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Ref. Tests regarding the effects of water-storing additives

The following parameters were examined for three differing water-storing additives

1. Increase in water storage in relation to soil saturation
2. Increase in water storage in relation to field capacity

The following additives were provided by the client and employed for the laboratory tests:

AM 514
AP 560
AM 614

Four addition amounts were determined for each additive:

0.25 kg/m3
0.5 kg/m3
1.0 kg/m3
2.0 kg/m3

The tests were carried out for three soils, which differed greatly in type. The determination of the grain distribution took place in line with Ö Norm L 1061-1 and L1061-2 (2002). In the case of the soils (compare Fig.5-7) this relates to:

Bodenart	Content Sand (%)	 Silt (%)	 Clay (%)
Sand (S)	84	13	3
Sandy loam (sL)	34	46	20
Loamy sand (lS)	40	50	10

In order to determine the dry density and the soil water content in the case of saturation, 100 cm3 coring sleeves were filled with air-dried soil material and manually compacted. The dry mass was then established. Subsequently, each sample was saturated with deionised water and left to stand for 24 hours in a covered condition, in order to avoid evaporation losses. The samples were then again saturated. The total water volume added was determined and related to the volume of the coring sleeves.

The saturated soil samples were then put onto water-saturated, 3-bar pressure plates and placed in the pressure plate apparatus. Afterwards they were subjected to pressure of 0.3 bar and the test was continued for two days until a balanced state was achieved (Ö Norm L 1063, 1988). The coring sleeves were then weighed and dried in a drying cabinet at 105°C until constant mass was reached. The corresponding water content was then calculated.

Results

Water storage capacity in relation to saturation

In the case of sand, all the additives demonstrated very similar values with regard to the increase in water storage (Fig. 1), which ranged between 5.8 and 24.8 Vol% for the four addition quantities (Table 1). This means that in every cubic metre of soil, approximately 6-25 l of water were additionally stored per dm of soil depth.

With sandy loam the values of the additional storable water volume varied between 7.5 und 19.9 Vol% or l/m3, and with loamy sand between 7.8 und 17.2 Vol% or l/m3 (Table 1; Fig. 1).

Where 1 kg/m3 was added to sand, 11-16% more water was stored than was the case without the additive. With sandy loam, this figure amounted to 9-18% and with loamy sand to 11-17% (Fig. 1). Accordingly, with such an added quantity, sand stores 11-16 l more water per dm of soil depth and cubic metre area, sandy loam 9-18 l and loamy sand 11-17 l more water, as opposed to the retention levels without an additive. If the assumed evaporation rates of approximately 3 mm/d or 3 l/m3 are applied, then the additional water stored per decimetre of depth will last for between three (9l) and a maximum of six days (18 l).

Water storage in relation to field capacity

Field capacity constitutes the volume of water that soil is able to hold in resistance to gravity.

In the case of sand and sandy loam, the addition of water storing substances results in a similar increase in field capacity. With sand the value ranges between 3 and 9% and with sandy loam to between 4 and 10% (Table 1; Fig. 3). Such additions to loamy sand result in a slightly smaller rise in field capacity (1-6%).

When 1 kg/m3 was added, the field capacity of sand rose by 4-7%, that of sandy loam by 4-10% and that of loamy sand by 2-5% (Table 1; Fig. 3). In absolute terms, with a soil depth of 1 dm and an area of 1 m3, an additional 4-7 l of water were stored in sand, 4-10 l in loamy sand and 2-5 l in sandy loam. Thus, if the assumed evaporation rate of 3 mm/day is applied, the water stored would suffice roughly for an extra 1-4 days.

pH value

The pH value of the water-storing additives was determined in a water sample using deionised water in a mixture ratio of 200 g of granulate to 200 ml of deionised water by means of a glass electrode. Each sample was allowed to stand for 24 hours prior to measurement.

