

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION (MSBTE)**I – Scheme****II – Semester Course Curriculum**Course Title: **Construction Materials**

(Course Code:)

Diploma programme in which this course is offered	Semester in which offered
Civil Engineering	Second

1. RATIONALE

Construction material is the key element in the construction project. A diploma civil engineer (also called technologist) has to constantly deal with selection of materials for various engineering project of constructions such as residential/ commercial buildings, roads, metro railways, bridges, dams, tunnels, and fly-over. The development of advance technology generates the necessity of new engineering materials. It is a challenging job for the civil engineer to select relevant material which is durable, economical and eco-friendly. New materials are introduced every day in the market. Modern techniques are developed to handle and use materials for economic and safer designs of engineering structure. At diploma level, students are expected to study about these aspects so as to develop their understanding, performance oriented abilities in order to apply their knowledge in construction industry

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Select relevant building material to fulfill construction requirements.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following *industry oriented* COs associated with the above mentioned competency:

- Identify relevant construction materials.
- Identify relevant natural construction materials.
- Select relevant artificial construction materials.
- Select relevant special type of construction materials.
- Select relevant finishing materials for construction.
- Identify processed construction materials.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			C	ESE	PA	ESE	PA	
3	-	2	5	70	30*	25	25	150

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain LOs required for the attainment of the COs.

Legends: *L*-Lecture; *T* – Tutorial/Teacher Guided Theory Practice; *P* - Practical; *C* – Credit, *ESE* - End Semester Examination; *PA* - Progressive Assessment.

