

CLEANSTONE

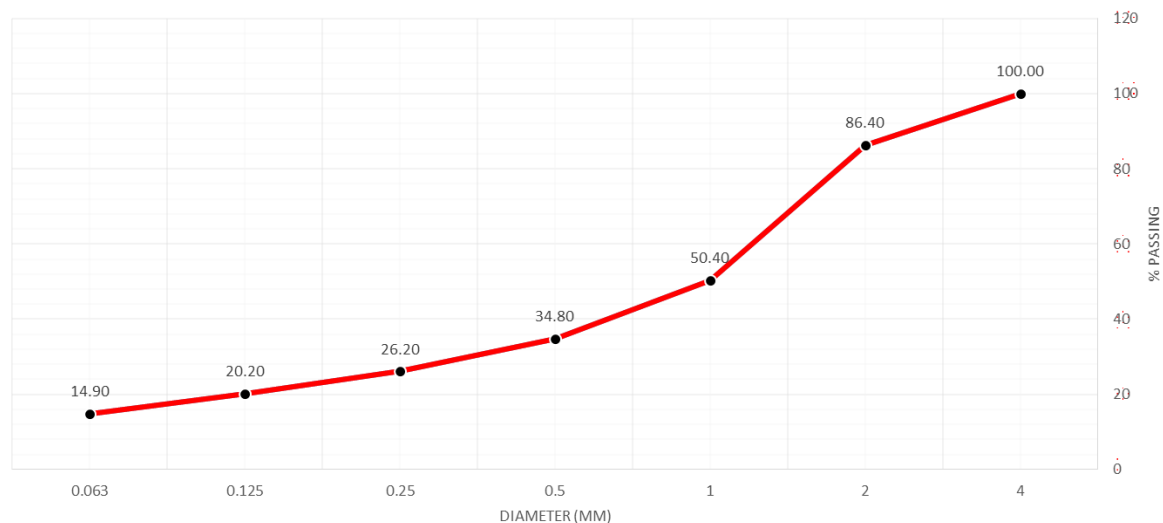
Online Meeting, 22.10.20

FH Kärnten Team involved in WP3 and WP4:

- FH-Prof. DI Dr. Martin Schneider
- DI Sandra Ofner, BSc
- M. Eng Peter Harsányi
- DI Maria Fernanda Medrano, MSc

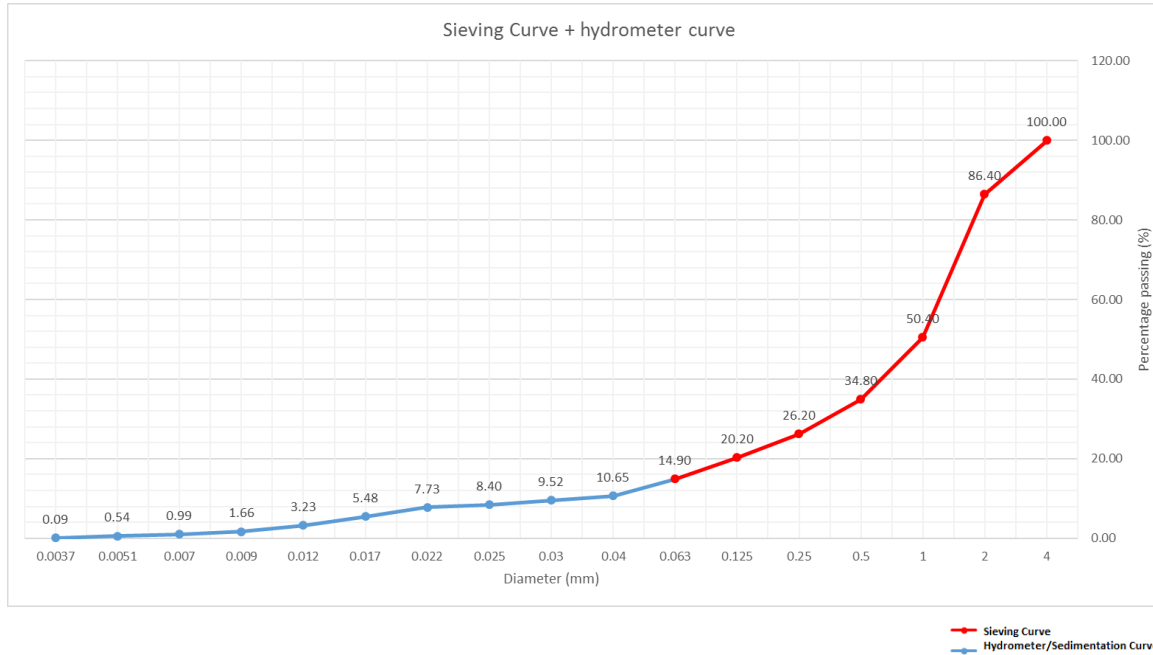
SIEVING CURVE

● Percent passing (%)



