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03 June 2026

Deformation under Load before and after ageing of DRAINplus products DN300 & DN360

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According to EAD 280001-00-0704 items 2.2.3, 2.2.10 upto 2.2.12

Colophon

Title	Deformation under Load before and after ageing of DRAINplus products DN300 & DN360
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P000505420HM00
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Contents

1. Introduction 4
2. Sample information 4
3. Test program 4
4. Results 5
5. Discussion 7
6. Conclusion 8

Annex-1: Individual results 9

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1. Introduction

This report presents the results of deformation-under-load testing commissioned by STOROpack Nederland B.V. and performed by Kiwa Nederland B.V. The tests were carried out in the context of the DRAINplus European Technical Assessment (ETA) process and cover the requirement “Deformation under Load” as specified in EAD 280001-00-0704. In accordance with quotation QUO-298434-R5N8V0, the test programme addresses EAD clauses 2.2.3, 2.2.10, 2.2.11 and 2.2.12 for two DRAINplus product types (DN300 and DN360).

In addition to testing of as-received samples (EAD 2.2.3), Kiwa conditioned part of the received samples prior to testing in accordance with the EAD. This included oxidative ageing (EAD 2.2.10) and hydrolysis (EAD 2.2.11). Microbiological ageing (EAD 2.2.12) was carried out by STOROpack by burying and subsequently excavating production samples in active soil; these activities were witnessed by Kiwa. For further background information on the microbiological ageing procedure within the DRAINplus ETA process, see STOROpack’s SPP 47 examination report dated 02 June 2025.

The objective is to determine the deformation-under-load behaviour of the submitted specimens before and after ageing and to provide documented test data for further technical evaluation and project documentation.

2. Sample information

Table 1 provides an overview of the samples received for deformation-under-load testing, including as-received products and microbiologically aged products.

Table 1: Samples received from STOROpack Nederland B.V.

Product type	As-received (new)	Microbiologically aged	Total received
DRAINplus DN300	16	5	21
DRAINplus DN360	16	5	21
Total	**32**	**10**	**42**

3. Test program

This chapter describes the test programme applied to the DRAINplus DN300 and DN360 samples, including conditioning/ageing and the deformation-under-load test procedure.

- All specimens were tested for indentation (deformation under load) according to EAD 280001-00-0704, following the procedures described in clauses 2.2.3, 2.2.10, 2.2.11 and 2.2.12.
- For each diameter (DN300 and DN360), five (5) specimens were subjected to oxidative ageing in a hot-air oven at 70 °C for 14 days (EAD 2.2.10).
- For each diameter (DN300 and DN360), two (2) specimens were subjected to hydrolysis by immersion in hot water at 60 °C, 70 °C and 80 °C prior to testing (EAD 2.2.11).
- Microbiologically aged specimens (EAD 2.2.12) were provided by STOROpack after burial and excavation in active soil (see Section 1).
- Indentation testing was carried out in accordance with EN ISO 604, using a crosshead/indentation speed of 2 mm/min.
- The deformation was determined at indentation forces of 1.5 kN, 3.0 kN, 6.0 kN and 10 kN (where achievable for the specimen/test set-up).
- After deformation-under-load testing, the aggregates were inspected. The initial assessment was carried out visually. For the DRAINplus DN300 product, a quantitative assessment was also performed using a representative aggregate sample of approximately 100 g. The aggregates in this sample were examined individually and classified as undamaged, slightly damaged, or broken. The mass of each category was determined and expressed as a percentage to obtain a quantitative rating. The same assessment was also carried out on untested products.

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4. Results

This chapter summarises the deformation-under-load results for DRAINplus DN300 and DN360.

For each condition, the mean deformation (mm) is reported at indentation forces of 1.5 kN, 3.0 kN, 6.0 kN and 10 kN, calculated from the individual tests.

Table 2 presents the mean deformation values for DRAINplus DN300, and Table 3 presents the mean deformation values for DRAINplus DN360. The results are also presented in Graphs 1 and 2 for DN300 and DN360, respectively. The individual results are presented in Annex 1.

