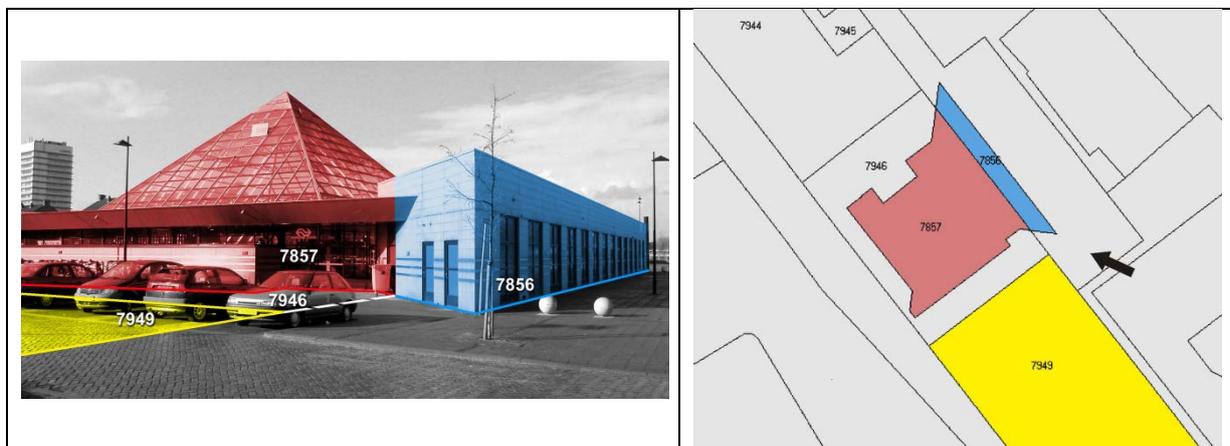
Rechten op vastgoed hebben betrekking op een ruimte boven of onder het grondoppervlak. Het enkele feit dat ruimten van meerdere rechtsobjecten zich boven op of onder een zelfde grondstuk bevinden kan in de praktijk tot onduidelijkheden leiden. Dat komt door de in Nederland gebruikelijke 2D weergave van grenzen op de kadastrale kaart, ook in gevallen waarin de situering van rechtsobjecten in feite alleen in 3D behoorlijk kan worden gepubliceerd. Dergelijke, hierna als 3D eigendomsverhoudingen aangeduide, gevallen hebben Kadasters over de hele wereld gedwongen oplossingen te vinden voor een soort van 3D registratie. In dit artikel wordt de stand van zaken en de laatste ontwikkelingen binnen Nederland beschreven. Dit omvat de ontwikkeling van een eenduidige richtlijn voor de inschrijving van 3D eigendomsverhoudingen.

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## 1. INTRODUCTION

Cadastral registration of multi-level properties increasingly receives attention because more and more situations occur for which common 2D registration appears to be problematic. This is also true in the Netherlands. Although it is possible to establish property rights with 3D boundaries, the main registration entity is – as in many countries - a 2D parcel. Multi-level property situations are therefore projected on the plane and 2D parcels are created based on those projections, as illustrated by Figure 1 (taken from Stoter, 2004). Although the registration as is currently practised represents the situation correctly from a formal perspective, the consequence might be that the registration may not provide sufficient insight. In some cases knowledge of the factual situation is even necessary to understand the registration instead of vice versa. Apart from lack of transparency, another drawback of a 2D approach for multi-level property registration is that real world objects are divided over several parcels, which introduces a risk for maintaining the cadastral registers.



**Figure 1. Station building on top of a railway tunnel. Projection of multi-level property on a plane results in fragmented 2D parcels on the locations of those projections. The blue part of the station building is constructed besides the tunnel, and therefore a separate parcel has been formed**

Several studies on national and international 3D cadastral developments have been carried out in The Netherlands (Stoter and Van Oosterom, 2005; Stoter and Salzman, 2003; Stoter and Ploeger, 2003). Until now these studies have focused on analysing the legal, technical and cadastral frameworks for 3D Cadastre and they proposed several (theoretical) alternatives for proper cadastral registration of multi-level property. This paper builds on these earlier studies and focuses on the actual implementation of a 3D registration of multi-level property in the Dutch land administration. This 3D registration is currently under study by the Dutch Kadaster. The motivation to make research results ready for use in practice at this moment, is

that on the one hand technically it has become possible to register digital documents in the land registers and that on the other hand recently several notaries and project developers have asked for support by the Netherlands' Kadaster because they faced problems in registering multi-level property. Therefore the need for a 3D cadastre has become feasible and urgent at the same time. The case studies presented in this paper are also new, in the sense that they focus on the problems met in practice to register multi-level properties that can be solved with an alternative 3D registration that still fit within the current legal, technical and cadastral frameworks. This alternative 3D registration is presented in this paper.

This paper is organised as follows. It starts from analysing the background in section 2 and 3. Section 2 summarises the existing legal and cadastral frameworks for multi-level property in the Netherlands and Section 3 analyses the bottlenecks of current registration practice through four case studies. Section 4 describes the 3D registration solution that is currently under study. The paper ends with conclusions and future work in Section 5.