Granulate	pH value	Mean value
AM 614 a	7.33	7.33
AM 614 b	7.32	
AM 514 a	7.21	7.22
AM 514 b	7.23	
AP 560 a	7.04	7.05
AP 560 b	7.05	

Yours sincerely,

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Bibliography

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Table 1 Water content in relation to saturation and field capacity for differing amounts of the four additives, as well as relative changes in water storage capacity, as compared to soil without additions

Soil	Addition quantity/agent	Soil water content with saturation (Vol.%)					Soil water content with field capacity (Vol.%)				
		0.00	0.25	0.50	1.00	2.00	0.00	0.25	0.50	1.00	2.00
Sand	AM 514	40.6	46.9	50.1	56.9	61.8	8.8	11.3	11.4	12.6	14.8
	AP 560	40.6	46.3	49.9	52.1	60.8	8.8	11.9	12.8	15.7	18.2
	AM 614	40.6	46.7	50.6	51.6	65.0	8.8	12.1	12.6	13.1	15.9
Sandy loam	AM 514	37.7	50.4	48.9	56.1	57.6	20.0	25.1	27.6	27.5	25.9
	AP 560	37.7	45.3	50.2	46.2	52.0	20.0	27.4	28.5	30.0	28.7
	AM 614	37.7	49.1	46.7	49.9	51.4	20.0	26.7	25.6	24.5	27.5
Loamy sand	AM 514	40.8	52.5	61.8	57.6	54.1	21.9	24.1	23.3	24.0	24.0
	AP 560	40.8	54.3	55.3	52.0	55.0	21.9	27.4	27.6	27.1	28.2
	AM 614	40.8	50.3	48.7	58.0	56.8	21.9	23.3	24.8	26.2	23.7
		Change in water storage with saturation (Vol.%)					Change in water storage with field capacity (Vol.%)				
Sand	AM 514		6.4	9.6	16.4	21.2		2.5	2.6	3.8	6.0
	AP 560		5.8	9.3	11.5	20.2		3.1	3.9	6.8	9.4
	AM 614		6.2	10.0	11.1	24.4		3.3	3.8	4.3	7.1
Sandy loam	AM 514		12.7	11.1	18.3	19.9		5.1	7.5	7.5	5.8
	AP 560		7,5	12.5	8.5	14.2		7.4	8.4	10.0	8.7
	AM 614		11.4	9.0	12.1	13.6		6.6	5.5	4.4	7.4
Loamy sand	AM 514		11.7	21.0	16.7	13.3		2.1	1.4	2.1	2.1
	AP 560		13.5	14.4	11.2	14.2		5.5	5.7	5.2	6.3
	AM 614		9.5	7.8	17.2	16.0		1.4	2.8	4.3	1.8
		Change in water storage with saturation (Rel.%)					Change in water storage with field capacity (Rel.%)				
Sand	AM 514		15.7	23.6	40.3	52.2		28.3	30.0	43.2	68.0
	AP 560		14.2	22.9	28.3	49.9		34.9	44.8	77.8	106.8
	AM 614		15.2	24.8	27.3	60.2		37.1	43.2	48.3	80.8
Sandy loam	AM 514		33.6	29.5	48.5	52.7		25.4	37.5	37.3	29.1
	AP 560		19.9	33.1	22.5	37.7		36.9	42.0	49.7	43.3
	AM 614		30.2	23.8	32.2	36.1		33.0	27.6	22.1	37.2
Loamy sand	AM 514		28.6	51.4	41.0	32.5		9.7	6.3	9.6	9.6
	AP 560		33.0	35.4	27.4	34.8		25.0	25.9	23.8	28.8
	AM 614		23.2	19.2	42.0	39.1		6.4	12.9	19.5	8.0

