Anti-Seismic Structural Improvements for a Kop-hals-romp Boerderij as Heritage

A RESEARCH BY
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Title:
Braced Idyll: Anti-Seismic Structural Improvements for a Kop-hals-romp Boerderij as Heritage

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Abstract

The research paper aims to give proper anti-seismic retrofit advices for the architectural typology of the Kop-hals-romp Boerderij as heritage. For the farmhouse that embedded with heritage value, it's very important to strengthen the building in a heritage friendly way. The notion of heritage value is thus discussed in the paper as to give a clear transformation requirement for the retrofit. The paper takes a specific farm, Onderdendamsterweg 8, as an example to elaborate the topic. Earthquake damages and their formation mechanism are studied to achieve a solid revising proposal, which contains four parts: reinforcement of single components, reducing deformation constraints at connections, adjusting the system stiffness ratio and optimizing load paths and load distribution. Unlike most of the safety-oriented anti-seismic retrofit methods, a kop-hals-romp boerderij intervention assessing system is established to help clearly response to the heritage and aesthetic value of the original building. Based on the assessing system, further design is carried out on several relevant details. Although the research is carried out mainly focus on the
example farmhouse, it's main purpose is to give a reference for the anti-seismic intervention on the kop-hals-romp boerderij, and the methods in judging the heritage value of the farmhouse and the suitability of the intervention can be applied to other farm as well.

Key words: Heritage evaluation, Transformation Requirement, Earthquake damage, Damage formation, Anti-seismic intervention.
Introduction

Problem Statement
General Problem
Kop-hals-romp Boerderij
Research Topic

Picture:
Earthquake damage and retrofit intervention in a farm in Groningen.

Source: http://www.sott.net/article/303918-Netherlands-gas-extraction-slanched-by-more-than-half-as-earthquakes-drive-locals-from-their-homes
Problem Statement

Earthquake

The extraction of gas by the NAM (Nederlandse Aardolie Maatschappij BV) in the area of Groningen induces earthquakes and causes quite some trouble to the residence living there. The general technical problem on architecture level is the lack of stability of the buildings in Groningen, most of which are masonry buildings constructed in old times without consideration of earthquake resistant design. The consequence is obvious and in a way tragic: the buildings start to crack and even fall down due to the continuous tremble from time to time. The treatment to the problem is carried out by the NAM via means of reinforcement, and reconstruction of the houses. Yet it is not the cure. The lack of aesthetics in design and regardless of history prove it’s not a good way to help the local residence. In the meantime, investigations of proper ways to reinforce the buildings is carried out and yet little satisfied results come out. Eventually people start to lose their confidence in the house as well as the area they live in. Thus, the technical problems grows into a social problem.1

Kop-hals-romp Boerderij

The Kop-hals-romp boerderij is a typical architecture typology in the province of Groningen, with the unique composition of three pars, the house, the connection and the barn as the head (kop), the neck (hals), the body (romp). As with the Kop-hals-romp Boerderij, earthquakes also manifest their impact on the building, technically and socially. As a handmade hybrid structure (masonry & timber) architecture type, the farmhouse also has safety threats induced by earthquakes.2 The cracks on the masonry walls damage the aesthetic value of the traditional building. Meanwhile, the improper interventions also introduce damage to the appearance of the building. Hence, problems of safety reveal another layer of beauty and cultural relevance. Consequently, proper treatment to the farmhouse is in need.

Apart from the earthquake problems, the kop-hals-romp boerderij in Groningen is also facing the problems caused by social and industrial situations like the shrinkage of population and the transformation of production on farm. Farmers leaving their land and moving to the big cities leave quite some farms vacant and for sale. While the change in the way of production on farm calls for bigger farmhouses and more modernized devices, and the traditional farmhouse is no longer suitable for this way of production. Therefore, traditional farmhouses are in a situation of transformation towards new function and space organization. The important thing here is that the transformation shouldn’t damage the original beauty of the building (according to aldo rossi, the change of function doesn’t change the meaning of the building, a monument will still be a monument in the sense of its location, its form, etc). Thus there’s the opportunity for architects to rethink about the heritage transformation oriented seismic intervention. The case in this research is also a case for further transformation.

1. More about the earthquake and social problem in Groningen, refer to: http://www.dwarshuis.com

2. About the specific damage on the kop-hals-romp boerderij, refer to the chapter of Seismic Damages, also refer to Handboek Aardbevingschade, Bevingshcade in het Groningen-gasveld by the NAM.
Working Scheme of the Research

Anti-Seismic Structural Improvement for the Kop-hals-romp Boerderij as Heritage

Earthquake

Heritage

Locations

Evaluation

Construction Features

Formations Suggestions

Transformation Requirements

Interventions

Reflections
Based on the problems of improper anti-seismic intervention on the Kop-hals-romp Boerderij, the research topic of the research will be:

**Anti-Seismic Structural Interventions for the Kop-hals-romp Boerderij as Heritage**

Keywords in this topic are Kop-hals-romp Boerderij, heritage, seismic, and interventions. On the basis of these keywords, the research will elaborate the topic in three parts: the first part focuses on the construction features of a kop-hals-romp boerderij and tries to develop a way of evaluating the heritage value within the design and construction of the farmhouse that can be used in judging the interventions; the second part lists the common damages on kop-hals-romp boerderijen and the formation mechanism of these damages (in terms of force flow), in order to develop the principles of intervention based on the damage; part three shows several intervention proposal that meets the requirements of heritage transformation and follow the principle of the formation mechanism. Among the three parts, the heritage requirements part and the intervention parts are based on a real case, while the earthquake damage part is more generally researched.

**Relevance**

The aim of the research is to find proper ways of strengthening the kop-hals-romp boerderij not only in consideration of the safety issue, but also the heritage as well as the aesthetic value. The relevance of the research is threefold:

1. To develop a method that introduce the assessment of heritage value into the operation of anti-seismic improvement;
2. To develop proper treatments on important details of a kop-hals-romp boerderij;
3. To serve as a reference for the intervention of other kop-hals-romp boerderijen.
Onderdendamsterweg 8, Description and Evaluation

Description
   General Description
   Construction Features
   Summary

Evaluation
   The Evaluation
   The Transformation Requirements

Picture:
Facade of the Small Barn at Onderdendamsterweg 8

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The boerderij Onderdendamsterweg 8, Middelstum 9991 TB is chosen as a case study for the research. Studies about the boerderij mainly focus on two aspects: description of the boerderij (its location, history, composition, function and construction), and evaluation of the boerderij (in terms of heritage conservation and anti-seismic intervention). The former will give an overview of the architectural features of the farmhouse, some of which can be referred to in the later phase of the research, the anti-seismic detail design, and others may be helpful in understanding the building and the context of the farmhouse for the design phase of this project. The latter will conclude the heritage value of the farmhouse and furthermore serve as the transformation requirements that can help control the design and select among interventions.

Description

The main methods to achieve an objective and accurate description is fieldwork. The specific work includes interview with the farm owner and documenting by measuring and photographing.