## **2. LEGAL AND CADASTRAL FRAMEWORKS FOR MULTI-LEVEL PROPERTY IN THE NETHERLANDS**

This section summarises the legal and cadastral frameworks for multi-level property in the Netherlands. This is the starting point for the proposed solution for 3D registration. The legal framework prescribes how property can be divided into the vertical dimensions (subsection 2.1). The cadastral framework regulates how such situations can be maintained in an information system and portrayed for the public (subsections 2.2 and 2.3).

### **2.1 Establishment of multi-level property**

According to the principle *superficies solo cedit*, ownership of land includes the ownership of buildings and constructions on and in land. In addition ownership of land includes the rights on the subsurface and the air space above the surface. According to Dutch law it is not possible to divide ownership of land as such, e.g. by creating ownership of 3D volumes or sale of a building without land.

However multilevel property rights can still be created by the establishment of apartment rights (condominium rights) and the limited rights in rem: superficies, long lease and easement.

The most common way to divide the use of building complexes over multiple owners is to split the complex into *apartment rights (condominium rights)*. An apartment right gives each apartment owner an exclusive right to use his apartment. The entire complex (land and building(s)) is in joint ownership. Furthermore, each apartment owner is compulsory member of the Homeowners Association (*Vereniging van Eigenaren*). In practice this membership appears to be an obstacle for selling individual units as well as for their funding. In addition the legal concept of joint ownership is not always accepted by foreign investors. Especially German financiers are limited by their articles of association in the freedom to invest in common ownership. Alternatives for establishing multi-level ownership are right of superficies, a right of lease (leasehold) or an easement.

A *right of superficies (opstal)* is a right to have buildings, works or plants above, on or below another property. The right therefore divides the property of physical objects or constructions from the surface property.

With a *right of long lease (erfpacht)* one does not become the legal owner of the real estate, but one gets a right to use it. However, the lessee has a position that is substantially equal to the position of an owner. Although in most cases the use applies to the entire property (land with buildings), it may also be limited in space. An example is the lease of the space above a metro tunnel (or other way round the lease for the metro tunnel itself).

An *easement* is a burden on the serving parcel in favour of a (usually neighbouring) parcel of another owner (the ruling parcel). Common examples include the right of way, the right to extend a building over the serving parcel or the right to have a pipeline in the serving parcel. But it is also possible that the burden guarantees a free view or prohibits the construction of new buildings. An easement may therefore be used to safeguard the free wind streams for a wind turbine or an unhindered “line-of-sight” for radio-links. In contrast to a right of superficies, the right of easement is thus not necessarily related to physical constructions. Instead a volume of air space can also be controlled by an easement, if the right is defined in terms of “tolerate” or “do not”.

Besides the above rights, the registration of cable- and pipeline-networks (registration compulsory since 2007) results in a separation of property in the vertical dimension. This is described in detail in Ploeger and Stoter (2004) and Döner et al (2010).

The choice whether to use apartment rights, right of superficies, right of long lease or an easement to establish multi-level property is up to the involved parties, who will often follow the advice of their legal advisers, such as a notary.

## **2.2 Land administration in the Netherlands in a nutshell**

The Dutch system of land administration is based on the deeds registration as introduced in the beginning of the 19<sup>th</sup> century. One organization, The Netherlands Cadastre and Land Registry Agency maintains both the land registers (register of deeds) and the cadastre (cadastral registration and cadastral map). Security of title is provided by the close cooperation between the latin notariat and the land registrar. Transfer of rights in land requires the registration of a notarial deed. Both the right and the object of the right (in general a piece of land) must be identified in the deed.

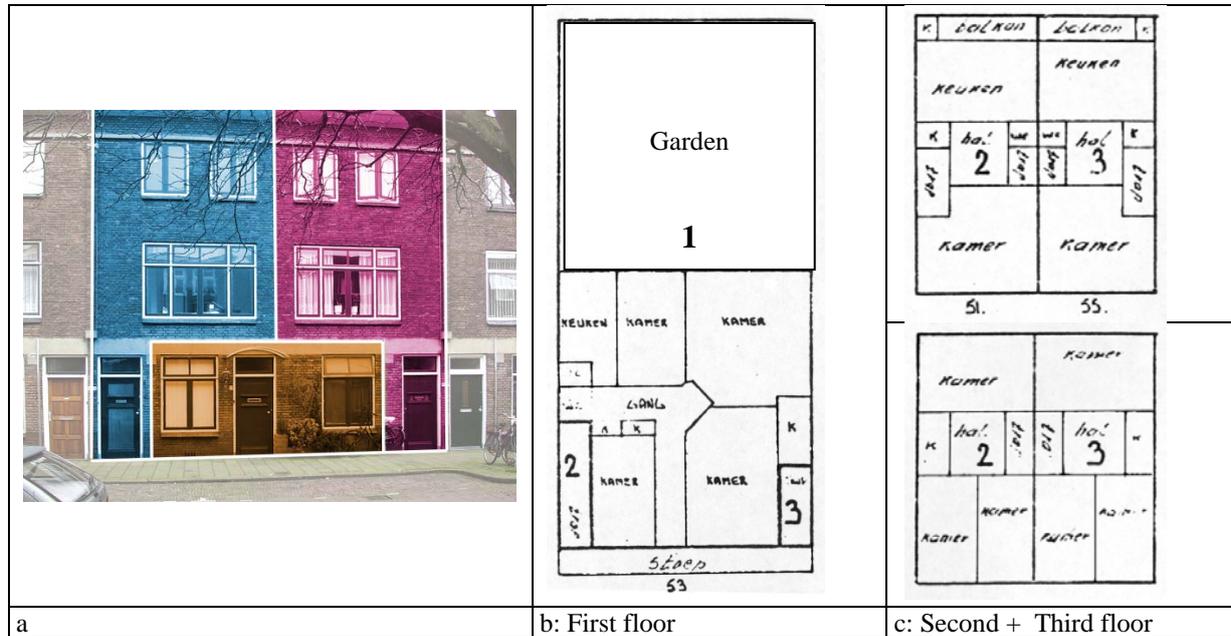
## **2.3 Publication of 3D property relationships in the land administration**