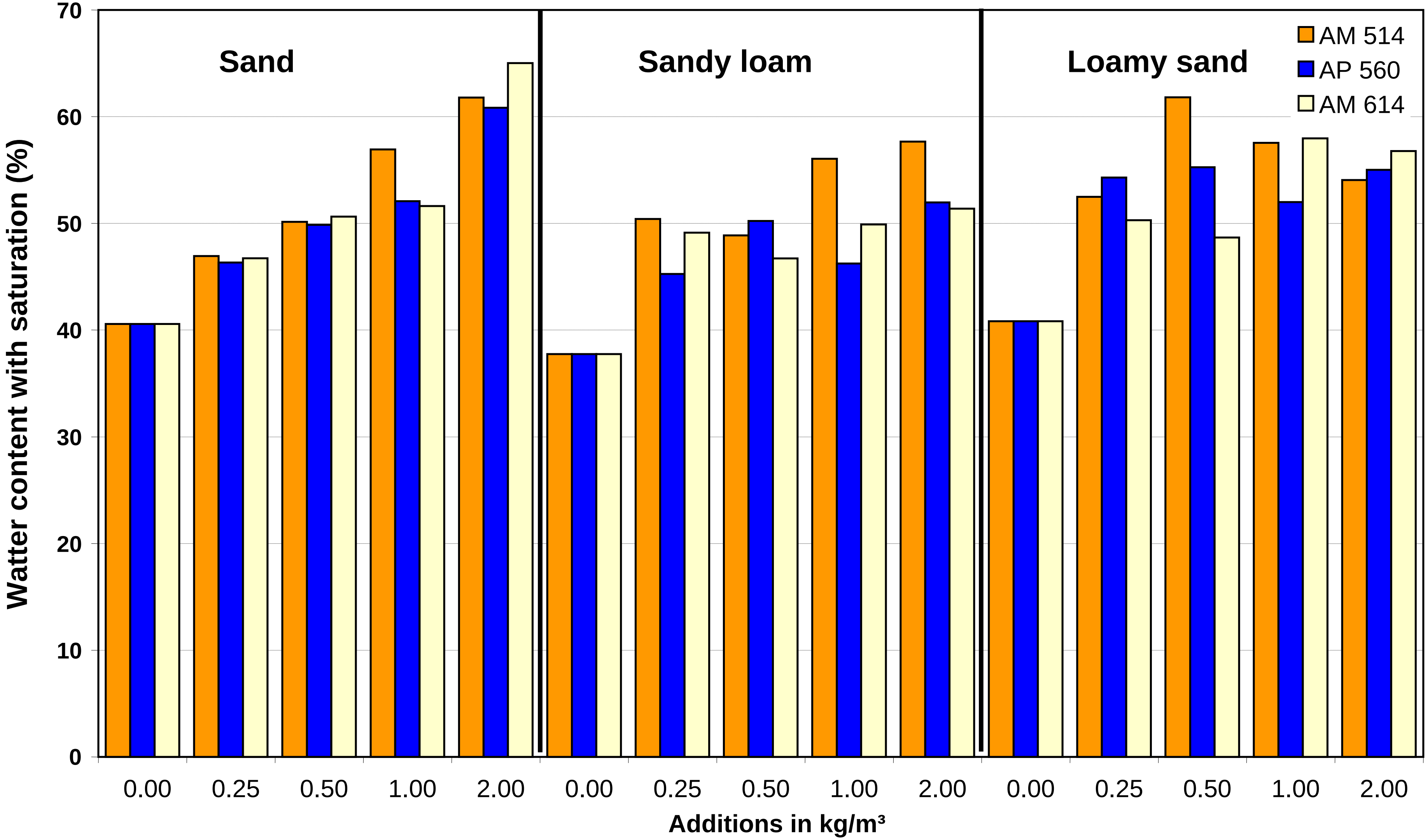

Fig. 1 Water content with saturation for the additives, added quantities and soils examined