General Description

The farmhouse situates alongside Road N996 on a moated yard with old trees in between the town of Middelstum and Onderdendam. The farm sits parallel with the road, facing east. A canal surrounds the yard on the south side of the farmhouse. The farm was built in 1900 in a typical kop-hals-romp type with a head, a neck and a large barn. A small adjacent barn was added in the 1950s as extension. Changes are made to the wall of the head and neck part, and partially to the cattle shed in the barn. But the main structure of the barn remains historical. The farmhouse no longer serves for the animal husbandry purpose but mainly a storage for hays and wastes.
Construction Features

Kop

The head house is built on a rectangular plan, acting as the main living area for the farmer’s family. The house has two storeys and a basement. The main facade (east) is symmetrical in design and has three bays, the middle of which used to be the entrance door and now is filled with brick wall and a window. The north facade also has three bays with the middle one filled up with brick. The main load bearing structure is the twin leaf masonry walls on the east and west part of the head, while the north and south gables act as shear walls. On the west wall, a big cavity is made as indoor connection between the head and the neck. Above the cavity an I profile steel beam is added as a lintel. The floor lies on timber beams sticking into the masonry wall. The roof structure is a triangular timber truss system with collar ties. On the ridge of the roof there are two brick chimneys.

Hals

The neck house has a rectangular plan smaller than the head part. It is a one storey building with a single space serving as the kitchen and dinning room. The load bearing structure is the twin leaf masonry walls on the north and south sides. The west facade of the head part helps resist the shear force together with a return wall on the west end of the neck part. The return wall is built inside the barn. The north facade is longer and has four bays. The location of the door is shifted from the fourth bay to the first bay counting from the east, and the original door cavity is filled up with bricks. The triangular collar roof structure sits on the masonry walls.

Romp

The body, namely the barn, has two adjacent buildings. The big one is built in 1900 and the small one is built around 1950s. The load bearing structures for both are the typical kop-hals-romp boerderij timber structure. The structure consisting of two row of columns divides both space into three aisles. There are 6 pairs of columns in the big barn and 4 in the small one. The north aisle of the big barn, which originally was the cattle shed, is enclosed by brick walls and brick roof, serving as a storage. Concrete columns are introduced to support the roof. At the west end bay of the big barn in the middle aisle, a horse shed is separated from the large space by brick walls. The east end bay of the barn is also enclosed with brick walls to achieve some space for a large bathroom, a summerhouse and a room for milk work. The milk room is now empty. The longitudinal facades are self supported single leaf masonry walls and also support a little bit the load of the heavy roof. The west gable is a self supported single leaf masonry wall, anchored with the walls of the horse shed as the shear wall. The small barn is a single space with single leaf masonry walls as all facades. The north wall is shared with the big barn.

1. The construction details of the roof is referred to Historische Houtconstructies in Nederland. Stichting Historisch Boerderij-Onderzoek, Arnhem, 1996.

2. The twin leaf of the hals is not proved, however, the owner of the house said so. So in the research we treat it as twin leaf.
Kop, Roof Structure

Hals, Roof Structure

Romp, Roof Structure

Kop, Beams under the Floor

Hals, Shearing Walls

Romp, Beams

Kop, Loadbearing and Shearing Walls

Hals, Loadbearing Walls

Romp, Columns
Summary

The describing work of the boerderij Onderdendamsterweg 8 reveals a structure of complexity in terms of seismic situation. It is complex not as delicate form representing the complicate load paths within the structure, but as a combination of different materials, geometry and load bearing scheme. First of all, on the architectural composition level, the building is not integrated as a single volume as it seems. Consisting of three parts, it is more like a collection of three structure systems since the dimension of the three parts are all different. Furthermore, on the structural level, two structure types are applied in a single farmhouse. The head and the neck, which are the residential area, are mainly masonry constructed while the barn is mainly a timber structure holding the huge roof. Besides, even for a single architecture volume, the structure is still hybrid: both the head and the neck have a wood roof structure on the brick load bearing walls, whereas the masonry longitudinal walls and gables of the barn only support themselves and a small percent of the roof load. During earthquake, the differences of the load bearing structures, the materials, and the dimension of the architecture volumes may induce the difference in the vibration frequency, which in consequence will cause sudden force change in the structure. Thus, these complexities in structure are closely related to the earthquake damages and smart solutions are in need.
Evaluation

The research on the heritage value of the kop-hals-romp boerderij is mainly literature based. On the heritage conservation level, the Venice Charter and Nara Document are refer to as guidelines for the farmhouse assessment and furthermore for the development of the transformation requirements. However, as the boerderij Onderdendamsterweg 8 is neither a national monument nor a municipal monument, the notion of heritage need to be reconsidered for this specific case.

“We use objects of heritage to shape our ideas about our past, present and future (Rodney, 2009).” On top of this argument, we can regard heritage as object that makes identification, that “embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values or that represent a significant and distinguishable entity whose components may lack individual distinction (Rodney, 2009).” To take a step further, archaeologist Laurajane Smith’s opinion that heritage is culturally ascribed, rather than intrinsic to things (Smith, 2006) puts more emphasis on the information conveyed within the physical objects and the heritage practices (assessing, conserving, revising, etc.) than on the objects itself.

These ideas become the foundation for the methodology of evaluating the Onderdendamsterweg 8. Thus principle of the evaluation is

To keep ( conserve and appreciate ) the physical feature that can reflect and response to the farm landscape, the agricultural history and the culture of living in rural areas.

Based on the principle, the evaluating work is operated under the framework of the Nara Document on Authenticity, and the transformation requirements is developed referring to the Venice Charter, the Nara Document and the concept of compatibility proposed at the Dahlem Conferences in Berlin 1997.

The Evaluation

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Based on the work of the Nara Document, a general assessment of Onderdendamsterweg 8 is achieved on different aspects, as shown in the above chart. Elaboration on each of the different aspect will further contribute to the understanding of authenticity of the farmhouse.
Principle: to keep (conserve and appreciate) the physical feature that can reflect and respond to the farm landscape, the agricultural history and the culture of living in rural areas.

Form & Design

As a dominant volume, the three composed form contributes to the beauty and integrity of the landscape in Groningen. The main volume also stays the same as in 1900. The facades are beautiful and remains the original appearance and proportion, although there are some changes in the doors and windows. The space division stays almost the same as previous (although some of the functions are no more the same), reflecting the way of living in old times.

Material & Substance

The masonry walls reflects an brick aesthetic in rural area, Groningen. The complex timber structure in the barn also manifests beauty and technique. Some walls and the timber structure can be dated to the very start of farm with all the traces of time on it. The wind bracing on the column responses to the flat topography in a coastal province where nothing will stop the sea wind.

Use & Function

While the head and neck part remains the function of living and dinning, that of the barn now is no longer the same as the origin, especially in the barn, which is now a warehouse for hays and life wastes.

 Tradition, Techniques & Workmanship

The design on the masonry work on the edge of the gable and the timber roof structure reflects an aesthetic of craftsmanship. It also reveals a certain period in the countryside when people use and appreciate handwork as the main labor force.

Location & Setting

The farm is an important element for the beautiful farm landscape of Groningen. The trees and the water together with the farmhouse make the location a unified integral scene (ever since the 1900s).

Spirit & Feeling

The building is just a normal ranch. There is little value of spirit and feeling inherited with the building for the public.
The farm has the typical architectural composition of the kop-hals-romp boerderij. The farm also suits the curve of the stream and has an adjacent small addition.

Source: Google map

The east facade stays almost the same as the original, except that the center door has been turned into a window. The farm together with the river, the grassland, the trees forms the special landscape of Groningen. Thus in the conservation of the farm, the trees and surroundings are also important.