5. COURSE MAP (with sample COs, Learning Outcomes i.e.LOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

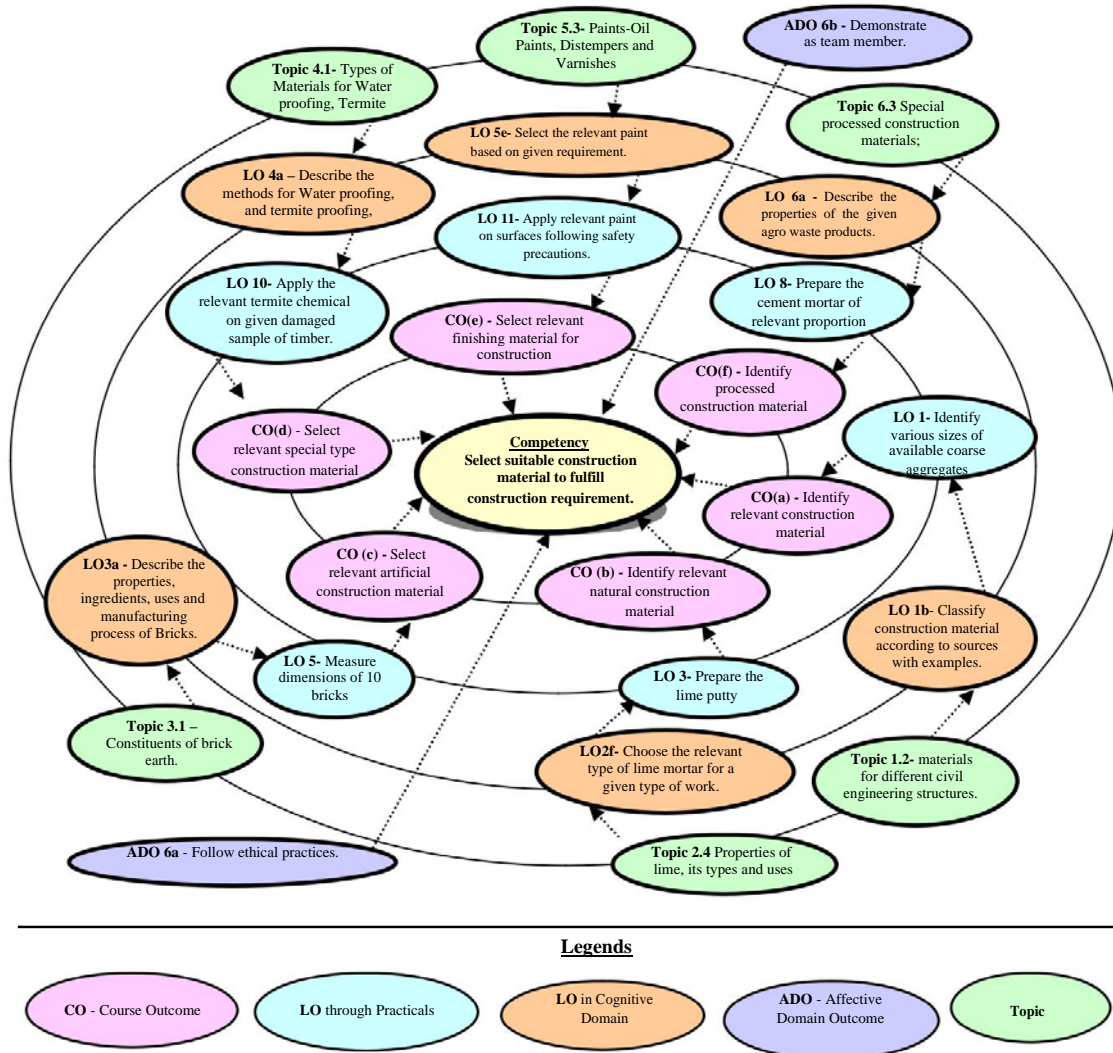


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals/exercises/tutorials in this section are psychomotor domain LOs (i.e.sub-components of the COs), to be developed and assessed in the student to lead to the attainment of the competency.

S. No.	Practical Exercises (Learning Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. required
1	Identify the various sizes of available coarse aggregates from	I	02*

S. No.	Practical Exercises (Learning Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. required
	sample of 10 kg in laboratory and prepare report (80, 40, 20,10 mm)		
2	Identify the available construction materials in the laboratory on the basis of their sources.	I	02
3	Identify the grain distribution pattern in given sample of teak wood in the laboratory and draw the various patterns. (along and perpendicular to the grains)	II	02*
4	Prepare the lime putty by mixing lime (1 kg) with water in appropriate proportion and prepare report on slaking of lime.	II	02
5	Identify various layers and types of soil in foundation pit by visiting at least 3 construction sites in different locations of city and prepare report consisting photographs and samples. Part I	II	02
6	Identify various layers and types of soil in foundation pit by visiting at least 3 construction sites in different locations of city and prepare report consisting photographs and samples. Part I	II	02
7	Select first class, second class and third-class bricks from the stake of bricks and prepare report on the basis of its properties.	III	02*
8	Measure dimensions of 10 bricks and find average dimension and weight. Perform field tests - dropping, striking and scratching by nail and correlate the results obtained.	III	02*
9	Measure dimensions of 10 bricks and find average dimension and weight. Perform field tests - dropping, striking and scratching by nail and correlate the results obtained.	III	02
10	Identify different types of flooring tiles such as vitrified tiles, ceramic tiles, glazed tiles, mosaic tiles, anti- skid tiles, chequered tiles, paving blocks and prepare report about the specifications. Part I	III	02*
11	Identify different types of flooring tiles such as vitrified tiles, ceramic tiles, glazed tiles, mosaic tiles, anti- skid tiles, chequered tiles, paving blocks and prepare report about the specifications. Part II	III	02
12	Apply the relevant termite chemical on given damaged sample of timber. Part I	IV	02*
13	Apply the relevant termite chemical on given damaged sample of timber. Part II	IV	02
14	Prepare the finished piece of glass of given dimension from broken and damaged pieces of glass and asbestos using standard cutting and filing tools with safe practices. Part I	IV	02
15	Prepare the finished piece of glass of given dimension from broken and damaged pieces of glass and asbestos using standard cutting and filing tools with safe practices. Part II	IV	02
16	Apply two or more coats of selected paint on the prepared base of a given wall surface for the area of 1m x 1m using suitable brush/rollers adopting safe practices. Part I	V	02*
17	Apply two or more coats of selected paint on the prepared base of a given wall surface for the area of 1m x 1m using suitable	V	02

S. No.	Practical Exercises (Learning Outcomes in Psychomotor Domain)	Unit No.	Approx. Hrs. required
	brush/rollers adopting safe practices. Part II		
18	Apply two or more coats of selected paint on the prepared base of a given wall surface for the area of 1m x 1m using suitable brush/rollers adopting safe practices. Part I	V	02
19	Apply two or more coats of selected paint on the prepared base of a given wall surface for the area of 1m x 1m using suitable brush/rollers adopting safe practices. Part II	V	02
20	Prepare the cement mortar of proportion 1:3 or 1:6 using artificial sand as a special processed construction material.	VI	02*
21	Prepare mortar using cement and Fly ash or Granite/marble polishing waste in the proportion 1:6 or 1:3.	VI	02
	Total		42

Note

- i. A suggestive list of practical LOs is given in the above table, more such practical LOs can be added to attain the COs and competency. A judicial mix of **minimum 12 or more practical LOs/tutorials need to be performed, out of which, the practicals marked as ‘*’ are compulsory**, so that the student reaches the ‘Precision Level’ of Dave’s ‘Psychomotor Domain Taxonomy’ as generally required by the industry.
- ii. Hence, the ‘Process’ and ‘Product’ related skills associated with each LO of the laboratory/workshop/field work are to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and Recording	10
5	Interpretation of result and Conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	100

Additionally, the following affective domain LOs (social skills/attitudes), are also important constituents of the competency which can be best developed through the above mentioned laboratory/field based experiences:

- a. Follow safety practices.
- b. Practice good housekeeping.
- c. Demonstrate working as a leader/a team member.
- d. Maintain tools and equipment.
- e. Follow ethical practices.