The publication of the legal status of property in the land administration, serves the land market. Therefore clear insight into multi-level property relationships is a necessity. Although it should be noted that for several reasons it is not possible to achieve 100% unambiguity. An important reason is the possibility that rights on real estate can be obtained without registration, for example, by adverse possession, marriage or succession. A second, in respect of our research more important, reason for not being able to meet 100% unambiguity, is that in the Netherlands the boundaries of rights as described in a notarial deed, e.g. by reference to physical markers, prevail above cadastral boundaries.

We now describe for the several rights as described in section 2.1, how the 3D boundaries can be described when the property is registered.

There are basically only requirements for indicating the 3D boundaries for apartment rights in the deed that establishes the right. The law requires the registration of a separate plan per floor

in the land registers. These floor plans provide a general overview of the land and building(s), and shows the boundaries of the individual apartment units. However, this is not always a clear reflection of the multi-level property situation. In the case of a large building complex it may require a mental exercise to reconstruct the complete ownership situation on the basis of a large number of (large) floor plans, see Figure 2.



**Figure 2. Floor plans (b) and (c) added to a deed of division of a rather simple building complex, as shown in (a)**

This is especially true if the apartment units are situated at different levels and for units with disconnected parts (for example a unit on the second floor with a storage in the cellar or a maisonette). The cadastral map itself shows only the ground parcels of the apartment complex and the footprint of the building. Currently the Dutch Kadaster is working on an improved access to the floorplans in the land registers. It is expected that in 2013 it will be possible to access the scanned apartment drawings directly from the cadastral registration. Despite the increased accessibility, this still requires to mentally integrate individual drawings to understand the entire ownership (as intended in the 3D reality).

In the case of the description of the spatial dimensions of a right of superficies, the right of long lease or an easement right, Dutch law does not provide requirements, except the general principle that the property should be “identifiable”. In practice both sketches or more detailed drawings can be registered in the land registers. For the more detailed drawings, the land registrar accepts 3D representations for a better reflection of the legal situation (either with cross sections or as 3D PDF), but (s)he cannot demand this. In fact the description in the deed may be fairly vague. A reference to a “demarcated area at location” is sufficient, which is of course dangerous because there can be changes in the real world at this location. In case the deed provides no description of the boundaries at all, the land registrar will refuse the registration of the deed. Within this wide frame of possibilities (between 3D representation and vague indication) the description is left to the parties (read: the notary who draws up the deed). Although it is also in own interest of these parties to be clear and unambiguous.

Because reliable and observable reference points are often missing, in practice the intentions of the involved parties are only verbally described in the deed. Consequently a 3D representation added to the deed often acts as a sketch with no legal meaning with respect to the exact locations of the boundary. In theory, the deed can include a representation of (surveyed) boundaries which are considered legally binding if the parties declare that the boundaries exactly reflect their intentions. In practice this rarely happens, although it is obvious that it would be helpful for both the submitting and the receiving parties if some voluntary best-practice based guidelines would exist; e.g. to clarify the situation in the form of 3D representation. This is an important disadvantage of current practice, since graphical representation may be very helpful to communicate the intentions of the parties rather than verbal descriptions, as will be shown in the next section.

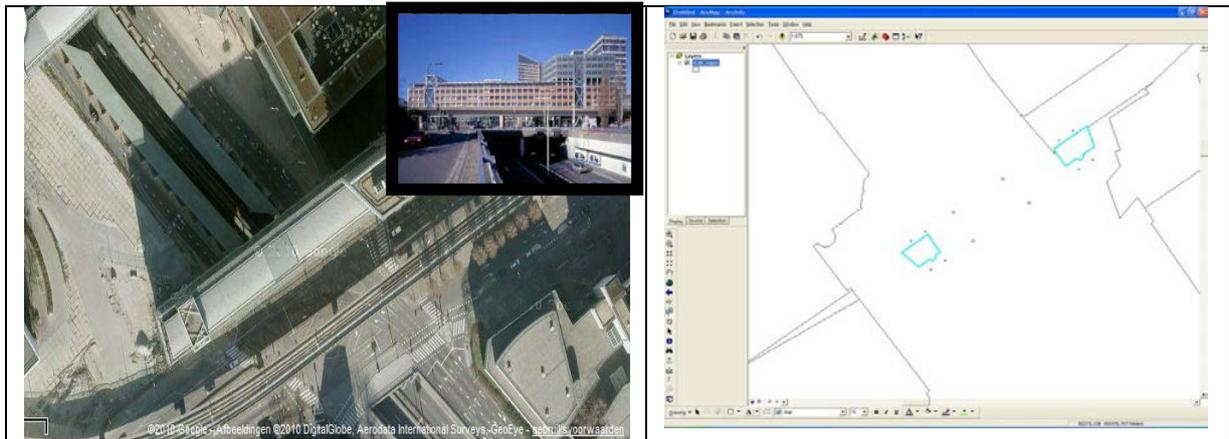
### 3. CASE STUDIES

This section shows how the existing legal and cadastral frameworks as described in the previous section are currently applied in practice to see how current registration practice for multi-level property can be improved within the same frameworks. We evaluate four cases: two cases with a building above a road (i.e. bridge-buildings); one above surface building-complex that is registered through its foundation piles and a building-complex with many parcels generated because of objects above and below the surface. As will be seen in the analysis of this section (Section 3.2), the registration of multi-level properties in the case studies is problematic regarding both maintenance and portrayal to the public, which requires a different way of registration, which will be the topic of Section 4.