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The brickwork of the facades, both its design and construction shows an aesthetic of traditional handmade architecture. The details on the roof edge of the gable also shows the craftsmanship within the vernacular architecture in Groningen rural area.

Copyrights: Lu Ding

The complex timber structure in the barn manifests its reflection to the area, for example, the wind support is to help resist the heavy wind in north Netherlands. The way of assembly also proves a good example of craftsmanship.

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To sum up, the boerderij of Onderdendamsterweg 8 is appreciated for:

1. Its unique composition of three parts and its relation to the surrounding landscape;
2. Its space division that reveals a farm lifestyle;
3. Its brickwork details that shows the skillful craftsmanship;
4. Its beautiful, complex yet reasonable barn timber structure design;
5. Its facade that manifests the appearance (proportions) of a typical kop-hals-romp boerderij (in 1900s);
6. Its structure scheme which is representative for a kop-hals-romp boerderij.
Transformation Requirements

The transformation requirements act as the overall guideline for the anti-seismic intervention research in this paper. The requirements help control the location for intervention, the material use in intervention, the methods of intervention and set limits to the extents of the intervention. Besides, the requirements also contribute to assess existing interventions.

The requirements is developed on the basis of the evaluation with the reference of the Venice Charter and the Nara Document.

The requirements are aimed to help make a proper anti-seismic intervention on the architecture of Onderdendamsterweg 8 in consideration of conserving its heritage value. In some cases, it may also be used as transformation requirements for other kop-hals-romp boerderij with critical thinking and contextual application:

**LOCATION**
1. The interventions must be operated in the places where there will be no distracts to the balance of the architectural composition, the original load bearing scheme, the artistic facade details, and the decoration that reflects the culture of rural life in the area.
2. The interventions should be hide in most cases and shouldn't disturb the integrity of the historical appearance. In case of exposure, the intervention must be modest and compatible with the building.

**MATERIAL**
3. The material choice for the intervention must respond harmoniously to the original mass. In case of exposure, the size, shape and position of the added material must be carefully considered to ensure the compatibility.

**DESIGN**
4. The intervention should ensure the safety requirements and must not introduce new damage to the original building.
5. Replacement and removal are allowed only when the operation doesn’t contrast with, but rather enhance the appreciation aspects elaborated in the evaluation.

**PURPOSE**
6. On top of safety consideration, the design of the upgraded details also aim to enhance the (authenticity) of the building by responding to characterization of the old design and historical and social context.

**MAINTANENCE**
7. All interventions should follow the principle of retreatability and repairability, and does not exclude further treatment.
Seismic Damages: Location, Formation & Suggestions

Location
Properties of Masonry-Timber Hybrid Structure
Seismic Damages
Summary
Formation and Suggestions
Formation
Suggestions

Picture:
Crack caused by earthquake on a masonry wall of the farm at Ter Laan 31, Bedum.

In this chapter, the earthquake damage is studied so as to get understanding about where the damages usually take place, why they happen and what the revised proposals are dealing with these damages. In the case of Onderdendamsterweg 8, the damages are specific. However, as future damages by coming earthquakes can’t be predicted, the study on the damage is a more universal one for the architecture typology of kop-hals-romp boerderij. Consequently, the revised proposal and the following interventions are universal practice as well. In this way, the proposal can also be applied to other farmhouses.

This chapter has two parts, the location of damages, and the formation and suggestions for these damages. For the latter part, as it is hard to simulate the damage by the complex seismic vibration, the formation mechanism is mainly force oriented, that is, for each type of damage, the research will focus on the forces that form the damage rather than the seismic movement that caused these forces. In this way, the research simplifies the process of earthquake damage while can still guide the development of anti-seismic interventions.

Location

The study of the locations of earthquake damage is mainly literature based. The study begins with the load bearing properties of the masonry and timer structure, the two main load bearing system in the kop-hals-romp boerderij. As the main structures are different from the head and neck part to the barn, the studies are also separated. The research is based on the information from The Earthquake Damage by the NAM, 2015.

Properties of Masonry-Timber Hybrid Structure

The load bearing behavior of masonry is anisotropic. Its stability and stiffness is largely determined by units bond and the properties of mortar. Masonry behaves well under compression, however it will easily get cracked under tension and bumped under torsion and bending moment. Therefore the main criterion for the compressive strength of masonry is the transverse tensile strength from the masonry units and the vertical compressive strength of the units brought about by transverse tensile strength.¹

The poor behavior towards tensile and the way of stack and bond makes masonry react poorly towards horizontal loads like wind, earth pressures, seismic loads and vibration. Thus, to ensure the three dimensional stability of a masonry building, bracing is often a necessity. The reason for bracing the building is to ensure that horizontal forces can be accommodated and transferred to the subsoil; and to limit horizontal deformations. To do this, both the stability of the entire building and the stability of individual masonry walls must be guaranteed. Structures which consist of several parts separated by joints must be designed in such a way that each part is stable and braced in itself.

A braced construction is accomplished with two elements: horizontal plates to accommodate horizontal loads, vertical plates to support the horizontal ones and hence transfer both horizontal and vertical forces to the subsoil. (Timber joist floors can also be turned into horizontal plates by including diagonal bracing naked on or floorboards providing a rigid floor in conjunction with peripheral ring anchors.)

Timber is a high strength-weight ratio material. Timber structure is a light weight structure, which is very good in terms of seismic behavior. As the lateral force of seismic vibration is product of earth acceleration and building weight, lighter structure will suffer lighter force. Meanwhile, the way that timber components assembled ensures that the joints can act as damper to some degree and absorb some earthquake energy.

**Seismic Damages**

Earthquake damage happens mainly due to the horizontal vibration of the structural components which cause sudden large stresses as tension and shear force in the structure. Factors that affect the damage can be the size and direction of the acceleration, and the plan, structure, construction and the state of construction of the building. For the kop-hals-romp boerderij, the damage is mostly common to happen on the brick walls in the form of cracks.

Kop & hals

In the head and neck part, the main load bearing structure is the masonry walls and the timber roof structure is self supported. As the roof structure has more flexibility than the brick walls, damages are not likely to happen on the roof structure, but rather on the brick walls and the connections between the walls and the roof. Due to the traditional handmade construction methods, the timber beams of the floor are not well connected to the wall, thus the floor can’t act as a diaphragm to help resist the deformation of the walls. The deformation of the walls can also cause consequent problems around openings and to the tiles. Damages usually take the form of cracks.

Romp

In the romp part, the structure is different from the other two parts. As the main load bearing structure is the timber roof structure, which has flexibility and the traditional connections between components can absorb the vibrations better, there’s little damage to the main structure. Though sometimes the wooden structure may fall down because of the vibration, that’s mainly the results of decay and deformation of the timber structure, and usually manifest the problem before the earthquake. However, severe earthquakes may also induce distortion to the wood structure. As with the facade, the masonry walls can suffer some similar damage as in the kop and hals parts. The gable may also suffer tilting or bumping if there’s not enough restraints from the interior walls (usually the wall of the horse stack).

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1. The elaboration on the earthquake damage on the Kop-hals-romp Boerderij is based on the research by the NAM. NAM. *Handboek Aardbevingschade, Bevingshcade in het Groningen-gasveld*, Nederlandse Aardolie Maatschappij, Assen, 2015.
**Summary**

Going through the seismic damages of the kop-hals-romp boerderijen, from a structural point of view, damages can be related to structural discontinuity, poor connections, and cavities on the wall. Structural discontinuity is mainly due to the change of the load bearing materials in the three parts. Poor connections between walls, roofs and floors are the sequence of traditional hand made way of construction. As the research is mainly about retrofit in a heritage friendly way, the cavities on the wall, which is part of the original design, will not be tackled in the research. While the structural discontinuity and poor connections will be elaborate more in the next section.