Visual inspection showed no observable differences in the aggregates before and after testing. The results of the aggregate rating for DRAINplus DN300 are presented in Table 4.

Table 2: DRAINplus DN300 deformation under load before and after ageing (mean values)

Load	**1,5 kN**	**3,0 kN**	**6,0 kN**	**10 kN**	**Unit**
As received	**30**	**44**	**63**	**82**	mm
After oxidative ageing at 70°C	**39**	**53**	**71**	**89**	mm
After hydrolysis ageing at 60°C	**35**	**48**	**66**	**84**	mm
After hydrolysis ageing at 70°C	**44**	**56**	**74**	**92**	mm
After hydrolysis ageing at 80°C	**33**	**45**	**63**	**81**	mm
After microbiological ageing (22 weeks)	**27**	**39**	**56**	**74**	mm
Min	***27***	***39***	***56***	***74***	*mm*
Max	***44***	***56***	***74***	***92***	*mm*
Range	***17***	***17***	***18***	***18***	*mm*

Table 3: DRAINplus DN360 deformation under load before and after ageing (mean values)

Load	**1,5 kN**	**3,0 kN**	**6,0 kN**	**10 kN**	**Unit**
As received	**42**	**56**	**74**	**91**	mm
After oxidative ageing at 70°C	**30**	**43**	**61**	**78**	mm
After hydrolysis ageing at 60°C	**38**	**50**	**68**	**87**	mm
After hydrolysis ageing at 70°C	**53**	**68**	**88**	**107**	mm
After hydrolysis ageing at 80°C	**32**	**45**	**63**	**79**	mm
After microbiological ageing (22 weeks)	**32**	**44**	**61**	**79**	mm
Min	***30***	***43***	***61***	***78***	*mm*
Max	***53***	***68***	***88***	***107***	*mm*
Range	***23***	***25***	***27***	***29***	*mm*

Table 4: DRAINplus DN300 rating of aggregates

DRAINplus diameter	**DN300**		
Description	**Undamaged**	**small damage**	**Broken**
No deformation	**97,2%**	**2,1%**	**0,7%**
Deformation under load (initial)	**97,4%**	**2,0%**	**0,7%**
Deformation under load (oxidative ageing 70°C)	**99,7%**	**0,2%**	**0,2%**
Deformation under load (hydrolysis ageing 80°C)	**97,3%**	**2,0%**	**0,6%**
Deformation under load after microbiological ageing	**98,2%**	**1,4%**	**0,5%**
Overall rating	**>97**	**<2**	**<1**

