

**Dyckerhoff SULFADUR® Doppel**  
Premium cement for concrete with high sulfate resistance

# Dyckerhoff SULFADUR® Doppel – Premium cement for concrete with high sulfate resistance

Dyckerhoff SULFADUR Doppel has been manufactured using special C<sub>3</sub>A-free cement clinkers for more than 50 years. It therefore reliably meets the requirements made on cement with high sulfate resistance.

The German cement standard DIN EN 197 specifies a special clinker basis for Portland cements that makes it possible to adhere to the limit values stated below. The combination of a specific composition and suitable grinding fineness leads to favorable processing and strength properties.

Dyckerhoff SULFADUR Doppel CEM I 42,5 R-SR 0/LA has proved itself as a dependable Portland cement for use in a sulfate environment for half a century.

Concretes made with Dyckerhoff SULFADUR recommend themselves for all structural components requiring high sulfate resistance, particularly for structural components in direct contact with soil or water, such as pipes, sewer systems and foundation structures.

## Requirements made on Portland cement CEM I

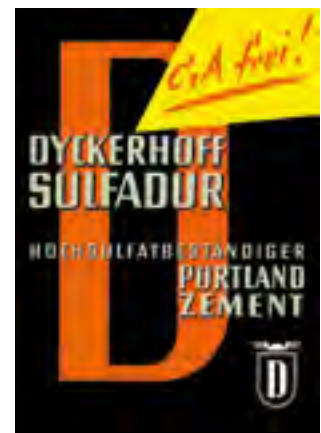
Special feature	High sulfate resistance SR 0	Low alkali content NA
	C <sub>3</sub> A content in the clinker (according to Bogue)	Na <sub>2</sub> O-equivalent
	< 0 M.-%	< 5.00 M.-%
		< 0.60 M.-%

## Cement data (average values)

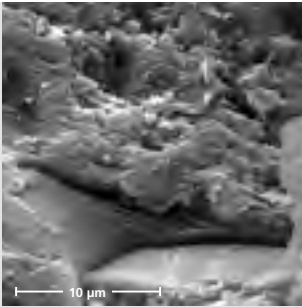
SULFADUR Doppel	CEM I 42,5 R-SR 0/LA
Cement Plant	Lengerich
Water demand [%]	26.5
Initial set [min]	200
Sulfate content SO <sub>3</sub> [%]	2.3
Na <sub>2</sub> O equivalent	0.5
C <sub>3</sub> A content (acc. to Bogue) [%]	0
Al <sub>2</sub> O <sub>3</sub> content [%]	3.5
Compressive strength N <sub>2</sub> [MPa]	28
Compressive strength N <sub>28</sub> [MPa]	59



Concrete pile construction



...for more than 50 years!



Structure of a mortar made with Dyckerhoff SULFADUR following 40 years of storage in Na<sub>2</sub>SO<sub>4</sub> solution!



Filling the pile with concrete



Pile drilling

### Excerpt from FMPA test report 12-26802:

“In 1956, concrete prisms with an edge length of 4 cm x 4 cm x 16 cm were made from Dyckerhoff Sulfadur Doppel – a Portland cement with high sulfate resistance – and 0/7 mm Rhine gravel sand at the Otto Graf Institute. These prisms were then stored under laboratory conditions in a 2.1 % sodium-sulfate solution.

Using the German DIN 4030 assessment standard – waters, soils and gases aggressive to concrete – as a reference, this solution, containing approximately 14,000 mg SO<sub>4</sub>/l, would be classified as highly aggressive to concrete, since the SO<sub>4</sub> content is more than four times higher than the relevant limit value of > 3,000 mg SO<sub>4</sub>/l for this classification. Thus, the results for the Sulfadur Doppel cement investigated here represent the outcome of a realistic, long-term investigation. Precisely such results should provide the most accurate information on behavior in day-to-day practice.