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**Earthquake Damage on the Kop and Hals Part**


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**Earthquake Damage on the Romp Part**

Formation & Suggestions

As it’s mainly the masonry part that suffers the earthquake damage in the form of cracks, the study on the formation will focus on the type of cracks and the force interaction behind them. The study is literature based.¹

Cracks don’t usually affect the safety of the building, but they do have impact on the serviceability of the building in terms of leakage and thermal insulation. Tension and shear stress are critical and liable to cause cracks because the tensile and shear strength of the masonry is comparatively low. As at present many of the critical variables which influence the formation of cracks cannot be measured sufficiently accurately, any analysis of the risk of cracking or factor of safety against cracking in masonry is very limited and only approximate. However, with a certain understanding of the relationships in crack formation, the frequent occurrence of damaging cracks in individual masonry constructions can be avoided.

Cracks in Lightweight Partitions

Craks in lightweight partitions may be caused by floor deflection. When the floor deforms on when edge, the consequent result is the deflection in the opposite directions on other edges. Thus, the floor will have compression on the partitions, and the deformation of the partitions will induce in plate tension in oblique direction and thus cause the emerce of oblique cracks near the floor. This can be reduced by minimizing the deflection of the slab, providing enough deformation opportunities on top of the wall.

Cracks on Lintels

Cracks on lintels are caused by excessive horizontal tensile stresses at the upper edge of the panel as a result of a ‘spreading’ of the vertical compression trajectories below the openings as well as lintel support reactions introduced eccentrically. The crack can be avoided by apply moveable joints on one side or both sides of the lintel to separate the lintel from the rest of the wall or adjacent piers. Bed joint reinforcement can also help distribute the loads evenly along the lintel.12

Cracks in Facing Work

Cracks on the facing work are induced by restraints of deformation by the connections with other components, which will cause tensile stresses that can’t be neutralized because of lack of compression from vertical loads. This will cause a vertical crack. Cracks in this case can be avoided by (under the circumstance of seismic damage) providing less restraints to deformation at the supports (intermediate pad of cards or foil), or introducing movement joints and non-structural bed joint reinforcement to distribute the cracks or limit their width.9

1. To be more clear, the vertical cracks above windows and doors always happen along with the fail of the lintels. When the lintel cannot hold the compression above, then there will be in plate tension in the wall above the lintel.

2. The cracks around cavities can also take different forms, a.k.a. oblique cracks starting from a corner of the cavities. The vertical crack here is just an example to show how the fail of lintels will affect the external wall.

3. The cracks in the external wall can also be in the form of stepped crack and oblique crack going through block units. These cracks always go along with cracks of the inner leaf, not just cracks on the outer cladding.
Horizontal Cracks in an External Wall Connected to an Internal Wall

For an internal wall and an external wall with a connection resisting deformation between the two, if the internal wall exhibits smaller deformation than the external wall, then external wall will suffer tensile stress at the mortar and bed joints. Thus, horizontal cracks on the bed joints will occur in the external wall around the junction with the internal wall. This can also be reduced by introducing a favorable stiffness ratio between the two walls, by adding more loads to the wall that tends to crack and by using butt-jointing.

Horizontal Cracks in an External Wall as a Result of Floor Slab Deflection

A relatively large floor deflection may cause the loading of the external wall eccentrically. Thus horizontal cracks will occur on the external masonry walls below the floor. These cracks can be avoided by reducing the deflection of the floor slab, increasing the depth of the support in the wall for the floor, developing a better support for the floor slab (centering the load transfer of the slab, or separate the slab from the masonry), or by anchoring the slab with the slab below via a vertical tie.
Cracks in an External Wall below Floor Slabs

Different deformation between the floor slabs and external masonry wall will introduce tensile stress on the wall and thus cause horizontal cracks. The different deformation maybe caused by the different vibrant frequency of the floor slab and the external wall. If the anchor between the external wall and the floor slab is strong enough, then the crack will most possibly happen in the second or third bed joints below the floor slab. These cracks may be reduced by applying a sliding bearing joint between the floor and the wall. If the upper and lower floors have the similar deformation, then the external wall may have crack in the middle part from the corner and gradually taper to zero along the wall. This is because the upper and lower connections are restricted. In this case, possible ways to reduce the cracks maybe by separating the masonry walls from the floor at the corner by ways of joints, or by employing reinforced concrete columns at the corner and connected to the floor slabs.

1. The extreme situation in this case can be the offset movement of the whole 1st storey or the top storey of the building, since the top part of the building suffers the most acceleration during an earthquake.

Cracks in an external wall below a floor slab

Cracks in an external wall between floor slabs with similar floor deformation
Diagonal Cracks in an Internal Wall Connected to an External Wall

Difference in vertical deformation will cause diagonal cracks between the internal wall and external wall. The connection between the two walls doesn’t allow independent deformation, and restricting deformation will cause tensile and shear stress in the wall that tends to shorten against the other wall. The crack can be reduced by introducing a favorable stiffness ratio between the two walls (e.g. stiff internal wall, soft external wall), by adding more loads to the wall that tends to crack and by applying butt-jointing rather than bond joint between the two walls. ‘The last technique in particular is a good way of considerably easing the restriction to deformation - and hence the stresses- between the internal and external walls.’

Summary & Limits

These cracks described in this section don’t cover all kinds of damage to the farmhouse. Some of damages that are not mentioned here are consequent results of these cracks, which means when these cracks are effectively prevented, other damages can also possibly be prevented. For example, the deformation of the window frames can be avoided if the in-plane deformation of the external wall is prevented (which can be prevented when several of the advices are taken into account in the previous research, since the deformation of the wall can be result of different reasons).

Other cracks can be seen as analogy in terms of force flow. For instance, stepped cracks at the connections between two external walls can be seen as analogy of cracks in a internal wall connected to an external wall. Also, to clarify, not all cracks are unacceptable and it’s impossible to prevent all cracks as long as it is a masonry building. Cracks can also happen because of the change of temperature and the water inside the wall.

One common seismic damage is not mentioned here, the tilting and falling of the chimney. More research needs to be done for this part.¹

1. The case of chimney is very common in the area of Groningen. Current interventions include steel struts bracing, and replace the brick chimney with a lighter material, aluminium one for instance. However, none of these interventions take the heritage value of chimneys into account. This research mainly focuses on the retrofit of wall construction, but there’s no doubt there should be more research on the case of chimneys.

Diagonal cracks in an internal wall connected to an external wall
Suggestions

To sum up, for the cracks in masonry wall, the basic solutions concentrate on four parts:

A. Reinforcement of single components: walls, floor slabs, plates, etc;

B. Reduce deformation restraints at connections;

C. Adjust the stiffness differences between components; (reduce or separate, under certain circumstances, it’s very hard to reduce the stiffness differences between different components (or structural system), in this sense, the difference should be accepted while the treatment may be proper separation between the two different systems or components).