#### 3.1 Case studies of 3D registrations in practice

##### *Case 1: Bridge-building over a high way*

The first case is the bridge building in The Hague over the A12 highway (Figure 3).



**Figure 3. Case 1: Bridge-building over a highway. Left: photo, Right: cadastral map**

A study of the public and cadastral registers shows that the building owner has a perpetual right of long lease on the footprints of the building. This building owner is also owner of the part of the building that was built over the A12 via a right of superficies. In the deed that establishes this right, the space of the right has been specified by indicating per floor the

location where the right applies to (in 2D), see Figure 4. Specific for this case is that those floor plans added to the deed do not match the cadastral map at that location (compare Figure 3, right and Figure 4): the area of the right of superficies overlaps the parcels in the map on which a right of long lease has been established. Apparently, the two processes (one for registration in the land registers and one for surveying the cadastral parcels) operated independently. In this situation, the deed will prevail above the cadastral map which was updated at a later moment.

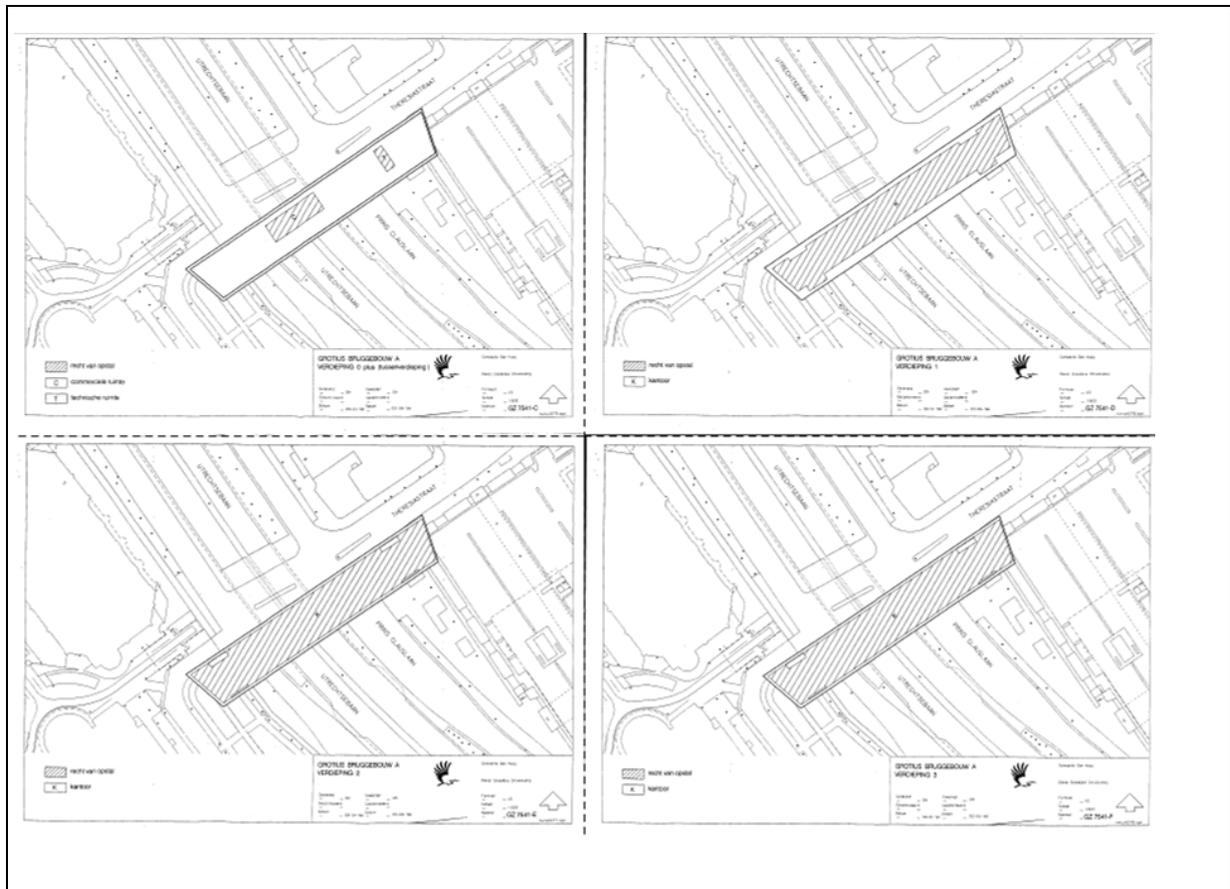


Figure 4. Selection of drawings added to a deed that establishes a right of superficies for a building over the highway

### Case 2: Bridge-building *Nationale Nederlanden*

The second case is the arch-shape *Nationale Nederlanden* building, also built over the A12 in The Hague (see Figure 5) and Stoter (2004).