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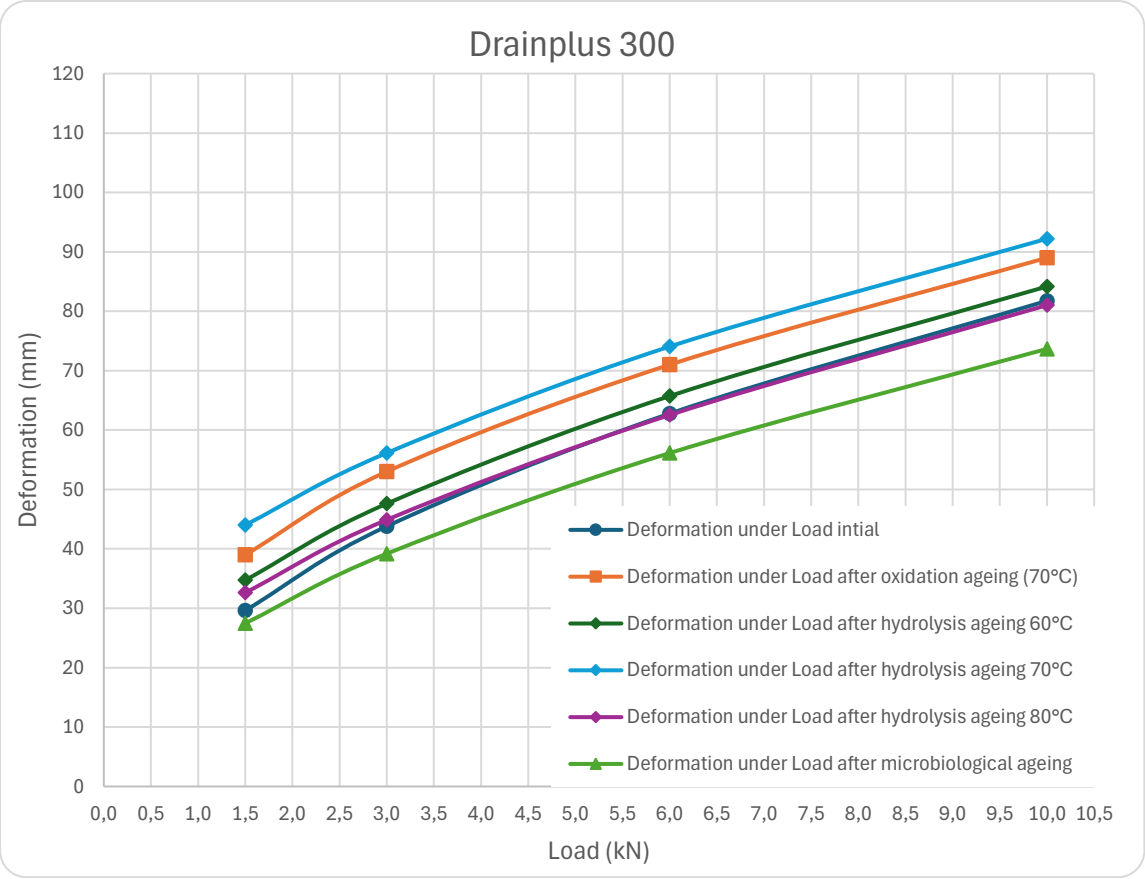
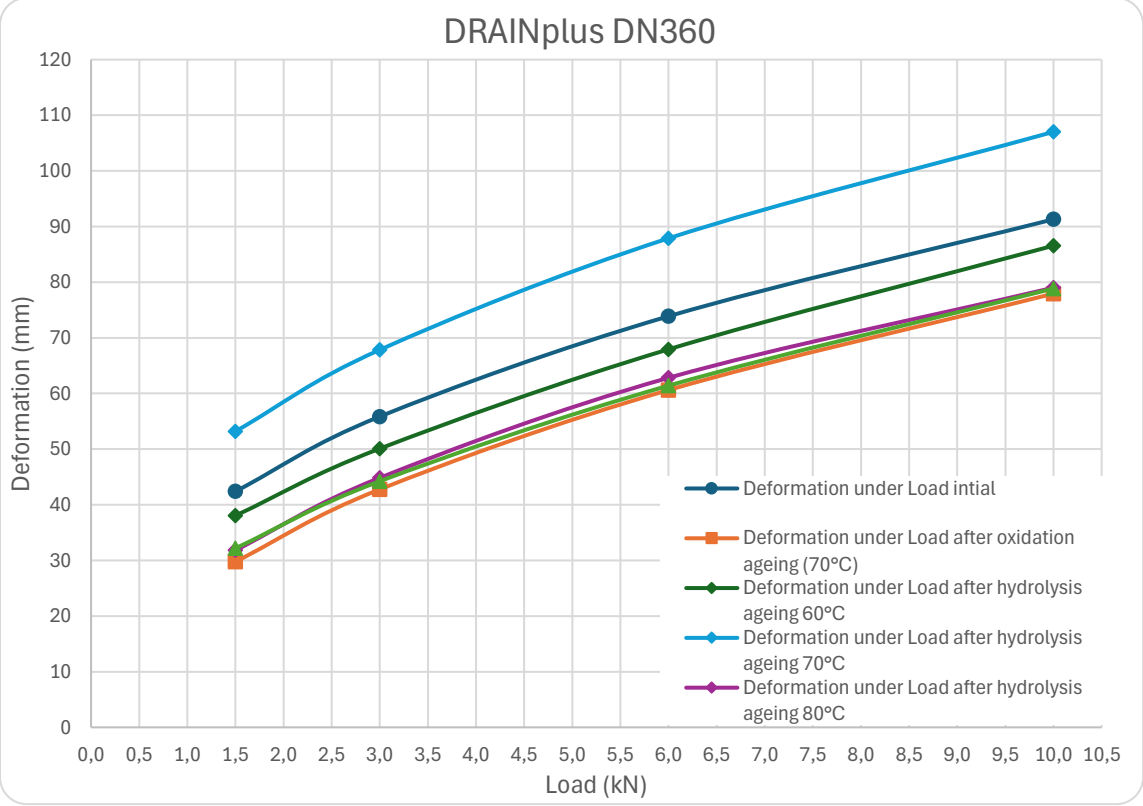


