Quantifying climate risk:

Foundation damage from drought in mortgage portfolios – Differential settlement

Achmea Mortgages

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- 400,000 Dutch homes face pile rot or differential settlement. This paper analyzes differential settlement: uneven foundation sinking from subsidence on clay and peat soils. Unlike pile rot, damage may recur.
- Portfolio-level financial impact remains limited at 0.3 basis points over the mortgage lifetime. The National Mortgage Guarantee (NHG) and loan-to-value headroom provide strong mitigation.
- Combined with pile rot, total foundation risk reaches 0.7 basis points.
- Achmea Mortgages has expanded its green loan with climate-adaptive measures, helping homeowners protect properties and reduce risk.

Introduction

This paper is part two of the foundation damage study and follows the analysis of pile rot in part one. For overall context, portfolio background, and shared assumptions, see part one. The focus here is on differential settlement and its financial implications for the mortgage portfolio.

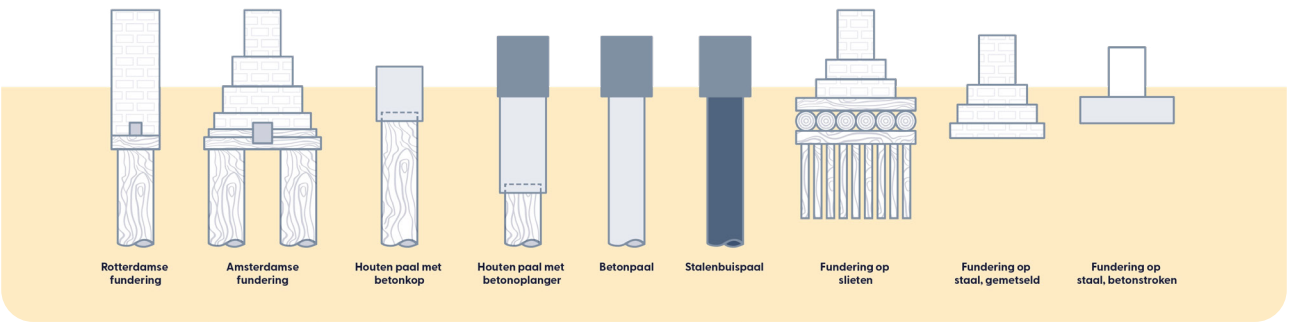
Achmea Mortgages has already carried out an assessment of its portfolio and the financial implications of foundation damage due to pile rot, which is one of the types of foundation damage relevant to Dutch homeowners. The extra expected loss over the lifetime of the mortgages was found to be 0.4 basis points, showing that on a portfolio level the risk is very much manageable from a financial standpoint. Pile rot is however is not the only kind of foundation damage driver in the Netherlands. A large part of the 400.000 homes at risk of foundation damage (source: RIi) can be affected by other foundation damage driver: differential settlement. Therefore Achmea Mortgages has decided to quantitatively model the potential costs associated with foundation damage due to differential settlement within its mortgage portfolio too.

The second part of this study on quantifying foundation damage risk addresses the key drivers and associated costs of differential settlement damage. It then outlines the methodology employed for cost modeling, followed by a presentation of the analysis results.

The results show that for foundation damage due to differential settlement the aggregate financial risk for investors is limited due to strong mitigation measures and portfolio diversification, while individual homeowners may face substantial hardship.

Drivers behind differential settlement damage

FIGURE 1: TYPES OF FOUNDATIONS USED IN THE NETHERLANDS (SOURCE: FUNDERMAPS)



Part one describes the main Dutch foundation types. This section focuses on shallow foundations on clay and peat soils *(fundering op staal)*, which are sensitive to drought-driven subsidence and differential settlement. Properties built after 1975 are generally assumed to have deep or concrete foundations and are therefore less exposed to damage from differential settlement.

The land subsidence that affects these shallow foundations is intensified by peat decomposition and changes in groundwater levels that remove soil moisture. This leads to differential settlement, causing structural stress, cracking, and eventually the need for major repairs. Drought further increases these risks (source: Deltares).