- Particle size distribution: 2 mm sand with some silt (ÖNORM EN ISO 17892-4)
- Water content bag : 1,53%-1,60%
- Particles smaller 0,063mm: **14,90% higher than 12%**. Necessary to make an hydrometer analyze
- Well graduated sand with high content of powder

Sieve mesh (mm)	(%) Passing
4	100
2	86.4
1	50.4
0.5	34.8
0.25	26.2
0.125	20.2
0.063	14.9

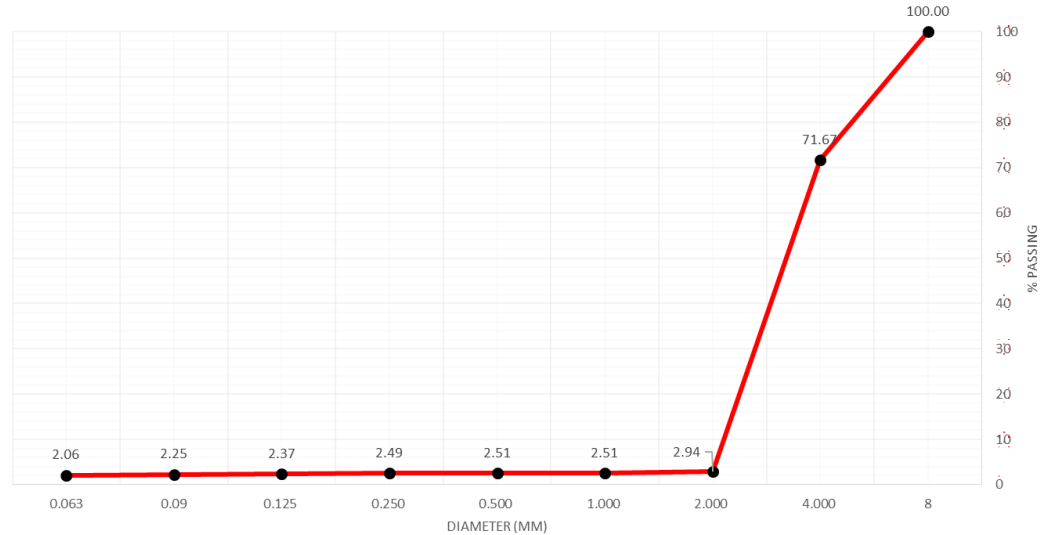


- Hydrometer Analysis: information of diameter and amount of material passing 0,063mm: particles between 0,0002 mm < D < 0,2 mm.
- Result: 2mm Sand with Silt particles (ratio between 0,04mm and 0,0039mm). Fine grains are bigger than clay (0,002mm).

Sieving test	Diameter(mm)	Percentage passing
	4	100.00
	2	86.40
	1	50.40
	0.5	34.80
	0.25	26.20
	0.125	20.20
	0.063	14.90
Hydrometer test	0.04	10.65
	0.03	9.52
	0.025	8.40
	0.022	7.73
	0.017	5.48
	0.012	3.23
	0.009	1.66
	0.007	0.99
	0.0051	0.54
	0.0037	0.09



SIEVING CURVE



- Particle size distribution: **2/4mm fine gravel, only one fraction. Not well graduated**
- Water content: 0,15 - 0,25%
- Type of rock: Limestone 100% CaCO3 **Calcium Carbonate**
- Used in glass, can be a expanding material under temperature conditions, used for clinker production.

