

TABLE OF CONTENTS

FOREWORD	9
1. DETERMINATION OF STRENGTH PROPERTIES OF GRANULAR AND BRITTLE MATERIALS.....	11
1.1. Theoretical introduction.....	11
1.1.1. Testing of soil and rock	11
1.1.2. Testing of uniaxial tensile strength.....	14
1.1.3. Uniaxial compression strength tests	15
1.1.4. Determination of strength parameters of soil and rock materials in triaxial compression tests.....	18
1.2. Description of the stands.....	20
1.2.1. Test stand for rock strength and elementary crushing processes – hydraulic press.....	20
1.2.2. Direct shear test	22
1.2.3. Triaxial compression apparatus	23
1.3. EXERCISE 1. Determination of uniaxial compressive and tensile strengths of rocks ...	24
1.3.1. Objective of the exercise	24
1.3.2. Course of the exercise	24
1.4. EXERCISE 2. Study on elementary crushing processes	24
1.4.1. Objective of the exercise	24
1.4.2. Course of the exercise	24
1.5. EXERCISE 3. Determination of Coulomb-Mohr characteristics – direct shear apparatus.....	25
1.5.1. Objective of the exercise	25
1.5.2. Course of the exercise	25
1.5.3. Elaboration of results.....	26
1.6. EXERCISE 4. Determination of Coulomb-Mohr characteristics – triaxial compression apparatus	27
1.6.1. Objective of the exercise	27
1.6.2. Course of the exercise	27
2. CRUSHING OF BRITTLE MATERIALS.....	29
2.1. Theoretical Introduction	29
2.1.1. General information.....	29
2.1.2. Classification of the crushing product	29
2.1.3. Terminology related to construction aggregates according to the standard [16]... 31	
2.2. Description of the laboratory stands	31

2.2.1. Laboratory jaw crusher.....	31
2.2.2. Laboratory impact crusher.....	35
2.2.3. Laboratory cone crusher.....	36
2.2.4. Sieve analysis shaker.....	37
2.3. EXERCISE 1. Rock crushing.....	38
2.3.1. Objective of the exercise.....	38
2.3.2. Course of the exercise.....	38
2.4. EXERCISE 2. Study of crushing processes in a model jaw crusher.....	40
2.4.1. Objective exercise.....	40
2.4.2. Course of the exercise.....	41
3. STUDIES ON THE MECHANICS OF THE CUTTING PROCESS OF BRITTLE MATERIALS.....	43
3.1. Theoretical introduction.....	43
3.1.1. General comments.....	43
3.1.2. Fundamentals of brittle material machining.....	43
3.1.3. Overview of tools and their working conditions using the example of an asphalt milling tool.....	46
3.2. Test stand overview.....	50
3.3. Measurement system.....	52
3.4. EXERCISE 1. Asphalt milling.....	53
3.4.1. Aim of the exercise 1.....	53
3.4.2. Conducting the exercise.....	53
3.4.3. Results analysis.....	54
3.5. EXERCISE 2. Brittle materials cutting.....	55
3.5.1. Aim of the exercise 2.....	55
3.5.2. Conducting the exercise.....	55
3.5.3. Results analysis – Cutting force in function of time and tool displacement.....	55
4. INTERACTION OF HEAVY MACHINERY WITH THE SOIL – SOIL CHANNEL.....	57
4.1. Theoretical introduction.....	57
4.1.1. General remarks.....	57
4.1.2. Track shoe types.....	57
4.1.3. Tractive force generated by flat shoes.....	58
4.1.4. Influence of anti-skid grousers on the tractive force.....	62
4.1.5. Track slip.....	62
4.2. Laboratory stand.....	63
4.2.1. Track-soil interaction of off-road undercarriages.....	63
4.2.2. Model tests of resistance to operation of working tools of earthmoving machines.....	64
4.3. EXERCISE 1. Track-soil interaction of off-road undercarriages.....	68
4.3.1. Aim of the exercise.....	68
4.3.2. Conducting the exercise.....	69
4.3.3. Results preparation.....	69
4.4. EXERCISE 2. Model tests of resistance to operation of working tools of earthmoving machines.....	69
4.4.1. Aim of the exercise.....	69
4.4.2. Conducting the exercise.....	70
4.4.3. Results preparation.....	70

5. VIBRATORY CONVEYORS	71
5.1. Theoretical introduction.....	71
5.1.1. General remarks.....	71
5.1.2. Single grain motion theory	74
5.2. EXERCISE 1. Vibrating conveyor	81
5.2.1. Aim of the exercise	81
5.2.2. Conducting the exercise	81
6. PLC PROGRAMMING	83
6.1. Introduction.....	83
6.1.1. PLC structure.....	86
6.2. The basic elements of sucosoft s40 programming language	87
6.2.1. Program structure	88
6.2.2. Declaration of real variable address	88
6.2.3. Program block	90
6.3. EXERCISE 1. PLC programming	93
6.3.1. Aim of the exercise.....	93
6.3.2. Conducting the exercise	94
7. SLEWING MECHANISM.....	97
7.1. Theoretical introduction.....	97
7.1.1. Functions analysis of the slewing mechanism equipped with a reductor.....	97
7.1.2. Control structure of the slewing mechanism operation.....	98
7.2. Testbench	101
7.2.1. General description of the testbench	101
7.2.2. Descriptions of hydraulic elements used in the testbench.....	103
7.3. EXERCISE 1	106
7.3.1. Aim of the exercise.....	106
7.3.2. Conducting the exercise	106
8. ANALYSIS OF THE EXCAVATION PROCESS IN AN AUTOMATIC CYCLE OF A BACKHOE EXCAVATOR	109
8.1. Theoretical introduction.....	109
8.2. Laboratory stand	113
8.3. EXERCISE 1. Testing the influence of the shape of the working tool on the energy efficiency of the digging process	117
8.3.1. Aim of the exercise.....	117
8.3.2. Conducting the exercise	118
8.4. EXERCISE 2. Testing the impact of changing the cutting angle of the tool on the energy consumption of the excavating process	119
8.4.1. Aim of the exercise.....	119
8.4.2. Conducting the exercise	119
LITERATURE	121