The costs of differential settlement damage

Repair cost classes (D1 to D5) and distributions are the same as in part one. For differential settlement, these classes are applied with the important caveat that damage can return if subsidence continues. As the time until return can be decades it is assumed that damage happens only once during the mortgage lifetime.

TABLE 1: FOUNDATION REPAIR DAMAGE COST CLASSES (SOURCE: KCAF)

Damage class	Required repair work	Repair cost (mean μ, stdev σ)	
D1	Interior painting	μ: €1,610	σ: €966
D2	+ Filling/repairing cracks (exterior), scaffold rental	μ: €3,542	σ: €1,673
D3	+ Plasterwork repair	μ: €7,728	σ: €5,152
D4	+ Repair of window frames and floors	μ: €45,080	σ: €32,200
D5	+ Foundation repair	μ: €96,600	σ: €57,960

Modelling differential settlement risk

The modelling approach for differential settlement uses the same Monte Carlo simulation as used for pile rot damage. For each property, the likely foundation type is determined using neighbourhood prevalence data. Shallow foundations constructed on sandy soils are generally considered stable with respect to differential settlement risk. The Klimaateffectatlas provides neighbourhood-level vulnerability for shallow foundations, expressed as the expected damage class by 2050. Damage progression is assumed to be linear, with interpolation from year of construction to 2050, to estimate the maximum damage class during the mortgage's lifetime. After the maximum class is set, the timing of damage is simulated and repair costs are drawn from a lognormal distribution with mean and variance as stated in table 1.

Present value calculations and credit risk modelling

Discounting of future expected repair costs and the credit risk modelling approach are identical to those in part one. The same assumptions are used for present value calculations, and credit losses are estimated using the same structural model. Mitigating factors such as loan-to-value headroom and the National Mortgage Guarantee are applied in the same way. For details, please see part one.

Results

Applying the model to the Achmea Mortgages portfolio shows that most properties are not affected by differential settlement. Homes built after 1975 are assumed to have deep or concrete foundations, reducing the number of potentially affected homes by 52.7%.

Many pre-1975 homes are also located in areas not susceptible to differential settlement, such as shallow foundation homes not built on clay or peat soils.

Overall, about 5.8% of the portfolio consists of homes that may be at risk of differential settlement. Within this group, 5.1% of the total portfolio is expected to fall into damage class 1 to 3 by 2050. An additional 0.7% could fall into damage class 4 or 5, indicating a relatively higher risk of severe damage. However, because the overall share of homes exposed to differential settlement is small, the potential impact on the portfolio remains limited.

Figure 3 shows the distribution of damage classes within the Achmea Mortgages portfolio related to differential settlement.

With the mean damage for properties below the D4 damage classes being less than around €45.000 and most of the affected portfolio being in these damage classes the percentage of properties facing an expected loss is limited. Figure 4 shows the percentage of properties in the total portfolio facing an expected loss, divided amongst the damage classes. It is evident that as damage becomes more severe, the portion of properties expected to incur a loss increases substantially. However, because there is often a significant loan-to-value headroom, the financial impact of these losses is typically small.

As a share of the total Achmea Mortgages portfolio the number of properties with an expected loss due to differential settlement is 0.3%. Taking into account the size of the expected loss the extra expected loss due to differential settlement damage within the portfolio is 0.3 basis points over the lifetime of the mortgages.