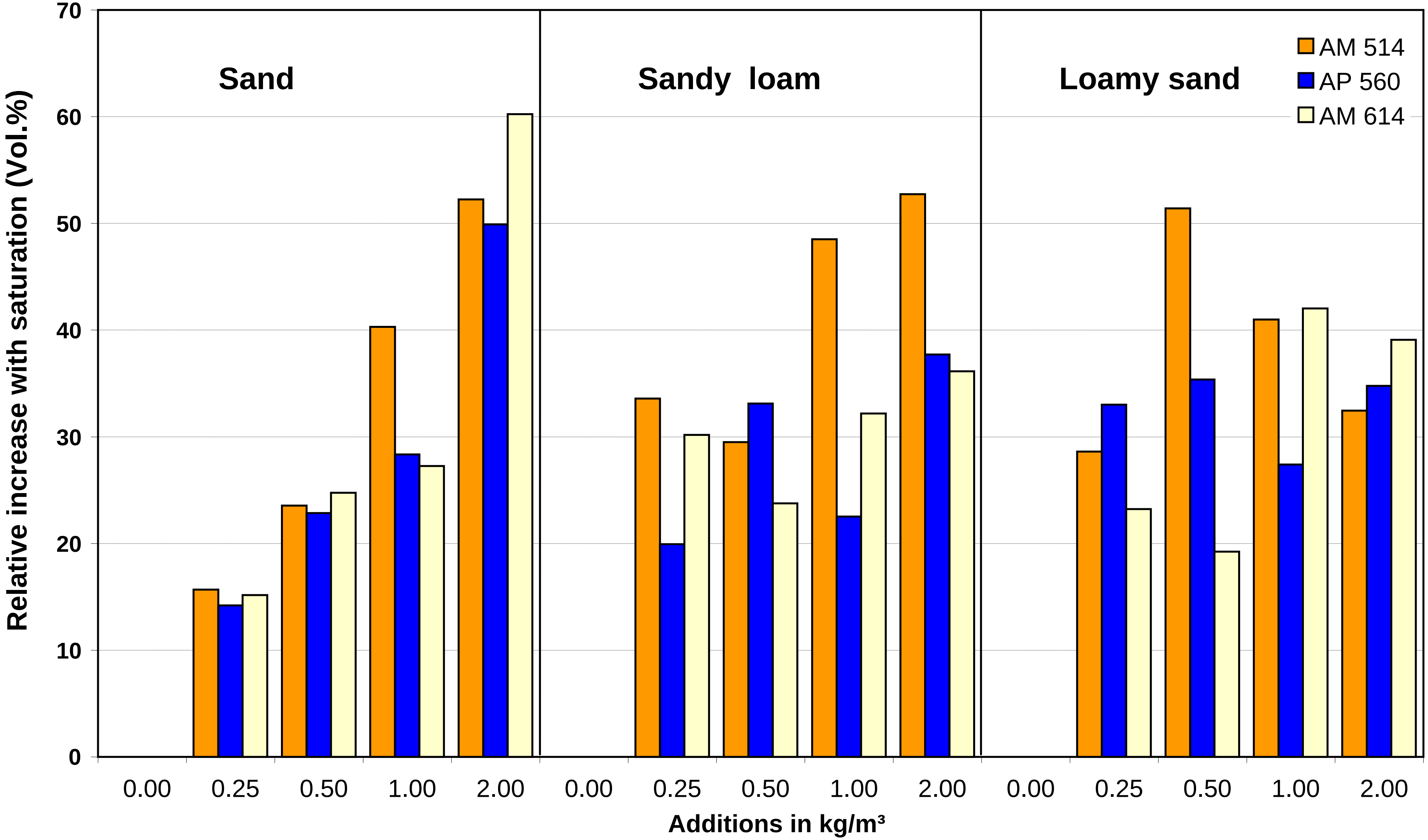

Fig. 2 Relative increase in saturation for the additives, added quantities and soils examined