Graph 1: mean values for deformation under load before and after ageing DRAINplus DN300.



Graph 2: mean values for deformation under load before and after ageing DRAINplus DN360.

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5. Discussion

This chapter discusses the main observations from the deformation-under-load testing of DRAINplus DN300 and DN360 before and after ageing. The discussion is based on the mean values presented in Tables 2 and 3 and Graphs 1 and 2 as well as all results as presented in Annex 1.

In the as-received condition, DN360 shows a slightly higher deformation than DN300 at all load levels. This is consistent with the larger diameter of this product.

Oxidative ageing (70 °C, 14 days) leads to a slightly increased deformation for DN300 across the full load range, which could indicate a softening effect under the applied test conditions. However for DN360, the mean deformation decreases slightly after oxidative ageing compared with the as-received condition. Therefore there appears to be no clear effect of oxidative ageing on the DRAINplus products.

After hydrolysis ageing, the effect seems to depend on water temperature. At 60 °C, both diameters show an increase in deformation relative to the as-received condition. At 70 °C, the deformation increases further for both DN300 and DN360, representing the highest mean values observed in this test series. At 80 °C, the mean deformation reduces again for both diameters compared with 70 °C, resulting in values close to the as-received condition. Overall, the test results show a non-linear temperature dependence for hydrolysis ageing between 60 °C and 80 °C. Therefore there appears to be no clear hydrolytic ageing effect, as any such effect would be expected to increase with increasing temperature.

Microbiological ageing results in a reduction of the mean deformation for DN300 compared with the as-received condition, while for DN360 the mean deformation is also lower than as-received at all load levels. Within the scope of this report, microbiological ageing therefore does not lead to an increase in deformation under the applied test method.

The repeatability varies by condition. For example, DN300 after oxidative ageing shows a comparatively large scatter (as reflected by the standard deviation values in the test data), whereas the DN360 results after hydrolysis at 60 °C show relatively low scatter. When interpreting these findings, it should be noted that the number of replicates differs per condition (e.g., five tests for the as-received and oxidative-aged series, and two tests for each hydrolysis temperature). In addition, for one DN300 as-received test, values at 6 kN and 10 kN were not available, which may slightly affect the calculated mean values at higher loads.

The assessment of the condition of the aggregates after testing showed no significant difference in the degree of aggregate damage before and after testing. Based on these results, the applied deformation under load did not result in relevant damage to the aggregates.

Overall, the results do not show a consistent change in deformation under load after oxidative, hydrolytic or microbiological ageing of the DRAINplus products. Although some differences between test conditions were observed, these differences were not systematic and were probably not significant. They may partly be related to test scatter, repeatability, and the limited number of replicates for some conditions. In addition, no relevant change in aggregate damage was observed after testing. Within the scope of this investigation, the ageing procedures applied did not indicate a clear adverse effect on the deformation-under-load behaviour of DRAINplus DN300 and DN360.

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6. Conclusion

The reference deformation-under-load values of the DRAINplus products in the unaged condition are presented in Table 5 for DN300 and Table 6 for DN360. These values represent the deformation behaviour of the products as supplied.

The additional ageing tests did not show a consistent adverse effect on the deformation-under-load behaviour of DRAINplus DN300 and DN360.