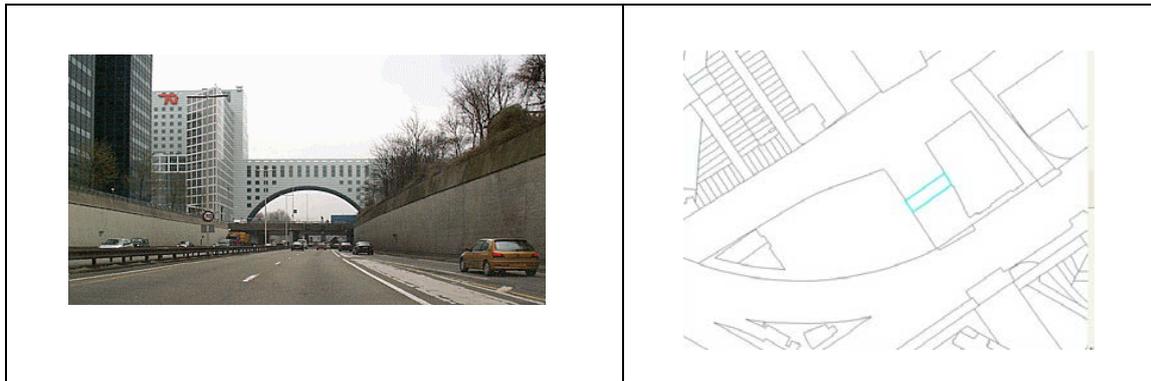


Figure 5. Case 2: Bridge-building over road. Left: Photo; Right: cadastral map

Again, the ownership of the arch-shape part of the building built over the A12 was established with a right of superficies. Interestingly, the notary specified the dimensions of the right (“legal space”) by adding a (verbal) description of the arch in the deed, with height values in the national height reference system (Figure 6). In this case the arch-shape made it impossible to make a description by means of drawings per floor as happened in the first case.

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- welk recht van opstal zich uitstrekt vanaf een -
- boog boven de Opstalgrond en daarboven, welke --
- boog: -----
- (i) ter plekke van de ongeveer noordwestelij-
- ke grens van de Opstalgrond eenhonderd ---
- zesentwintig graden vierendertig minuten -
- negenendertig seconden (126°34'39'') is --
- en aanvangt op de hoek van de ongeveer ---
- noordwestelijke en ongeveer zuidwestelij-
- ke grenzen van de Opstalgrond - welke ----
- hoek met de letter "g" is aangegeven -----
- op de aan deze akte te hechten schets, ---
- welke schets hierna wordt aangeduid als: -
- le Opstaltekening - tienduizend vijf- ----
- onderd veertig millimeter boven Normaal -
- amsterdams Peil (10.540 + NAP) en ein- ---
- digt op de hoek van de ongeveer noordwes-
- telijke en ongeveer noordoostelijke gren-
- zen van de Opstalgrond - welke hoek met --
- de letter "h" is aangegeven op de -----
- Opstaltekening - drieduizend achthonderd -
- tweëntachtig millimeter boven Normaal ---
- Amsterdams Peil (3.882 + NAP); -----

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Figure 6. Description of the space to which the right of superficies applies. The text refers to a drawing showing the vertical boundaries of the right (“*opstaltekening*”) and furthermore give a description of the horizontal boundaries referring to national datum (Amsterdam Ordnance Datum, NAP)

The cadastral map (Figure 5, right) also shows a further division of parcels in 2D at the location of the arch to further specify the right of superficies on the map, which was not done in the first case.

### ***Case 3: Office tower and underground parking at the Amsterdam Zuid-as***

The third case of a multi-level property situation is the division of property between a building (an office tower) and the underground parking at the Amsterdam Zuid-as (Figure 7; right building). The foundation piles of the office tower are situated in the underground parking. For both constructions leaseholds have been established by the land owner, the municipality of Amsterdam. As land owner the municipality retains all rights on the public space on the roof of the parking that is not occupied by the office tower; as near the entrance of the building (shown in Figure 7).