D. Adjust load path and load distribution.
Interventions

Basic Information
Categorization
Assessing Interventions
Interventions

Picture:
Steel wall supports of a farmhouse

This chapter concentrates on specific anti-seismic interventions. The research method is mainly research by design. During the design process, the transformation requirements serve as the control for the form, profile, material selection, etc. of the intervention, while the revised suggestions are the main intervention schemes. Literature research is also involved in this part. The ARUP Guidelines Design Consultation is mainly referred to for the typical connection details. The chapter has two parts; first is the basic information about the intervention, e.g. the categorization of the intervention, the relevant details for intervention, etc.; the second part is the interventions.

Basic Information

**Categorization**

According to the construction feature of the kop-hals-romp boerderij, the complexity of structure is demonstrated on different scales from architectural composition, structural scheme to connection restraints. Each scale of complexity will manifest its own effect on the damage. Therefore for each damage, the intervention may be carried out on different scales. Thus the interventions are also categorized according to these scales.

**Architectural composition:** Interventions on this scale are mainly dealing with the geometry imbalance caused by the composition of the boerderij, including the cavities on the facade, the eccentricity of the load paths, etc.

**Structural scheme:** Interventions on this scale deal with the stiffness differences caused by the different material and geometry in the structure.

**Connection restraints:** Interventions on this scale deal with the border condition of different structural components, aka, the connections and restraints.

**Assessing Interventions**

All the interventions shown in next part is arranged in a certain way so that readers can easily understand the methods as well as the relevance in terms of heritage value. For each intervention, an original detail is shown as the raw material, followed by the drawing of the intervention scheme. Along with each scheme, there is also an elaborating and assessing chart, explaining the following information:

1. Categorization: which scale this intervention is operating.
2. Method: the principle of the intervention according to the revising proposal and the technique used here.
3. Purpose: what forces the intervention is dealing with and what damage it is preventing.
4. Heritage assessment: how the intervention shows respect to the heritage value embedded in the building according to the transformation requirements and evaluation.
Interventions

For an earthquake-threatened building, interventions can be countless. To better understand how the assessment works, several interventions are proposed. These interventions satisfied each of the previous assessing rules. For each intervention, a relevant detail is shown to explain how the intervention works on a construction level.

Interventions are not only details. For the case of Onderdendamsterweg 8, which is neither a national monument nor a municipal monument but embedded with a heritage value, the intervention is transformation oriented rather than conservation oriented. In this sense, demolishing and redesigning is also allowed, as long as its purpose is to keep the authenticity of the space.

Interventions here are just examples to show how the heritage related intervention and assessing method works. More interventions can be designed in future research.

**Intervention I: Separation of Volumes**

The intervention is trying to separate the three volumes of the kop, the hals, and the romp, so that the their differences of vibration frequency due to different geometry won't affect each other, thus won't cause sudden increase of tension and shear force between each other.

The relevant detail is the connection between the kop and the hals on the north facade.
The intervention is operated on an architectural composition level. The detail showed here is the wall-wall connection between the kop and the hals on the north facade. The intervention is achieved by inserting a 100mm gap between the two volume as the expansion joint. To cover the gap, a drainage pipe is also installed at the gap. The material is weathering steel which has the red color that goes along with the brick. Inside, the dilatation is covered by a piece of metal that is achored on one end to the wall of the kop, which leaves flexibility during vibration. When detached from the kop and the romp volume, the stability of the hals is ensured by the two interior walls (one is shown in the drawing) that act as shear walls and help resist the horizontal deformation.

### Evaluation

<table>
<thead>
<tr>
<th>Categorization</th>
<th>Architectural Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Method</strong></td>
<td>Reduce deformation restraints at connections</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>Prevent the influence of different volumes during earthquake because of the difference in geometry.</td>
</tr>
<tr>
<td><strong>Heritage Assess.</strong></td>
<td>The intervention 1. doesn't interrupt the unique architectural composition; 2. uses drainage pipe as a cover of the expansion joints, the material of the pipe is weathering steel, which color goes well with the existing red brick wall; 3. is retretable.</td>
</tr>
</tbody>
</table>

![Weathering steel](image)

![Masonry brick: English bond](image)

![Vision of revised wall-wall connection between the kop and the hals on the north facade. Elevation](image)
Intervention II: Connecting the External Wall with the Floor

The intervention is trying to make good connections between the external wall and the floor, so that they can act as a whole during the earthquake. To have the best effect, this intervention should be carried out together with the floor bracing (Intervention III).

Relevant details includes connection between the beam and the inner leaf of the external wall, and the fixing of the outer leaf.

The original detail. The external wall is a twin leaf wall with the inner leaf as the load bearing part. The original floor sits on wooden beams which stick into the inner leaf.

The intervention: first connect the inner leaf with the outer leaf so that the outer leaf will not be detached during earthquake; then fix the inner leaf to the timber beams so that the diaphragm of the floor can transfer the horizontal load more efficiently to the loadbearing walls.
To reduce the loss of historical materials on the facade during the intervention, the technology of TurboTie is used while fixing the outer leaf to the inter leaf. The technique has four steps (see pictures on the left):

1. Drill 6mm pilot hole into the existing wall;
2. Load tie into and held or power support tool and line up with pilot hole while resting support tool on new leaf;
3. Drive in tie with hammer or SDS drill.
4. Fill the hole with mortar or grout, and redo the pointing joint.

<table>
<thead>
<tr>
<th>Evaluation</th>
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<tbody>
<tr>
<td><strong>Categorization</strong></td>
</tr>
<tr>
<td><strong>Method</strong></td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
</tr>
<tr>
<td><strong>Heritage Assess.</strong></td>
</tr>
</tbody>
</table>
Intervention III: Bracing the Floor

The intervention is trying to brace the floor to make it work as a diaphragm to help resist the deformation of the floor and distribute the horizontal seismic load more efficiently. The bracing of the wooden floor also reduces the stiffness difference between the floor and the masonry wall so that their vibration frequency will not be so different during an earthquake.

Relevant detail is the way the timber planks assembled.

Original floor plan of the kop. 1st Floor.

The timber bracing planks consist of two different kinds: one longer one that runs through all the floor and nailed directly to the beam; one shorter one nailed to the longer one. Each set of planks includes two longer ones and two shorter ones.

Copyrights: Xinming Li

Picture of traditional herringbone timber floor planks.

Copyrights: Xinming Li
Evaluation

<table>
<thead>
<tr>
<th>Categorization</th>
<th>Structural Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>Adjust load path and load distribution; Adjust the stiffness difference; Bracing single component</td>
</tr>
<tr>
<td>Purpose</td>
<td>Prevents possible floor deflection and consequent cracks; acts as a diaphragm that can help resist the horizontal seismic load during earthquake.</td>
</tr>
<tr>
<td>Heritage Assess</td>
<td>The intervention 1. uses the material of timber for bracing, which goes in harmony with the wooden interior decoration and structure; 2. uses the pattern of herringbone as bracing, which is commonly and traditionally used in the Netherlands.</td>
</tr>
</tbody>
</table>

Revised floor plan of the kop. 1st Floor.
Conclusion

The main purpose for the research is twofold. First, for the specific case of Onderdendamsterweg 8, the research is to find a proper way to apply anti-seismic interventions to the building for further transformation. The main problems to solve here are where and how to apply the interventions. The heritage evaluation and the intervention requirements help make the decision. To make it clear, as the interventions are transformation oriented, the operations are not limited to only details. To emphasize more the authenticity of the original space, demolition and restoration are also allowed, and these are also where the interventions can be applied. Meanwhile, if there’s any extension to the building, the anti-seismic intervention should also be operated in consideration of the authenticity of the original building. In this case, the workflow and scheme of the research can also be well applied.