Sieve mesh (mm)	(%) Passing
8	100
4.000	71.67
2.000	2.94
1.000	2.51
0.500	2.51
0.250	2.49
0.125	2.37
0.09	2.25
0.063	2.06



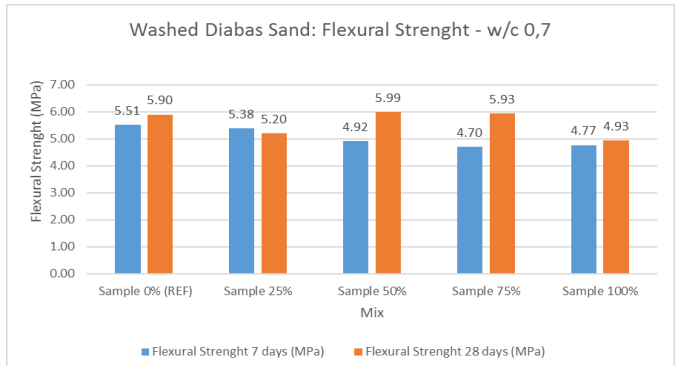
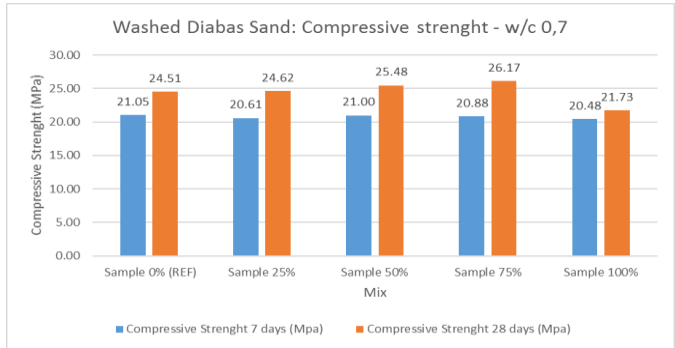
- Goal: Check if Diabas sand is suitable for mortar
- Compression and flexural strength Mortar samples Tested on :
 - Washed Diabas sand samples **without** Superplasticizer
 - Unwashed Diabas sand samples **without** Superplasticizer
 - Unwashed Diabas sand samples **with** Superplasticizer
- Comparison REF sample with sand replacements:
 - Reference sample: 100% River sand
 - Replacements of river sand by Diabas sand: 25%, 50%, 75% and 100%
 - Several mixtures were tried empirically by measuring the workability of the paste till getting a good workability, starting from 0,5 w/c ratio till 0,7
 - Since the sand has a lot of powder 0,5w/c without superplasticizer was not possible, without SP it was possible 0,7 w/c with workability



Washed Dust Diabas Sand					
Mix proportion of mortar					
Mortar mixtures kg/m3					
Mix	Sample 0% (REF)	Sample 25%	Sample 50%	Sample 75%	Sample 100%
Replacement Diabas (%)	0	25	50	75	100
Water/cement ratio	0.7	0.7	0.7	0.7	0.7
Cement	350	350	350	350	350
River sand Kostmann 0/4 mm	1719.30	1289.48	859.65	429.83	0.00
Washed Diabas Bad Bleiberg 0/2 mm	0.00	429.83	859.65	1289.48	1719.30
Compressive Strength 7 days (MPa)	21.05	20.61	21.00	20.88	20.48
Compressive Strength 28 days (MPa)	24.51	24.62	25.48	26.17	21.73
Flexural Strength 7 days (MPa)	5.51	5.38	4.92	4.70	4.77
Flexural Strength 28 days (MPa)	5.90	5.20	5.99	5.93	4.93

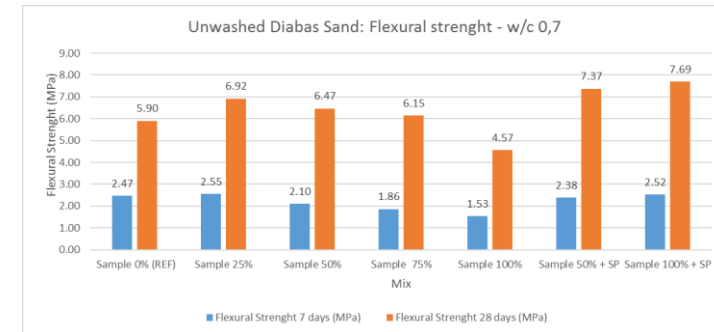
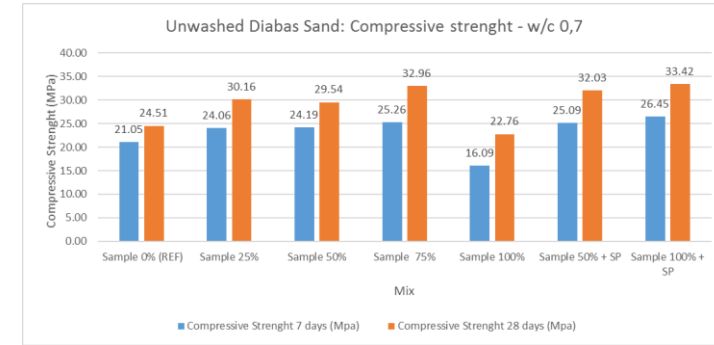
• Washed sand:

- First batch: good workability was possible with 0,7 w/c
- Values of compressive strength at 7 and 28 days were low:
 - At 7 days they remain constant compared with REF at different replacements (around 21MPa)
 - At 28 days compared with REF they increase with the increase of replacement but at 100% replacement decrease again





Unwashed Dust Diabas Sand							
Mix proportion of mortar							
Mortar mixtures kg/m3							
Mix	Sample 0% (REF)	Sample 25%	Sample 50%	Sample 75%	Sample 100%	Sample 50% + SP	Sample 100% + SP
Replacement Diabas (%)	0	25	50	75	100	50	100
Water/cement ratio	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Cement	350	350	350	350	350	350	350
River sand Kostmann 0/4 mm	1719.30	1289.48	859.65	429.83	0.00	859.65	0.00
Washed Diabas Bad Bleiberg 0/2 mm	0.00	429.83	859.65	1289.48	1719.30	859.65	1719.30
Compressive Strength 7 days (MPa)	21.05	24.06	24.19	25.26	16.09	25.09	26.45
Compressive Strength 28 days (MPa)	24.51	30.16	29.54	32.96	22.76	32.03	33.42
Flexural Strength 7 days (MPa)	2.47	2.55	2.10	1.86	1.53	2.38	2.52
Flexural Strength 28 days (MPa)	5.90	6.92	6.47	6.15	4.57	7.37	7.69
Superplasticizer (ml/l) (SP)	0.00	0.00	0.00	0.00	0.00	1.00	1.00



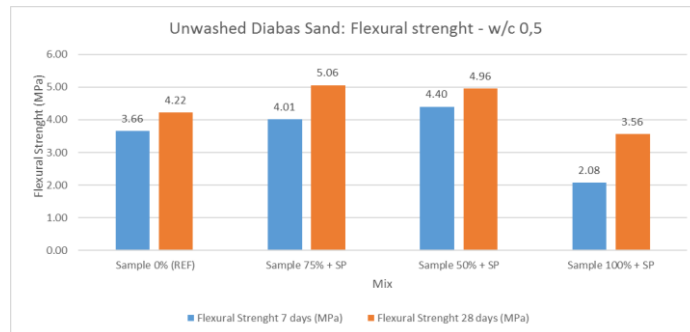
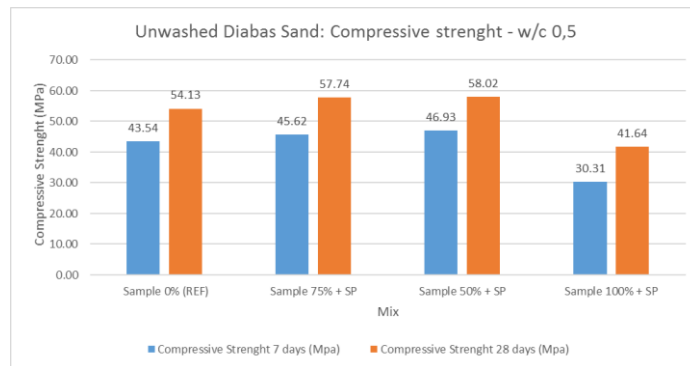
Unwashed sand:

- Second batch: good workability possible with 0,7 w/c
- The values of compressive strength at 7 and 28 days are low:
 - At 7 days compared with REF values increase as the replacement increases but at 100% replacement decreases. Admixture of SP (at 50 and 100% replacement) values makes values higher
 - At 28 days compared with REF values increase as the replacement increases but not for 100% replacement. Admixture of SP (50 and 100%) makes values are higher.