**Figure 7. Photograph of the real situation of case 3 (building on the rights)**

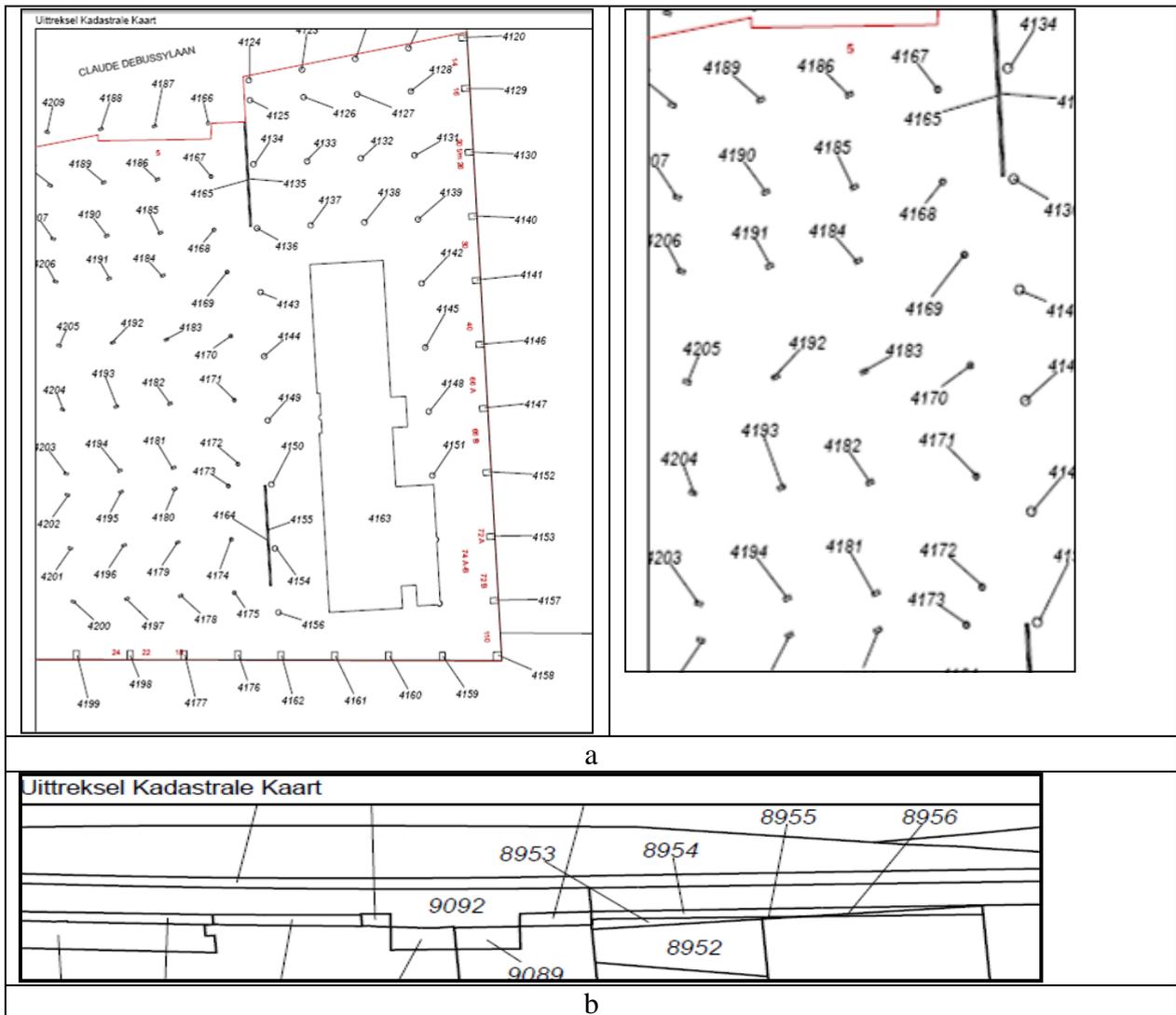
The lease right on the office tower on top of the parking is registered through its foundation piles resulting in about 80 mini-parcels in Figure 8a. This way of registration (i.e. dividing one real world object over many parcels) may have disadvantages for registration (see in the conclusion of the cases at the end of this section).

### ***Case 4: Building Complex in Amsterdam, North***

The cadastral map in Figure 8b shows the complexity of registering property rights of objects on top of each other in a 2D parcel map. In this case several rights of superficies have been established for physical objects such as such as dam walls, parking ramps and spaces for technical equipment. This resulted in the creation of several (very small) parcels because the 2D projections of the rights for the concerning objects overlap. This specific case led to many questions regarding aligning the created parcels to the rights that have been established for the different physical objects. Because more than one right is established on the concerning parcels, it is not easy for the user to found out who is owner of what object.

## **3.2 Analysis of the case studies**

Conclusion from these cases is that the registration and publication of rights on multi-level property is possible within the existing system of land registration in the Netherlands. However, the way it is currently done in practice may require a mental exercise to understand the situation based on information available in the land and cadastral registers. Sometimes reality is even needed to understand the registration instead of vice versa.



**Figure 8. Examples of the creation of very small parcels because spaces to which right applies are projected on the surface. In figure 8a (above) each parcel contains a foundation pile of the building that is on top of the underground parking garage. In figure 8b (below) the creation of small parcels is the result of (in 2D) overlapping property rights due to objects above and below the original parcel. In the system of the Dutch Casastre Act the establishment of a property right on a part of a parcel will result in the subdivision of this parcel. Also the very small parcels in the middle of figure 8a are the result of projecting objects on the surface to register them through surface parcels**

The non-transparent registration can be seen for example in the 2D “footprint” registration-method of 3D property situations. That method resulted in a cloud of very small parcels at the locations of the foundation piles in the case of the building on top of the underground parking (case 3). This method leads both to inefficient parcel creation which are hard to maintain and to non-transparent property registrations. The obscurity of those mini-parcels is even bigger in case of rights for two distinct objects above and below the parcel, such as a building-over-road combined with underground constructions (as also shown in case 4). It may well happen that in a deed referring to the mini-parcels a typing error is made or that in the future one of the parcels is forgotten in a deed transferring the single real world object. Another disadvantage of these mini-parcels is that after subdivision of the original larger parcel all the

rights, limitations and restrictions of the original parcel are copied to all the mini-parcels, while most likely those do not apply to all the mini-parcels. In most situations not the initial creation will cause problems, but the maintenance afterwards: updating the same legal fact attached to 80 mini-parcels after one real world change might be quite error prone.