The second purpose of the research is more universal. The research tries to offer a general method to make decisions of heritage related anti-seismic interventions in the first stage of the design. In the process, the evaluation is the starting point of the research, however, the principle of the evaluation might be different according to different cases. In this phase, the principle must be as specific as possible so as to keep more essential elements of the original building during the transformation. Once the evaluation principle is settled, one can continue with the transformation requirement work with the help of the Venice Charter and the scheme of the Nara Document of Authenticity. This part can be applied to any building with heritage value, however, for the damage formation and suggestion part, it’s mainly focused on the kop-hals-romp boerderij. Thus, if one want to do some interventions to a church, it may be a different story. The interventions to Onderdendamsterweg 8 is mainly preventive intervention, and the aim isn’t repairing the existing damage. However, the method provided in the research can also be used for retrofit. Another important step in the process is the assessment of the interventions, especially the heritage assessment. In this way, the ‘heritage’ building seismic retrofit process becomes a loop that people can develop, test and refine the intervention proposals.

Yet, there are still some limit in the research that require critical reading and smart application. First, the case of Onderdendamsterweg 8 is neither a national monument nor a municipal one, which offers great freedom in the transformation. While in a real heritage case, the problem can be more complicated and the methods in the research must be used together with other rules and possibly, laws. Second, in some cases, the building can be really badly damaged that it is almost impossible to do the intervention without changing the authenticity of the building. Then, the tips in the research should be used wisely to try to keep more original essence of the building. Third, the discussion of authenticity is quite controversial even with the help of the Venice Charter and Nara Document. One must be critical when tries to decide what represent authentic in the original building. Forth, for the interventions to the Onderdendamsterweg 8, they are not tested. Thus it may be possible that they will not resist a severe earthquake (though it’s not likely to happen in Groningen). Thus, to test the interventions will help make the research more solid.
Bibliography

**Kop-hals-romp Boerderij**


**Construction Technology**


**Heritage and Heritage Retrofit**


**Earthquake Damage**


**Anti-Seismic Solutions**


Appendix

Drawings of Onderdendamsterweg 8
Heritage Records of Onderdendamsterweg 8
Historical Kop-hals-romp Boerderij Drawings
Table of Earthquake Damage by the NAM
Heritage Evaluation Documents
  - International Charter for the Conservation and Restoration of Monuments and Sites (The Venice Charter)
  - The Nara Document on Authenticity
 Principle and Rules in the Research

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Picture:
Landscape met Boerderijen, Jan van Lockhorst, 1858
Source: Rijksmuseum
Drawings of Onderdendamsterweg 8
Location & Settings:
The farmhouse and the surroundings (trees, river, the curve of the road) together form the view of the site. The unity of the landscape should not be interrupted.

Form & Design:
The east facade still remains the original proportion. The only change is the change of the entrance to a window in the central bay, which will be restored the original state during the transformation.

Traditions, Techniques & Workmanship:
The assembly of the timber components remains the way of traditional handmade construction.

Use & Function:
The use of the barn has changed from the space for livestocks into a space for family waste and vehicles.

Material & Substance:
The timber construction of the barn still remains its feeling of a heavy structure.
Form & Design:
The setting of the "order" at the end of the west gable shows an aesthetic in architecture decoration in the rural area of Groningen.

Traditions, Techniques & Workmanship:
The edge of the gable which has a special triangular bond manifests the labor of handwork.

Material & Substance:
The ground around the barn is also paved with bricks. This is the special setting of material in the site, rendering the space experience of the integraty in material.

Form & Design:
The facade of the big barn is a typical design for a kop-hals-romp boerderij, including the doors implying the scale on site and different functions behind the doors, and the owlboard as a tradition way of decoration.

Form & Design:
The facade of the small barn also indicates the scale inherited on site: that of machine, and that of animals.

Traditions, Techniques & Workmanship:
The sliding door in the big barn is a simple but efficient design for a time when hand is the mainly labor force and producing methods.
Historical Drawings of a Kop-hals-romp Boerderij

Drawing:
The drawings of a kop-hals-romp boerderij in Leeuwarden in 1882.

Source: www.campingekenstein.nl/omgeving.htm
Drawing:

The drawings of a kophals-romp boerderij in Leeuwarden in 1882.

Source: www.geheugenvannederland.nl/?/nl/items/FSM01:BT-023-A
# Tables of Earthquake Damage By the NAM

## Kop & Hals

<table>
<thead>
<tr>
<th>Exterior Wall</th>
<th>Gable detached from roof structure</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Diagonal cracks between windows</td>
</tr>
<tr>
<td></td>
<td>Oblique cracks at the corner of the windows/doors</td>
</tr>
<tr>
<td></td>
<td>Vertical cracks above the windows/doors</td>
</tr>
<tr>
<td></td>
<td>More or less vertical cracks on the thinner wall of the house corner</td>
</tr>
<tr>
<td></td>
<td>Horizontal cracks at the connection between the wall and the first floor</td>
</tr>
<tr>
<td></td>
<td>Horizontal cracks at the lintels above windows and doors</td>
</tr>
<tr>
<td></td>
<td>Horizontal cracks at the junction with the roof</td>
</tr>
<tr>
<td>Interior Wall</td>
<td>Oblique cracks from the top corner of the door to the top corner in the room</td>
</tr>
<tr>
<td></td>
<td>Vertical cracks above doors</td>
</tr>
<tr>
<td></td>
<td>More or less vertical cracks on narrow wall surfaces at the corners</td>
</tr>
<tr>
<td></td>
<td>Horizontal cracks in connection with the first floor</td>
</tr>
<tr>
<td></td>
<td>Horizontal cracks at the lintel of the door</td>
</tr>
<tr>
<td></td>
<td>Diagonal cracks from the lower corner to the upper corner</td>
</tr>
<tr>
<td>Wooden Floors and Roofs</td>
<td>Deformation of latticework, rafters and purlins</td>
</tr>
<tr>
<td></td>
<td>Loose connection with the brickwork</td>
</tr>
<tr>
<td></td>
<td>Presented anchor and nails</td>
</tr>
<tr>
<td></td>
<td>Cracks on the beam support when beam is connected with brickwork*</td>
</tr>
<tr>
<td>Wooden Windows</td>
<td>Ground Floor</td>
</tr>
<tr>
<td></td>
<td>Ground Floor Tiles</td>
</tr>
<tr>
<td></td>
<td>Other Floors</td>
</tr>
<tr>
<td></td>
<td>Floor Tiles of Other Floors</td>
</tr>
<tr>
<td></td>
<td>Wall Tiles</td>
</tr>
</tbody>
</table>

## Romp

<table>
<thead>
<tr>
<th>Beams and the Roof</th>
<th>Deformation*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Slackness</td>
</tr>
<tr>
<td></td>
<td>Refer to wind load</td>
</tr>
<tr>
<td>Longitudinal Walls and Gables</td>
<td>Vertical cracks above windows/doors on thin walls</td>
</tr>
<tr>
<td></td>
<td>Horizontal cracks on the lintels of windows/doors</td>
</tr>
<tr>
<td></td>
<td>Horizontal cracks on half the height of the walls</td>
</tr>
<tr>
<td></td>
<td>Oblique cracks from the window/door corners to the wall corners</td>
</tr>
<tr>
<td></td>
<td>Vertical cracks on the thinner wall at the building corner</td>
</tr>
<tr>
<td></td>
<td>Diagonal cracks between windows</td>
</tr>
</tbody>
</table>
International Charter for the Conservation and Restoration of Monuments and Sites (The Venice Charter)


Adopted by ICOMOS in 1965.