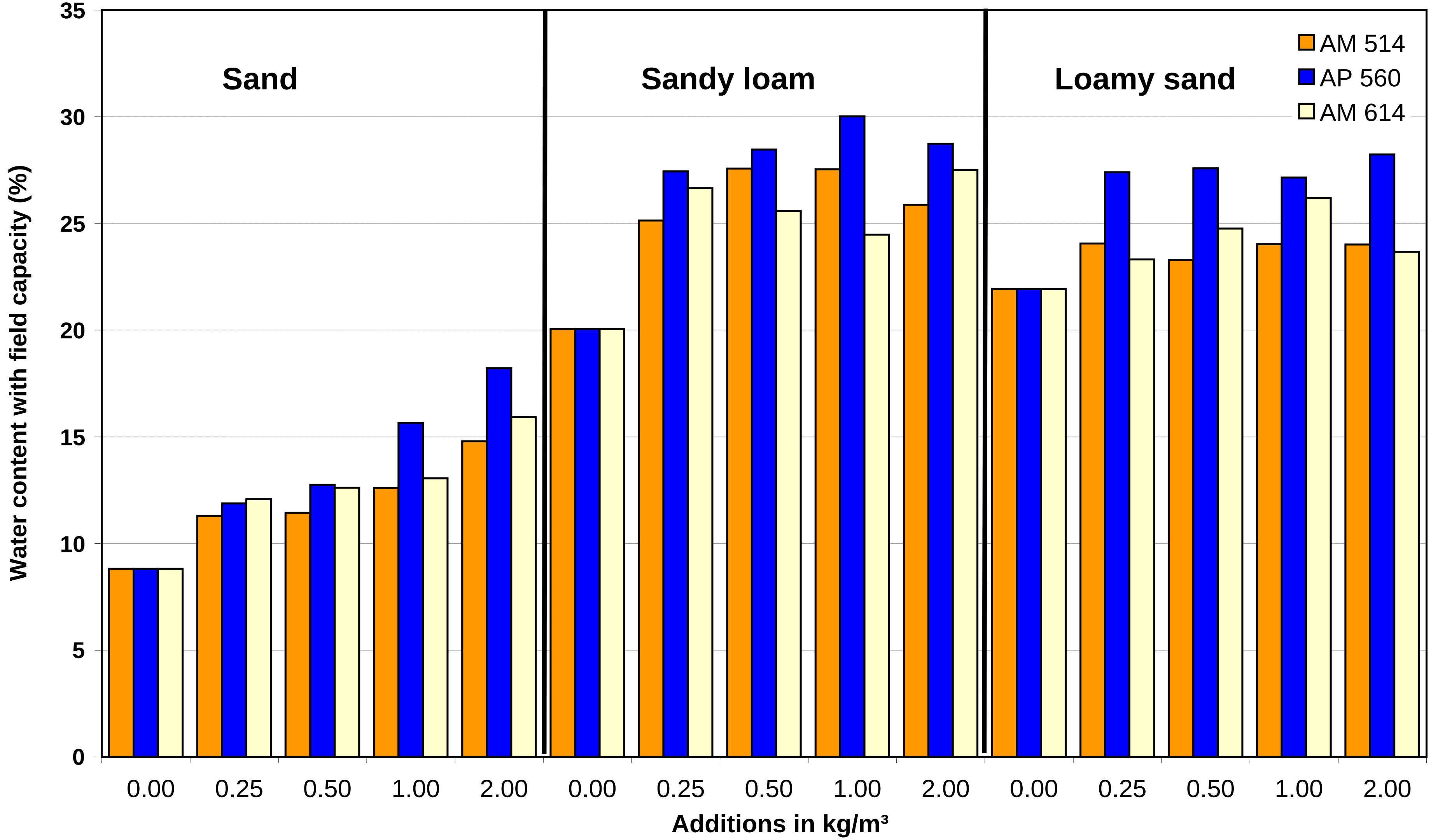

Fig.3 Water content with field capacity for the additives, added quantities and soils examined