An alternative to this "footprint" registration would be the registration of a 3D representation in the land registers that reflects the space to which the right applies. In that case the original 2D parcel can be kept in the cadastral registration with a so-called notification about a limitation on the parcel that links to the 3D representation in the land registers. Such a registration is possible within the current legal and cadastral frameworks; but not commonly known by the concerning persons in practice (notaries and other legal advisers). Unfortunately, under the current legal regulations the legal registrar cannot demand such a 3D representation.

#### **4. 3D REGISTRATION IN THE LAND REGISTERS**

To address the problems analysed in the previous section, this section presents a new method on how 3D situations can be better registered and portrayed. This method fits in the current legal and cadastral frameworks and is being formulated in a guideline that support notaries (responsible for the registration of property of real estate in the Netherlands) in deciding in which situations they should use this 3D registration approach and how they can do it (i.e. what information should they provide and how).

The solution is sought within the existing legal framework to avoid a lengthy process of changing the law as well as unnecessary resistance. Although the proposed solution makes use of existing possibilities, it is a new use of those possibilities and therefore it is an innovation for cadastral registration in the Netherlands.

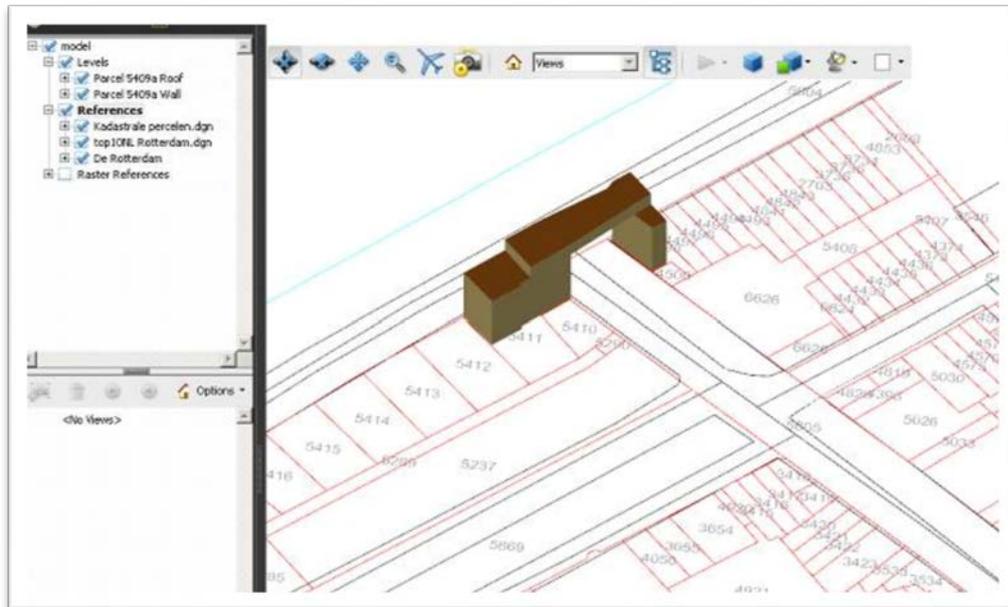
The method of 3D registration starts with no longer accepting that complicated 3D property situations are registered through (many) surface parcels. Currently it is already possible that a land registrar refuses the creation of very small parcels in the interest of an "effective parcel formation". This rule can be used to avoid that complicated multi-level property situations are registered via the surface parcels. In such situations the original large parcel will be maintained and a land registrar can require a 3D representation that provides insight into the property situations (established with either apartment right, right of long lease, right of easement or right of superficies). For apartment rights it would mean an extension of the guidelines for apartments, in such a way that the requirement to register floor plans can also be met by registration of 3D representations.

A notification can be administrated on the parcel on which a 3D representation has been registered. In addition the footprint or 2D projection of the 3D representation could be added to the cadastral map by an extra layer, like is done in Australia (Queensland Government, 2008; Stoter and Van Oosterom, 2005) and Norway (Valstad, 2010). To which extent the 3D representation is legally binding still depends on the parties involved.

In consultation with the notary it is being identified which situations require such a 3D approach as well as what the exact requirements for the 3D representations are.

The focus is on 3D representations for registration in the land registers to be accepted via 3D PDF. A 3D PDF provides interaction and query possibilities that are very helpful in understanding 3D situations. The concept of registration of a 3D representation in a 3D PDF

in the land registers is shown in Figure 9. This PDF shows the user the property registration of a building over road in an interactive manner. The PDF provides clear insight into the property situation, including which parcels overlap with the building (when projected). Therefore it is not necessary to divide the surface parcels to reflect the multi-level property situation.



**Figure 9. Prototype of registration of 3D representation of multi-level property in the land registers via 3D PDF (created with Bentley software)**

Guidelines are needed to make sure that the 3D representations meet the criteria of a proper 3D registration. Issues that need to be addressed in the guidelines are:

- How to specify the Z coordinates: relative to the surface or absolute in the national height datum or both?
- Must the footprint and/or the projection on the earth surface of the 3D representation be added in the 3D representation? And in the cadastral map in a separate layer?
- What are the conditions for the geometries in the 3D representation: 1. fully enclosed by flat surfaces (polyhedron) or even by curved surfaces with precise mathematical descriptions of such as parts? 2. it is allowed to have 3D representations that are open at the top (sky) or at the bottom (earth)?
- How to check the quality of the 3D representations (closure; non-overlapping; .....
- Should the 3D representation be checked by Kadaster (or otherwise be verified) before it is used as a 3D boundary?
- Should the volume of the 3D representation be included in the deed? (if not open at bottom or top)
- Do the 3D representations get a unique identification?
- What objects are needed for reference and orientation in the 3D environment? Compare this with the existing buildings on the 2D cadastral map.
- What precision is needed?