Imbued with a message from the past, the historic monuments of generations of people remain to the present day as living witnesses of their age-old traditions. People are becoming more and more conscious of the unity of human values and regard ancient monuments as a common heritage. The common responsibility to safeguard them for future generations is recognized. It is our duty to hand them on in the full richness of their authenticity.

It is essential that the principles guiding the preservation and restoration of ancient buildings should be agreed and be laid down on an international basis, with each country being responsible for applying the plan within the framework of its own culture and traditions.

By defining these basic principles for the first time, the Athens Charter of 1931 contributed towards the development of an extensive international movement which has assumed concrete form in national documents, in the work of ICOM and UNESCO and in the establishment by the latter of the International Centre for the Study of the Preservation and the Restoration of Cultural Property. Increasing awareness and critical study have been brought to bear on problems which have continually become more complex and varied; now the time has come to examine the Charter afresh in order to make a thorough study of the principles involved and to enlarge its scope in a new document.

Accordingly, the IIInd International Congress of Architects and Technicians of Historic Monuments, which met in Venice from May 25th to 31st 1964, approved the following text:

DEFINITIONS

Article 1.

The concept of a historic monument embraces not only the single architectural work but also the urban or rural setting in which is found the evidence of a particular civilization, a significant development or a historic event. This applies not only to great works of art but also to more modest works of the past which have acquired cultural significance with the passing of time.

Article 2.

The conservation and restoration of monuments must have recourse to all the sciences and techniques which can contribute to the study and safeguarding of the architectural heritage.

Article 3.

The intention in conserving and restoring monuments is to safeguard them no less as works of art than as historical evidence.
CONSERVATION

Article 4.

It is essential to the conservation of monuments that they be maintained on a permanent basis.

Article 5.

The conservation of monuments is always facilitated by making use of them for some socially useful purpose. Such use is therefore desirable but it must not change the lay-out or decoration of the building. It is within these limits only that modifications demanded by a change of function should be envisaged and may be permitted.

Article 6.

The conservation of a monument implies preserving a setting which is not out of scale. Wherever the traditional setting exists, it must be kept. No new construction, demolition or modification which would alter the relations of mass and colour must be allowed.

Article 7.

A monument is inseparable from the history to which it bears witness and from the setting in which it occurs. The moving of all or part of a monument cannot be allowed except where the safeguarding of that monument demands it or where it is justified by national or international interest of paramount importance.

Article 8.

Items of sculpture, painting or decoration which form an integral part of a monument may only be removed from it if this is the sole means of ensuring their preservation.

RESTORATION

Article 9.

The process of restoration is a highly specialized operation. Its aim is to preserve and reveal the aesthetic and historic value of the monument and is based on respect for original material and authentic documents. It must stop at the point where conjecture begins, and in this case moreover any extra work which is indispensable must be distinct from the architectural composition and must bear a contemporary stamp. The restoration in any case must be preceded and followed by an archaeological and historical study of the monument.

Article 10.

Where traditional techniques prove inadequate, the consolidation of a monument can be achieved by the use of any modern technique for conservation and construction, the efficacy of which has been shown by scientific data and proved by experience.

Article 11.

The valid contributions of all periods to the building of a monument must be respected, since unity of style is not the aim of a restoration. When a building includes the superimposed work of different periods, the revealing of the underlying state can only be justified in exceptional circumstances and when what is
removed is of little interest and the material which is brought to light is of great historical, archaeological or aesthetic value, and its state of preservation good enough to justify the action. Evaluation of the importance of the elements involved and the decision as to what may be destroyed cannot rest solely on the individual in charge of the work.

**Article 12.**

Replacements of missing parts must integrate harmoniously with the whole, but at the same time must be distinguishable from the original so that restoration does not falsify the artistic or historic evidence.

**Article 13.**

Additions cannot be allowed except in so far as they do not detract from the interesting parts of the building, its traditional setting, the balance of its composition and its relation with its surroundings.

**HISTORIC SITES**

**Article 14.**

The sites of monuments must be the object of special care in order to safeguard their integrity and ensure that they are cleared and presented in a seemly manner. The work of conservation and restoration carried out in such places should be inspired by the principles set forth in the foregoing articles.

**EXCAVATIONS**

**Article 15.**

Excavations should be carried out in accordance with scientific standards and the recommendation defining international principles to be applied in the case of archaeological excavation adopted by UNESCO in 1956.

Ruins must be maintained and measures necessary for the permanent conservation and protection of architectural features and of objects discovered must be taken. Furthermore, every means must be taken to facilitate the understanding of the monument and to reveal it without ever distorting its meaning. All reconstruction work should however be ruled out "a priori". Only anastylosis, that is to say, the reassembling of existing but dismembered parts can be permitted. The material used for integration should always be recognizable and its use should be the least that will ensure the conservation of a monument and the reinstatement of its form.

**PUBLICATION**

**Article 16.**

In all works of preservation, restoration or excavation, there should always be precise documentation in the form of analytical and critical reports, illustrated with drawings and photographs. Every stage of the work of clearing, consolidation, rearrangement and integration, as well as technical and formal features identified during the course of the work, should be included. This record should be placed in the archives of a public institution and made available to research workers. It is recommended that the report should be published.
The following persons took part in the work of the Committee for drafting the International Charter for the Conservation and Restoration of Monuments:

Piero Gazzola (Italy), Chairman Raymond Lemaire (Belgium), Reporter José Bassegoda-Nonell (Spain)
Luis Benavente (Portugal)
Djurdje Boskovic (Yugoslavia)
Hiroshi Daifuku (UNESCO)
P.L. de Vrieze (Netherlands)
Harald Langberg (Denmark)
Mario Matteucci (Italy)
Jean Merlet (France)
Carlos Flores Marini (Mexico)
Roberto Pane (Italy)
S.C.J. Pavel (Czechoslovakia)
Paul Philippot (ICCROM)
Victor Pimentel (Peru)
Harold Penderleith (ICCROM) Deoclecio Redig de Campos (Vatican) Jean Sonnier (France)
Francois Sorlin (France)
Eustathios Stikas (Greece)
Gertrud Tripp (Austria)
Jan Zachwatowicz (Poland)
Mustafa S. Zbiss (Tunisia)
The Nara Document on Authenticity

PREAMBLE

1. We, the experts assembled in Nara (Japan), wish to acknowledge the generous spirit and intellectual courage of the Japanese authorities in providing a timely forum in which we could challenge conventional thinking in the conservation field, and debate ways and means of broadening our horizons to bring greater respect for cultural and heritage diversity to conservation practice.

2. We also wish to acknowledge the value of the framework for discussion provided by the World Heritage Committee’s desire to apply the test of authenticity in ways which accord full respect to the social and cultural values of all societies, in examining the outstanding universal value of cultural properties proposed for the World Heritage List.

3. The Nara Document on Authenticity is conceived in the spirit of the Charter of Venice, 1964, and builds on it and extends it in response to the expanding scope of cultural heritage concerns and interests in our contemporary world.