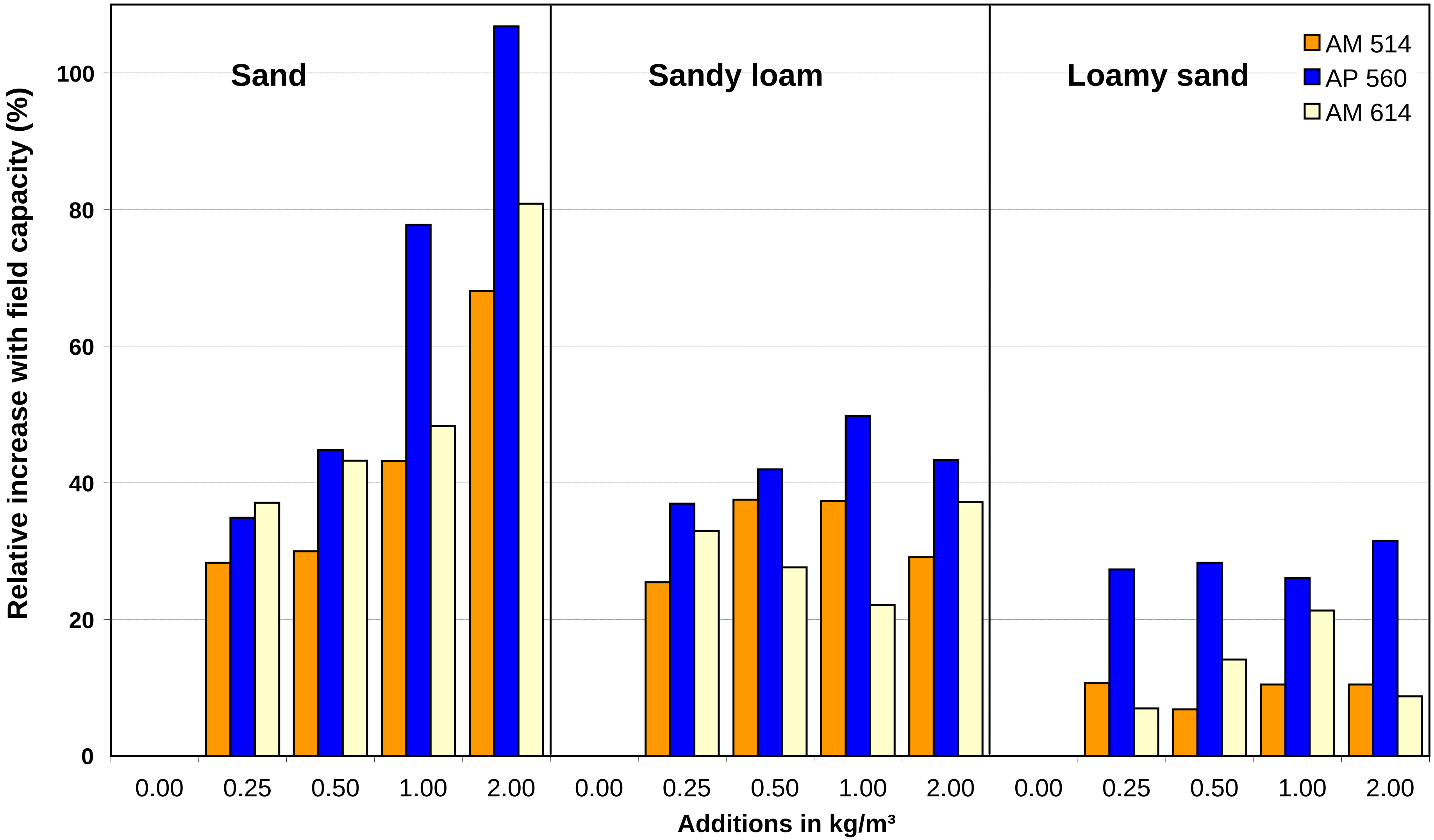

Fig 4 Relative increase in field capacity for the additives, added quantities and soils examined