The development of the attitude related LOs of Krathwohl’s ‘Affective Domain Taxonomy’, the achievement level may reach:

- ‘Valuing Level’ in 1st year
- ‘Organising Level’ in 2nd year
- ‘Characterising Level’ in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	Exp. No.
1	Weighing balance	2 to 5
2	Pan, spade	2 to 6
3	Steel Tape	5 to 6
4	Saw of different types (Rip saw having 4 to 6 mm pitch, cross cut saw with tooth pitch 2 to 3 mm, panel saw)	2
5	Painting brushes of different size for oil, acrylic painting and rollers of different size for smooth finishing work.	11
6	Manual Glass cutter with diamond tip at end	13
7	Trowels (Brick, Buttering, Pointing) , triangular, ranging in size up to about 11 inches (279.40 mm) long and from 101.6 mm to 203.2 mm wide i.e. (4 to 8 inches wide).	1,3,7,8, 12
8	Portable Hammer , Spade, Pans (Ghamela), Thread, lime	1,3,4,7, 8,12
9	Square, mason's level, and straightedge 28.57 mm to 38.10 mm and the middle portion of the top edge from 152.40 mm to 254 mm wide	3,5,12
10	Ordinary Portland Cement	8
11	Bricks of standard size 230 mm x 115 mm x 75 mm,	4,5
12	Fly ash or Granite/marble polishing waste	12
13	Paints-OBD, acrylic, plastic emulsion.	11
14	Broken pieces of Glass	13

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop LOs in cognitive domain for achieving the COs to attain the identified competency.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Overview of Construction Materials	1a. Describe the civil engineering applications in the given field of civil engineering. 1b. Classify the given construction material according to sources with examples. 1c. Describe the criteria to select the construction materials for the given situation. 1d. Suggest the construction material in the given situation with justification.	1.1 Scope of construction materials in Building Construction, Transportation Engineering, Environmental Engineering, Irrigation Engineering (applications only). 1.2 Selection of materials for different civil engineering structures on the basis of strength, durability, Eco friendly and economy. 1.3 Broad classification of materials – Sources of materials, Natural, Artificial- special, finishing and recycled.
Unit – II Natural Construction Materials	2a. Describe the properties and structure of the given natural construction material. 2b. Explain the given type of defect(s) in timber. 2c. Explain the procedure of preservation of timber in the given situation. 2d. Select the natural construction material for the given situation with justification. 2e. Choose the relevant type of lime mortar for the given type of construction work with justification.	2.1 Requirements of good building stone; general characteristics of stone; quarrying and dressing methods and tools for stone. 2.2 Structure of timber, general properties of good timber, seasoning, preservation and defects in timber and uses, use of bamboo in construction. 2.3 Asphalt, bitumen and tar used in construction, properties and their uses. 2.4 Properties of lime, its types and uses. 2.5 Types of soil and its suitability in construction. 2.6 Properties of sand and uses. 2.7 Classification of coarse aggregate according to sizes and its uses.
Unit- III Artificial Construction Materials	3a. Describe the properties, ingredients, uses and manufacturing process of the given type of brick. 3b. Classify the given artificial construction materials. Classify different artificial construction material 3c. Select relevant type of artificial	3.1 Constituents of Brick earth, Conventional / Traditional bricks, Modular and Standard bricks, Characteristics of good brick, Classification of burnt clay bricks and their suitability, Special bricks. Common Field tests on Bricks, Manufacturing process of burnt clay brick.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	<p>material for the given type of construction work with justification.</p> <p>3d. Select the type of precast concrete products for the given civil structure with justification.</p> <p>3e. Select relevant type of ferrous metal for the given type of construction work with justification.</p> <p>3f. Select relevant type of non-ferrous metal for the given type of construction work with justification.</p>	<p>3.2 Flooring tiles – Types, uses</p> <p>3.3 Manufacturing process of Cement - dry and wet (only flow chart), types of cement and its uses.</p> <p>3.4 Pre-cast concrete blocks- hollow, solid, pavement blocks, balustrades, and their uses.</p> <p>3.5 Plywood, particle board, Veneers, laminated board and their uses.</p> <p>3.6 Types of glass: soda lime glass, lead glass and borosilicate glass and their uses.</p> <p>3.7 Ferrous and non-ferrous metals and their uses.</p>
Unit– IV Special Construction Materials	<p>4a. Describe the method used for water proofing, termite proofing, thermal and sound insulation in the given situation.</p> <p>4b. Select the relevant material required for the given operations with justification.</p> <p>4c. Describe the fibers required for the given construction material.</p> <p>4d. Select features of the given fiber which can be used as construction material with justification.</p> <p>4e. Describe the features of the given type of geopolymer cement.</p>	<p>4.1 Types of material and suitability in construction works of following materials: Water proofing, Termite proofing; Thermal and sound insulating materials.</p> <p>4.2 Fibers – Types –Jute, Glass, Plastic Asbestos Fibers, (only uses).</p> <p>4.3 Geopolymer cement : Geo-cement: properties, uses and applications</p>
Unit– V Finishing Materials	<p>5a. Choose the relevant proportion adopted in mortars for the given type of construction work with justification</p> <p>5b. Select the relevant type of POP board for the given type of work with justification.</p> <p>5c. Describe properties of the given type of paint.</p> <p>5d. Select the relevant type of paint to be used for the given situation with justification.</p> <p>5e. Choose the relevant type of finishing material for the given situation with justification.</p>	<p>5.1 Lime Mortar, Cement Mortar, Special Mortars and their uses as plastering material.</p> <p>5.2 Constituents and uses of POP (Plaster of Paris), POP finishing boards, sizes and uses.</p> <p>5.3 Paints-Oil Paints, Distempers and Varnishes with their uses (situations where used).</p>
Unit– VI Processed	<p>6a. Describe the properties of the given industrial or agro waste</p>	<p>6.1 Industrial waste materials- Fly ash, Blast furnace slag, Granite and</p>