Although some differences between test conditions were observed, these were not systematic and were probably influenced in part by test scatter, repeatability, and the limited number of replicates for some conditions.

No relevant change in aggregate damage was observed after testing.

Table 5: Reference deformation-under-load values for DRAINplus DN300

Load (kN)	Reference value	Unit
1,5	**30**	mm
3,0	**44**	mm
6,0	**63**	mm
10,0	**82**	mm

Table 6: Reference deformation-under-load values for DRAINplus DN360

Load (kN)	Reference value	Unit
1,5	**42**	mm
3,0	**56**	mm
6,0	**74**	mm
10,0	**91**	mm

Rijswijk, 03 June 2026

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Annex-1: Individual results

Table 7: Deformation under load as received of DRAINplus DN 300

Size	DN300			
Load (kN)	**1,5**	**3,0**	**6,0**	**10,0**
Test-1	33,6	46,6	64,5	82,9
Test-2	28,5	43,7	62,1	80,8
Test-3	28,0	42,5	62,4	82,4
Test-4	28,5	42,6	62,0	80,9
Test-5	29,5	43,6	-	-
Mean value of deformation (mm)	**30**	**44**	**63**	**82**
Standard deviation	**2**	**1**	**1**	**1**
Min	**28**	**43**	**62**	**81**
Max	**34**	**47**	**65**	**83**
Delta Max/Min	**6**	**4**	**2**	**2**

Table 8: Deformation under load as received of DRAINplus DN 360

Size	DN360			
Load (kN)	**1,5**	**3,0**	**6,0**	**10,0**
Test-1	41,2	55,6	74,3	92,2
Test-2	41,1	54,0	71,7	88,4
Test-3	44,1	56,9	74,5	91,9
Test-4	40,4	54,2	72,1	89,3
Test-5	45,2	58,6	76,8	94,8
Mean value of deformation (mm)	**42**	**56**	**74**	**91**
Standard deviation	**2**	**2**	**2**	**2**
Min	**40**	**54**	**72**	**88**
Max	**45**	**59**	**77**	**95**
Delta Max/Min	**5**	**5**	**5**	**6**

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Table 9: Deformation under load after 14 days of oxidative ageing at 70°C DRAINplus DN300

Size	DN300			
Load (kN)	**1,5**	**3,0**	**6,0**	**10,0**
Test-1	54,4	67,5	85,7	102,3
Test-2	32,0	44,7	62,9	81,1
Test-3	39,5	53,4	71,7	90,5
Test-4	29,2	41,7	59,4	77,2
Test-5	41,8	55,2	74,1	93,0
Mean value of deformation (mm)	**39**	**53**	**71**	**89**
Standard deviation	**9**	**9**	**9**	**9**
Min	**29**	**42**	**59**	**77**
Max	**54**	**68**	**86**	**102**
Delta Max/Min	**25**	**26**	**26**	**25**

Table 10: Deformation under load after 14 days of oxidative ageing at 70°C DRAINplus DN360

Size	DN360			
Load (kN)	**1,5**	**3,0**	**6,0**	**10,0**
Test-1	30,5	42,7	60,4	78,5
Test-2	30,8	43,4	61,0	77,4
Test-3	29,6	42,8	60,5	78,1
Test-4	30,9	44,8	63,3	80,8
Test-5	26,9	40,2	57,9	74,9
Mean value of deformation (mm)	**30**	**43**	**61**	**78**
Standard deviation	**1**	**1**	**2**	**2**
Min	**27**	**40**	**58**	**75**
Max	**31**	**45**	**63**	**81**
Delta Max/Min	**4**	**5**	**5**	**6**

Table 11: Deformation under load after 28 days of hydrolysis at 60°C DRAINplus DN300

Size	DN300			
Load (kN)	**1,5**	**3,0**	**6,0**	**10,0**
Test-1	28,7	40,9	58,5	77,0
Test-2	40,8	54,4	72,9	91,3
Mean value of deformation (mm)	**35**	**48**	**66**	**84**
Standard deviation	**6**	**7**	**7**	**7**
Delta Max/Min	**12**	**13**	**14**	**14**