4. In a world that is increasingly subject to the forces of globalization and homogenization, and in a world in which the search for cultural identity is sometimes pursued through aggressive nationalism and the suppression of the cultures of minorities, the essential contribution made by the consideration of authenticity in conservation practice is to clarify and illuminate the collective memory of humanity.

CULTURAL DIVERSITY AND HERITAGE DIVERSITY

5. The diversity of cultures and heritage in our world is an irreplaceable source of spiritual and intellectual richness for all humankind. The protection and enhancement of cultural and heritage diversity in our world should be actively promoted as an essential aspect of human development.

6. Cultural heritage diversity exists in time and space, and demands respect for other cultures and all aspects of their belief systems. In cases where cultural values appear to be in conflict, respect for cultural diversity demands acknowledgment of the legitimacy of the cultural values of all parties.

7. All cultures and societies are rooted in the particular forms and means of tangible and intangible expression which constitute their heritage, and these should be respected.

8. It is important to underline a fundamental principle of UNESCO, to the effect that the cultural heritage of each is the cultural heritage of all. Responsibility for cultural heritage and the management of it belongs, in the first place, to the cultural community that has generated it, and subsequently to that which cares for it. However, in addition to these responsibilities, adherence to the international charters and conventions developed for conservation of cultural heritage also obliges consideration of the principles and responsibilities flowing from them. Balancing their own requirements with those of other cultural communities is, for each community, highly desirable, provided achieving this balance does not undermine their fundamental cultural values.

VALUES AND AUTHENTICITY

9. Conservation of cultural heritage in all its forms and historical periods is rooted in the values attributed to the heritage. Our ability to understand these values depends, in part, on the degree to which information sources about these values may be understood as credible or truthful. Knowledge and understanding of these sources of information, in relation to original and subsequent characteristics of the cultural heritage, and their meaning, is a requisite basis for assessing all aspects of authenticity.
10. Authenticity, considered in this way and affirmed in the Charter of Venice, appears as the essential qualifying factor concerning values. The understanding of authenticity plays a fundamental role in all scientific studies of the cultural heritage, in conservation and restoration planning, as well as within the inscription procedures used for the World Heritage Convention and other cultural heritage inventories.

11. All judgements about values attributed to cultural properties as well as the credibility of related information sources may differ from culture to culture, and even within the same culture. It is thus not possible to base judgements of values and authenticity within fixed criteria. On the contrary, the respect due to all cultures requires that heritage properties must be considered and judged within the cultural contexts to which they belong.

12. Therefore, it is of the highest importance and urgency that, within each culture, recognition be accorded to the specific nature of its heritage values and the credibility and truthfulness of related information sources.

13. Depending on the nature of the cultural heritage, its cultural context, and its evolution through time, authenticity judgements may be linked to the worth of a great variety of sources of information. Aspects of the sources may include form and design, materials and substance, use and function, traditions and techniques, location and setting, and spirit and feeling, and other internal and external factors. The use of these sources permits elaboration of the specific artistic, historic, social, and scientific dimensions of the cultural heritage being examined.

APPENDIX 1

Suggestions for follow-up (proposed by H. Stovel)

1. Respect for cultural and heritage diversity requires conscious efforts to avoid imposing mechanistic formulae or standardized procedures in attempting to define or determine authenticity of particular monuments and sites.

2. Efforts to determine authenticity in a manner respectful of cultures and heritage diversity requires approaches which encourage cultures to develop analytical processes and tools specific to their nature and needs. Such approaches may have several aspects in common:
   - efforts to ensure assessment of authenticity involve multidisciplinary collaboration and the appropriate utilization of all available expertise and knowledge;
   - efforts to ensure attributed values are truly representative of a culture and the diversity of its interests, in particular monuments and sites;
   - efforts to document clearly the particular nature of authenticity for monuments and sites as a practical guide to future treatment and monitoring;
   - efforts to update authenticity assessments in light of changing values and circumstances.

3. Particularly important are efforts to ensure that attributed values are respected, and that their determination includes efforts to build, as far as possible, a multidisciplinary and community consensus concerning these values.

4. Approaches should also build on and facilitate international co-operation among all those with an interest in conservation of cultural heritage, in order to improve global respect and understanding for the diverse expressions and values of each culture.
5. Continuation and extension of this dialogue to the various regions and cultures of the world is a prerequisite to increasing the practical value of consideration of authenticity in the conservation of the common heritage of humankind.

6. Increasing awareness within the public of this fundamental dimension of heritage is an absolute necessity in order to arrive at concrete measures for safeguarding the vestiges of the past. This means developing greater understanding of the values represented by the cultural properties themselves, as well as respecting the role such monuments and sites play in contemporary society.

**APPENDIX 2**

**Definitions**

**Conservation:** all efforts designed to understand cultural heritage, know its history and meaning, ensure its material safeguard and, as required, its presentation, restoration and enhancement. (Cultural heritage is understood to include monuments, groups of buildings and sites of cultural value as defined in article one of the World Heritage Convention).

Information sources: all material, written, oral and figurative sources which make it possible to know the nature, specifications, meaning and history of the cultural heritage.

The Nara Document on Authenticity was drafted by the 45 participants at the Nara Conference on Authenticity in Relation to the World Heritage Convention, held at Nara, Japan, from 1-6 November 1994, at the invitation of the Agency for Cultural Affairs (Government of Japan) and the Nara Prefecture. The Agency organized the Nara Conference in cooperation with UNESCO, ICCROM and ICOMOS.

This final version of the Nara Document has been edited by the general rapporteurs of the Nara Conference, Mr. Raymond Lemaire and Mr. Herb Stovel.
Principles and Rules in the Research

**Transformation Requirement**

The requirements are aimed to help make a proper anti-seismic intervention on the architecture of Onderdendamsterweg 8 in consideration of conserving its heritage value. In some cases, it may also be used as transformation requirements for other kop-hals-romp boerderij with critical thinking and contextual application:

**LOCATION**
1. The interventions must be operated in the places where there will be no distracts to the balance of the architectural composition, the original load bearing scheme, the artistic facade details, and the decoration that reflects the culture of rural life in the area.
2. The interventions should be hide in most cases and shouldn’t disturb the integrity of the historical appearance. In case of exposure, the intervention must be modest and compatible with the building.

**MATERIAL**
1. The material choice for the intervention must respond harmoniously to the original mass. In case of exposure, the size, shape and position of the added material must be carefully considered to ensure the compatibility.

**DESIGN**
1. The intervention should ensure the safety requirements and must not introduce new damage to the original building.
2. Replacement and removal are allowed only when the operation doesn’t contrast with, but rather enhance the appreciation aspects elaborated in the evaluation.

**PURPOSE**
1. On top of safety consideration, the design of the upgraded details also aim to enhance the (authenticity) of the building by responding to characterization of the old design and historical and social context.

**MAINTANENCE**
1. All interventions should follow the principle of retreatability and repairability, and does not exclude further treatment.

**Intervention Methods**

a. Reinforcement of single components: walls, floor slabs, plates, etc;
b. Reduce deformation restraints at connections;
c. Adjust the stiffness differences between components; (reduce or separate, under certain circumstances, it’s very hard to reduce the stiffness differences between different components (or structural system), in this sense, the difference should be accepted while the treatment may be proper separation between the two different systems or components).
d. Adjust load path and load distribution.