FIGURE 2: THE PART OF THE PORTFOLIO THAT COULD BE AFFECTED BY DIFFERENTIAL SETTLEMENT

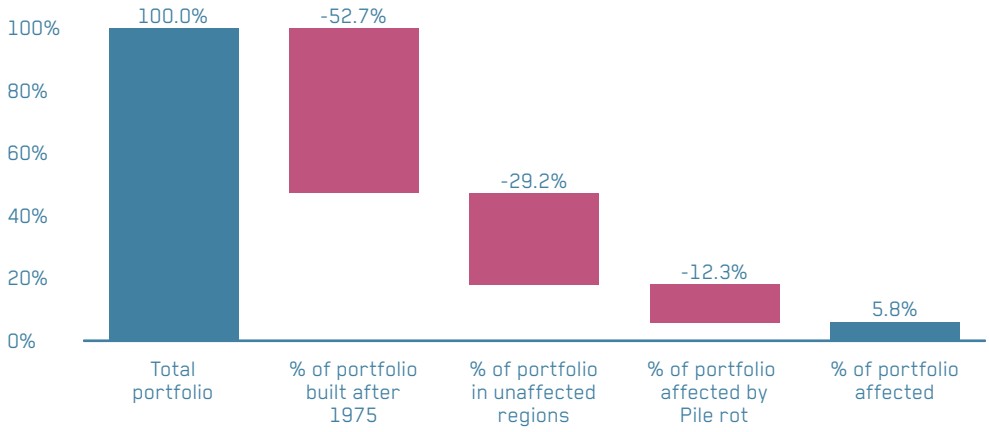


FIGURE 3: DISTRIBUTION OF DAMAGE CLASSES WITHIN THE ACHMEA MORTGAGES PORTFOLIO

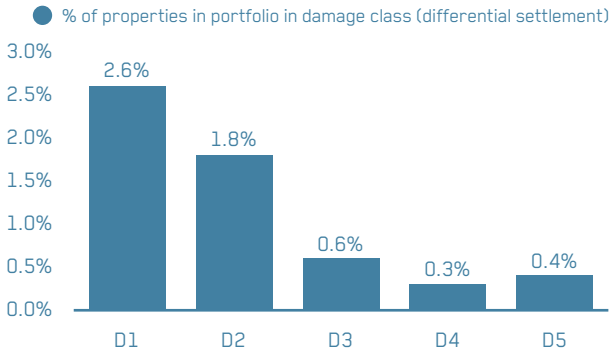
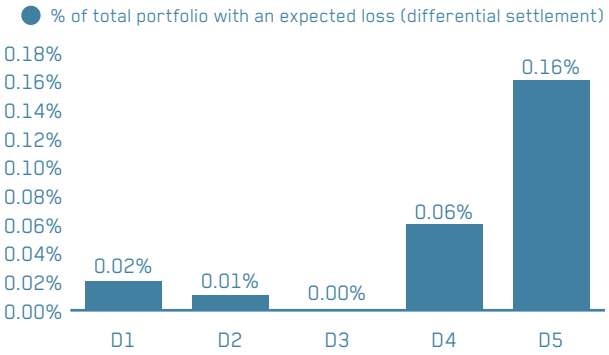


FIGURE 4: SHARE OF PROPERTIES WITH AN EXPECTED LOSS PER DAMAGE CLASS



Conclusion

This paper on differential settlement is part two of our foundation damage series and follows the analysis of pile rot in part one. Read together, the two papers provide a complete view of drought-related foundation risk in the portfolio. The majority of the risk is concentrated in a minority of homes, primarily those built before 1975.

About 18.1% of the portfolio may be susceptible to either pile rot or differential settlement. For differential settlement, about 5.8% of the total portfolio is expected to be exposed by 2050. Around 5.4% is expected to remain in damage classes D1 to D4, and about 0.4% could reach D5.

For pile rot, most affected properties fall in the lower damage classes and severe cases are rare.

The financial impact at portfolio level is small. The expected loss from pile rot is about 0.4 basis points over the life of the mortgages. The expected loss from differential settlement is about 0.3 basis points. Together this combined equals an expected loss of about 0.7 basis points. Exposure at default is also limited, supported by loan-to-value headroom and the National Mortgage Guarantee.

For individual homeowners the consequences can be severe. Repair costs can be high and disruption can be significant. To further reduce risk and support home-owners, Achmea Mortgages has expanded its green loan to include climate-adaptive measures alongside energy efficiency improvements. The climate-adaptive measures support foundation protection, water management, and other improvements that enhance resilience against drought-related foundation damage.

In short, part one shows that pile rot is manageable at portfolio scale, and part two confirms the same for differential settlement. Combined, the analysis indicates that foundation damage is a manageable financial risk for investors, while reinforcing the need to identify issues early and support affected homeowners.

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