Unwashed Dust Diabas Sand				
Mix proportion of mortar				
Mortar mixtures kg/m ³				
Mix	Sample 0% (REF)	Sample 50% + SP	Sample 75% + SP	Sample 100% + SP
Replacement Diabas (%)	0	50	75	100
Water/cement ratio	0.5	0.5	0.5	0.5
Cement	450	450	450	450
River sand Kostmann 0/4 mm	1350.00	675.00	337.50	0.00
Washed Diabas Bad Bleiberg 0/2 mm	0.00	675.00	1012.50	1350.00
Compressive Strength 7 days (MPa)	43.54	46.93	45.62	30.31
Compressive Strength 28 days (MPa)	54.13	58.02	57.74	41.64
Flexural Strength 7 days (MPa)	3.66	4.40	4.01	2.08
Flexural Strength 28 days (MPa)	4.22	4.96	5.06	3.56
Superplasticizer (ml/450 gr cement) (0.00	1.27	1.27	1.70

• Unwashed sand + Superplasticizer (SP):

- Third batch: good workability with 0,5 w/c only possible at a minimum dosage of SP
- Compressive strength: acceptable results: Values higher 42,5 MPa at 7 days and lower 62,5MPa at 28th days.
- Compared with REF values increase when replacement increases but not for 100% replacement. 100% replacement Diabas has no good values for low dosage of SP
- 50% and 75% replacement show better workability and compressive strength values



Washed Dust Diabas Sand W/C 0.7								
Compressive Strenght (Mpa)	0% (REF)	25%	50%		75%		100%	
7 days WS 0.7	21.05	20.61	21.00		20.88		20.48	
28 days WS 0.7	24.51	24.62	25.48		26.17		21.73	
Unwashed Dust Diabas Sand W/C 0.7								
Compressive Strenght (Mpa)	0% (REF)	25%	50%	50% + SP	75%	75% + SP	100%	100% + SP
7 days UWS 0.7	21.05	24.06	24.19	25.09	25.26		16.09	26.45
28 days UWS 0.7	24.51	30.16	29.54	32.03	32.96		22.76	33.42
Unwashed Dust Diabas Sand W/C 0.5								
Compressive Strenght (Mpa)	0% (REF)	25%	50%	50% + SP	75%	75% + SP	100%	100% + SP
7 days UWS 0.5	43.54			46.93		45.62		30.31
28 days UWS 0.5	54.13			58.02		57.74		41.64
WS: Washed Sand	UWS: Unwashed Sand							

- Results between **washed and unwashed replacement w/c 0,7**:
 - 7 days and 28 days: **Higher values for unwashed** sand than **washed** sand. Values increase by adding of SP. Besides being higher, they are still **low values**
- Results between **unwashed sand w/c 0,7** and **unwashed sand w/c 0,5** addition of superplasticizer:
 - 7 days and 28 days: By **reducing the w/c by adding SP** it is possible: **higher and acceptable values** of compressive strenght
- Conclusion:** Great Values of compression strenght, flexural strenght and workability are possible by the addition of superplasticizer, since it is possible to reduce w/c ratio from 0,7 to 0,5 (high content of fine particles)



- Goal: use Diabas to create a lightweight porous and thermal insulation material by exposing balls to firing process and check if they have expanding properties.
- Usa lightweight balls as a filler, e.g.: in lightweight concrete mixtures
- Different mixtures and pastes were made to shape balls:

Materials	Goal	Result
Diabas sand	Make lightweight material composed of Diabas and another aggregates.	Shaping balls it is possible in presence of water. Contains 50% Silicium oxide considered as expanding material under firing conditions.
Clay	Expanding material under firing conditions (400-1000°C)	Confers plasticity to the wet paste and when firing generates porosity and hardness
Sawdust	Lightweight material possible to burn afterwards	Porosity is possible after burning it
Calc	Binder	Plasticity to the wet paste and hardness
Cement	Binder	Confers Compressive strenght but makes balls heavier. Water resistant balls.
Fly ash	Binder/Replacement of cement	Dissagregation of paste in higher amounts but helps to dry very plastic mixtures with higher amounts of plastic fine particles.

Firing process	Time (min)	Temperature (°C)
Step 1	4	400
Step 2	8	1100
Average Ramp heating time to reach the desired temperatures	40	0-400; 400-1100

Table 3.1 Firing process steps



- **Shaping balls:** Mixture design development with expanding materials under Thermal conditions e.g.: Perlite, Clay, Glass, Dolomite, etc.
- **Normal Concrete Mixture design:** analysis of the particle size distribution of Diabas and its capability to be suitable for concrete structures
- **UHPC** (Ultra high performance concrete, concrete with compression strength greater than 150MPa): analysis of the particle size distribution of Diabas and the possibility of the usage of Diabas sand in UHPC mixtures
- **Online platform:** Design a list of question to collect information from quarry partners



Thanks for your
attention!