The concrete prisms have now endured approx. 35 years of storage in the sodium-sulfate solution undamaged. The dimensional stability and the sharp edges still exist; the cement skin is nearly completely intact – there is, moreover, no visual evidence of cracking. The sulfate content in the concrete, determined as SO<sub>3</sub>, after 35 years of Na<sub>2</sub>SO<sub>4</sub> storage, has increased in the edge zone to 0.91 M.-% as compared to the 0.42 M.-% in the core area, which is to be regarded as the initial value. However, no negative effects from this were observed. The results of tests of the dynamic modulus of elasticity, the flexural-tensile strengths and the compressive strengths contained in the summary report of Otto Graf Institute dated 18 February 1991, confirm that the concrete’s properties correspond to the expectations.”

Test age	Storage up to testing in	Flexural-tensile strength N/mm <sup>2</sup>	Compressive strength N/mm <sup>2</sup>	Dynamic E-modulus N/mm <sup>2</sup>
28 days	H <sub>2</sub> O	8.4	63	not measured
7 months	Na <sub>2</sub> SO <sub>4</sub> *	12.0	84	not measured
1 year	Na <sub>2</sub> SO <sub>4</sub> *	11.9	87	not measured
35 years	Na <sub>2</sub> SO <sub>4</sub> *	11.6	92	49,200

\* Na<sub>2</sub>SO<sub>4</sub> content corresponds to approx. 14,000 mg SO<sub>4</sub>/l (Limit value as per DIN 4030: above 3,000 mg SO<sub>4</sub>/l = extremely aggressive)  
Table extract



FMPA test report 12-26802

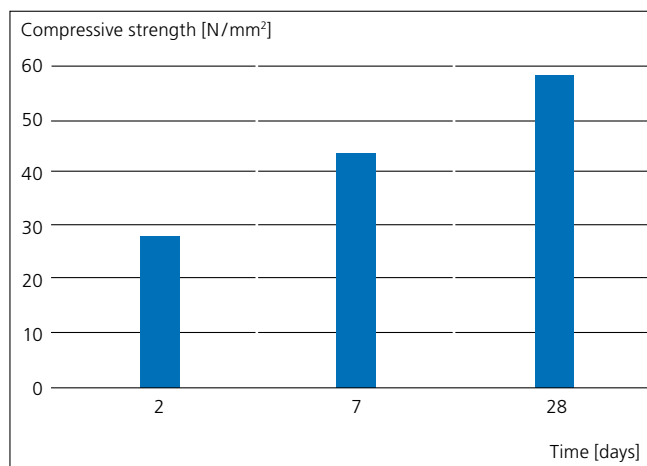
### Mix design examples

Initial constituents	No-slump concrete of C1 consistency used in pipe production			
Dyckerhoff SULFADUR Doppel CEM I 42,5 R-SR 0/LA	[kg/m <sup>3</sup> ]	360	340	340
Water-cement ratio		0.39	0.41	0.41
Aggregate		Rhine sand/gravel 0/8, basalt chips 8/16		
Grading curve		A/B 16	A/B 16	A/B 16
Fresh concrete temperature	[°C]	15	20	20
Storage 1–4 h	[°C]	15	20	40
<b>Festigkeiten</b>				
Compressive strength	8 h [N/mm <sup>2</sup> ]	1,5	3,8	17
Compressive strength	16 h [N/mm <sup>2</sup> ]	12	18	26
Compressive strength	24 h [N/mm <sup>2</sup> ]	22	28	32
Compressive strength	2 d [N/mm <sup>2</sup> ]	38	40	41
Compressive strength	7 d [N/mm <sup>2</sup> ]	64	63	65
Compressive strength	28 d [N/mm <sup>2</sup> ]	85	80	80

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### Ready-mixed concrete consistency F2 with Rhine sand/gravel 0/32, grading curve A/B 32 with 360 kg/m<sup>3</sup> Dyckerhoff SULFADUR Doppel Lengerich (w/c 0.46)



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