Table 12: Deformation under load after 28 days of hydrolysis at 60°C DRAINplus DN360

Size	DN360			
Load (kN)	**1,5**	**3,0**	**6,0**	**10,0**
Test-1	37,2	49,2	67,2	85,9
Test-2	38,9	51,0	68,7	87,2
Mean value of deformation (mm)	**38**	**50**	**68**	**87**
Standard deviation	**1**	**1**	**1**	**1**
Delta Max/Min	**2**	**2**	**2**	**1**

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Table 13: Deformation under load after 28 days of hydrolysis at 70°C DRAINplus DN300

Size	DN300			
Load (kN)	**1,5**	**3,0**	**6,0**	**10,0**
Test-1	39,5	52,0	69,8	88,0
Test-2	48,6	60,3	78,3	96,4
Mean value of deformation (mm)	**44**	**56**	**74**	**92**
Standard deviation	**5**	**4**	**4**	**4**
Delta Max/Min	**9**	**8**	**9**	**8**

Table 14: Deformation under load after 28 days of hydrolysis at 70°C DRAINplus DN360

Size	DN360			
Load (kN)	**1,5**	**3,0**	**6,0**	**10,0**
Test-1	47,1	61,1	80,4	99,7
Test-2	59,3	74,6	95,3	114,4
Mean value of deformation (mm)	**53**	**68**	**88**	**107**
Standard deviation	**6**	**7**	**7**	**7**
Delta Max/Min	**12**	**13**	**15**	**15**

Table 15: Deformation under load after 28 days of hydrolysis at 80°C DRAINplus DN300

Size	DN300			
Load (kN)	**1,5**	**3,0**	**6,0**	**10,0**
Test-1	31,9	43,0	59,7	77,6
Test-2	33,3	46,7	65,4	84,4
Mean value of deformation (mm)	**33**	**45**	**63**	**81**
Standard deviation	**1**	**2**	**3**	**3**
Delta Max/Min	**1**	**4**	**6**	**7**

Table 16: Deformation under load after 28 days of hydrolysis at 80°C DRAINplus DN360

Size	DN360			
Load (kN)	**1,5**	**3,0**	**6,0**	**10,0**
Test-1	39,0	53,0	71,8	90,2
Test-2	24,6	36,7	53,8	67,8
Mean value of deformation (mm)	**32**	**45**	**63**	**79**
Standard deviation	**7**	**8**	**9**	**11**
Delta Max/Min	**14**	**16**	**18**	**22**

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Table 17: Deformation under load after 22 weeks of microbiological ageing in active soil DRAINplus DN 300

Size	DN300			
Load (kN)	**1,5**	**3,0**	**6,0**	**10,0**
Test-1	28,1	39,9	56,7	74,2
Test-2	24,3	36,8	54,8	72,6
Test-3	30,3	41,0	57,0	73,7
Test-4	25,4	36,8	53,7	71,5
Test-5	29,2	41,3	58,5	76,4
Mean value of deformation (mm)	**27**	**39**	**56**	**74**
Standard deviation	**2**	**2**	**2**	**2**
Min	**24**	**37**	**54**	**71**
Max	**30**	**41**	**58**	**76**
Delta Max/Min	**6**	**5**	**5**	**5**

Table 18: Deformation under load after 22 weeks of microbiological ageing in active soil DRAINplus DN 360

Size	DN360			
Load (kN)	**1,5**	**3,0**	**6,0**	**10,0**
Test-1	25,6	37,5	54,9	72,9
Test-2	28,9	40,5	57,2	74,1
Test-3	33,9	45,6	62,3	79,8
Test-4	32,0	44,2	61,4	78,6
Test-5	40,4	53,4	71,3	88,9
Mean value of deformation (mm)	**32**	**44**	**61**	**79**
Standard deviation	**5**	**5**	**6**	**6**
Min	**26**	**37**	**55**	**73**
Max	**40**	**53**	**71**	**89**
Delta Max/Min	**15**	**16**	**16**	**16**

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