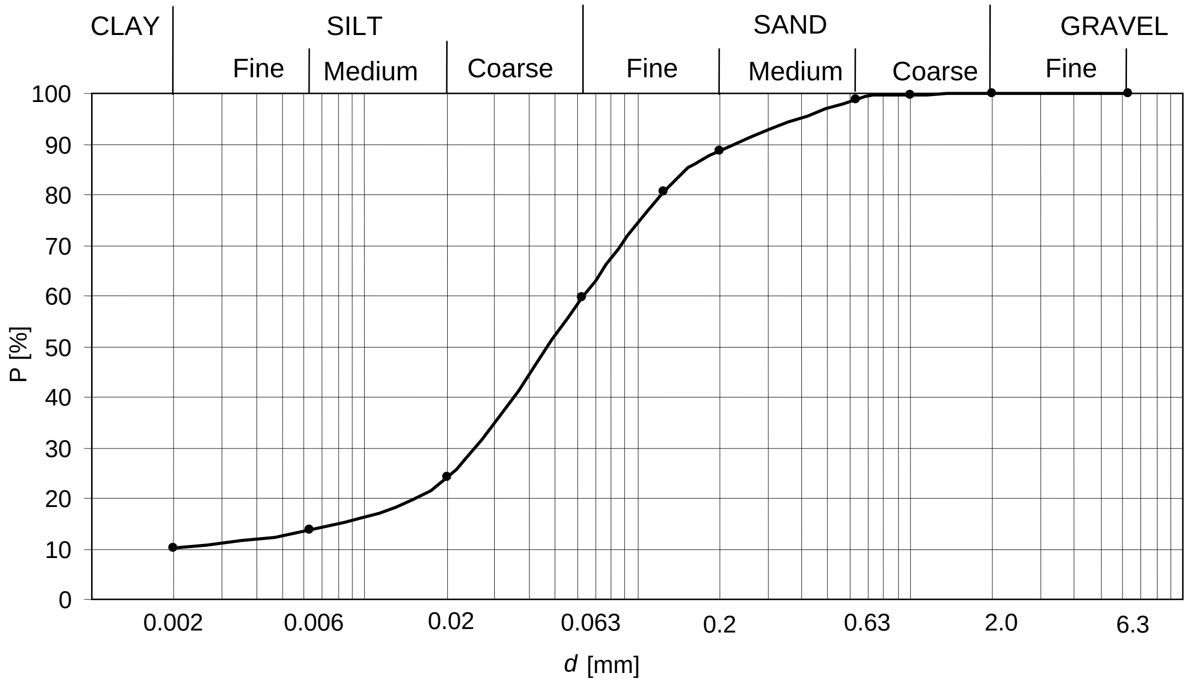

Fig.5 Grain distribution curve of sand

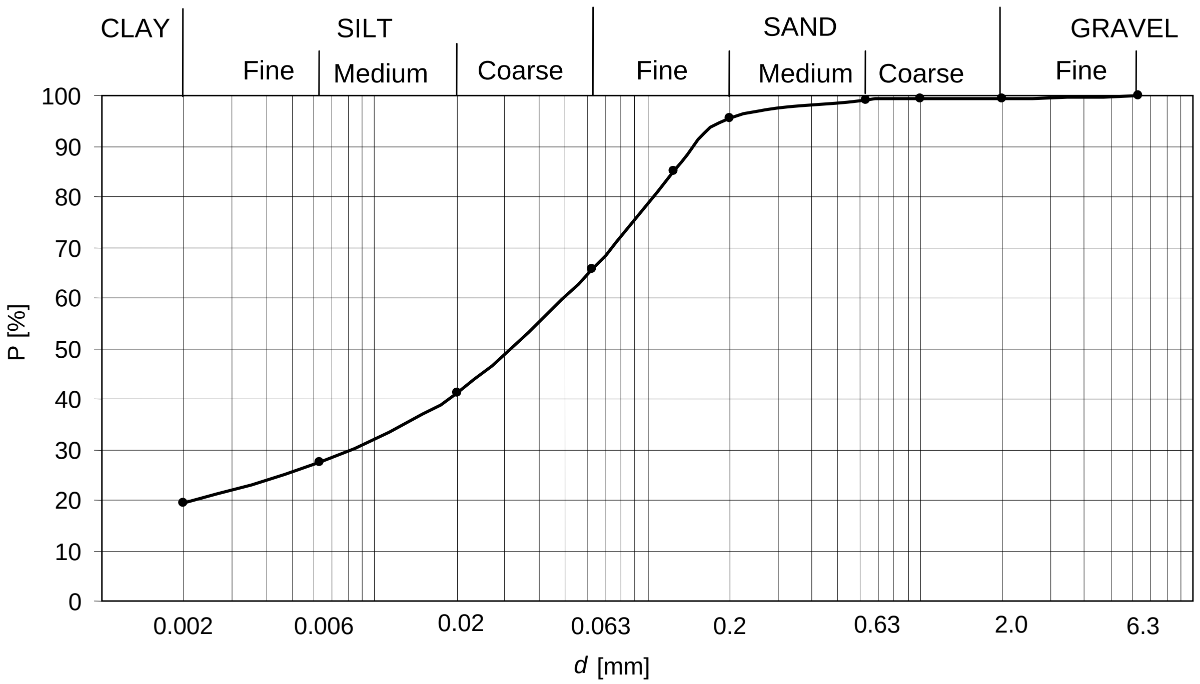