- Is a topological structure required to efficiently and consistently describe many neighbouring objects in building complexes?

Although the first focus is on registration of 3D representations in the land registers, the registration of the data itself is studied in parallel for future use. The data is necessary to check the validity of the 3D representations (Is the space to which the right applies closed? Does it not overlap with spaces of other rights?). In addition, data is needed to generate an overview that combines different 3D representations in a 3D overview (i.e. the 3D cadastral map).

It is expected that the 3D representations can be generated based on design (i.e. CAD and BIM) drawings of the constructions, but verified with survey to check after construction of designed object. Therefore a case study is being set up with some architects to see if 3D representations of properties can be generated from the building information models (BIM) originally generated for the design and construction of building-complexes. The outcomes of this study may describe standard procedures for external parties of how to generate the information required for a 3D registration.

## 5. CONCLUSIONS

This paper presented the study of the Dutch Kadaster to register 3D representations in case of multi-level property, which is one of the ambitions in the Long-Term Policy Plan of the Kadaster (Kadaster, 2011). In a selected set of situations the new 3D registration method may formulate an obligation to establish a notification of a 3D property existence on a parcel combined with a registration of the 3D representation in the land registers. Introducing such a requirement necessitates further investigation to a) identify cases that require such a 3D registration, b) define requirements concerning the quality and accuracy of the 3D representation in that 3D registration (including the issue of using 3D topology to represent shared 3D boundaries between two neighbour 3D objects). Future work will focus on obtaining 3D representations for cadastral purposes from digital 3D drawings from the BIM domain. In addition future research will cover the steps after the submission of a 3D representation: how will this be managed in the cadastral database(s), how can users (within and outside the Kadaster) access this 3D information?

## ACKNOWLEDGEMENTS

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## BIOGRAPHICAL NOTES

**Jantien Stoter** (1971) defended her PhD thesis on 3D Cadastre in 2004, for which she received the prof. J.M. Tienstra research-award. From 2004 till 2009 she worked at the International Institute for Geo-Information Science and Earth Observation, ITC, Enschede, the Netherlands ([www.itc.nl](http://www.itc.nl)). As associate professor at ITC she led the research group in the field of automatic generalization. She was project leader of an EuroSDR project on generalisation from 2005 till 2009. Since October 2009, she fulfils a dual position: one as Associate Professor at Section GIS technology at OTB and one as Consultant Product and Process Innovation at the Kadaster. From both employers she is posted to Geonovum (the National Spatial Data Infrastructure executive committee which develops and manages the geo-standards). The topics that she works on are 3D, information modeling and multi-scale data integration. Since January 2010 she leads the national 3D pilot that established a national 3D standard compliant to CityGML as a collaboration of about 60 partners. In November 2010 she received a VIDI grant, which is a prestigious award given by the Netherlands Organisation for Scientific Research (NWO) for excellent senior researchers to start a new research group (budget 800 000 Euros). Jantien has a wide national and international network in the areas of 3D modeling and automated generalization.

**Hendrik Ploeger** (1965) studied law at Leiden University and the Free University of Amsterdam, The Netherlands. In 1997 he finished his PhD-thesis on the subject of the right of superficies and the horizontal division of property rights in land. He is associate professor at Delft University of Technology (OTB Research Institute) and holds the endowed chair in land law and land registration at VU University of Amsterdam. His research expertise focuses on land law and land registration, especially from a comparative legal perspective.

**Wim Louwman** (1946) started in January 1965 as a legal clerk working for the Netherlands Agency for Cadastre and Land Registers. He obtained the degree of Master of Law at the University of Utrecht in 1980. Since 1982 he was registrar and since 2004 chief registrar. In august 2011 he retired as chief registrar. In May 2011 he was elected President of the European Land registry Association (ELRA). He is editor of various legal magazines and was University lecturer. He is also project leader of an important European project on cross border electronic conveyancing.

**Peter van Oosterom** obtained an MSc in Technical Computer Science in 1985 from Delft University of Technology, The Netherlands. In 1990 he received a PhD from Leiden University for this thesis 'Reactive Data Structures for GIS'. From 1985 until 1995 he worked at the TNO-FEL laboratory in The Hague, The Netherlands as a computer scientist. From 1995 until 2000 he was senior information manager at the Dutch Cadastre, where he was involved in the renewal of the Cadastral (Geographic) database. Since 2000, he is professor at the Delft University of Technology (OTB institute) and head of the section 'GIS Technology'. He is the current chair of the FIG joint commission 3 and 7 working group on '3D-Cadastres' (2010-2014).

**Barbara Wünsch** (1967) is acting Registrar of the Landregisters and the Public Registers. She obtained the degrees of Master of Civil Law, of International Law and Notarial Law in 1991 from the VU University of Amsterdam. She started as junior civil-law notary in 1991 and became civil-law notary with her own company in 2000. In December 2010 she resigned as civil-law notary. She is acting registrar of Cadastre and Land Registers in Apeldoorn, auditor for the KNB, (royal dutch organisation of civil-law notaries) and legal advisor.

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