Fig. 6 Grain distribution curve of sandy loam

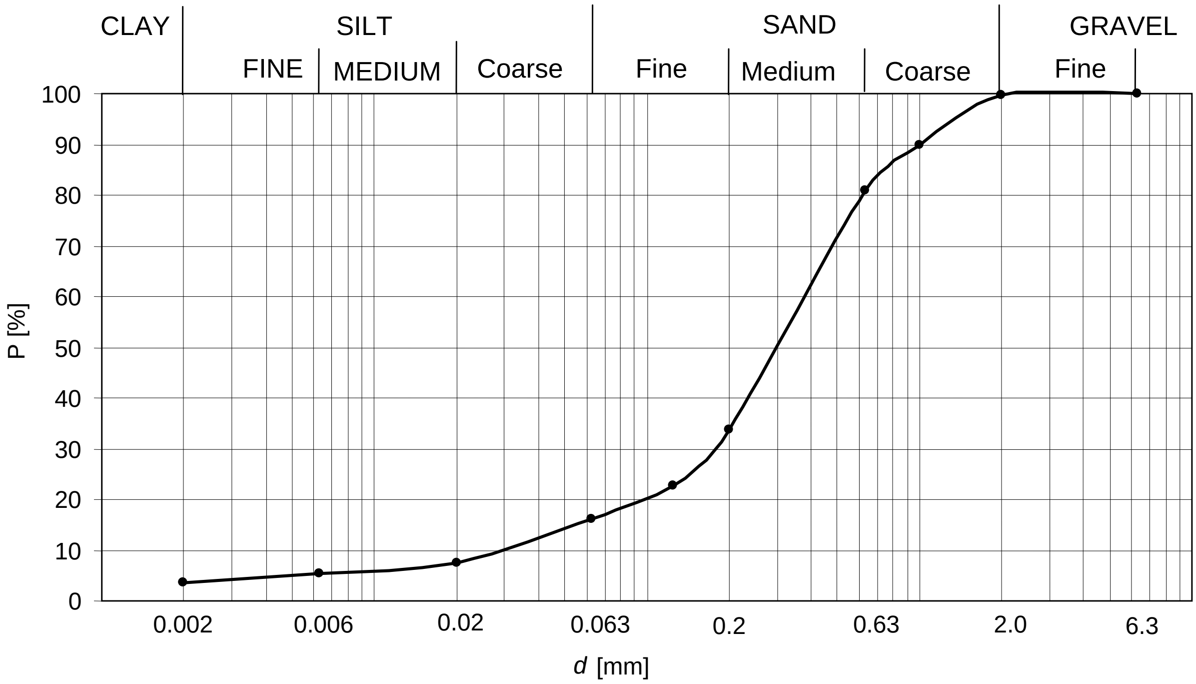

Fig. 7 Grain distribution curve of loamy sand