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Construction Materials	products used for the given type of work. 6b. Describe the salient properties of the given modern construction material. 6c. Describe the salient properties of the given special construction material. 6d. Select the relevant processed construction material for the given situation with justification.	marble polishing waste and their uses. 6.2 Agro waste materials - Rice husk, Bagasse, coir fibres and their uses. 6.3 Special processed construction materials; Geosynthetic, Ferrocete, Artificial timber, Artificial sand and their uses.

Note: To attain the COs and competency, above listed Learning Outcomes (LOs) need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Overview of Construction Materials	04	04	04	--	08
II	Natural Construction Materials	12	04	08	04	16
III	Artificial Construction Materials	14	06	08	04	18
IV	Special Construction Materials	06	00	04	04	08
V	Finishing Materials	06	02	04	04	10
VI	Processed Construction Materials	06	02	04	04	10
Total		48	18	32	20	70

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of LOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course:

- a. Undertake a market survey of different construction materials and compare the following points.
 - i. Structure
 - ii. Properties
 - iii. Applications.
- b. Prepare journals consisting of sketches of construction materials.
- c. Undertake a market survey from local dealers for procurement of civil engineering material.
- d. Inspect the various activities related to Construction material at sites of different civil structures.
- e. Teacher guided self-learning activities

- f. Course/ library /internet based mini-projects.
- g. Literature survey of available at institute library regarding construction material used for different purposes and situations.
- h. Develop Power point presentation or animation for demonstrating laying and fixing the construction materials.
- i. Seminar on any relevant topic related to construction materials.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- a. Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.
- b. '*L*' in item No. 4 does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- c. About *15-20% of the topics/sub-topics* which is relatively simpler or descriptive in nature is to be given to the students for *self-directed learning* and assess the development of the LOs/COs through classroom presentations (see implementation guideline for details).
- d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.
- e. Guide student(s) in undertaking micro-projects.
- f. Procure various materials required for practical exercises.
- g. Arrange visit to nearby industries and workshops for understanding various construction materials.
- h. Use video/animation films to explain various processes like Manufacturing of construction materials, concrete mixing, and base preparation for painting, mortar laying, carpentry work, false ceiling.
- i. Use different instructional strategies in classroom teaching.
- j. Demonstrate different samples of various construction materials like Stone, aggregate of different sizes, timber, lime, bitumen, Bricks, tiles, precast concrete products, Water proofing material, Termite proofing material, Thermal insulating material, plaster of Paris, paints, distemper, and varnishes.
- k. Display various technical brochures of recent building materials.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student assigned to him/her in the beginning of the semester. S/he ought to submit it by the end of the semester to develop the industry oriented COs. Each micro-project should encompass two or more COs which are in fact, an integration of practicals, cognitive domain and affective domain LOs. The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than *16 (sixteen) student engagement hours* during the course.

In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should be individually undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty:

- a. Collect the market rates for following construction materials from various dealers/suppliers of local market for different brands.
 - i. Bricks.
 - ii. Stone / aggregate (20 mm, 40 mm and 80 mm)
 - iii. Teak wood.
 - iv. Flooring tiles.
 - v. Ordinary Portland Cement
 - vi. Oil paint
 - vii. Cement Paint
 - viii. Plaster of Paris
 - ix. Plastic paints
 - x. Recent types of paint.
- b. Download the IS 456 and IS 800 and attach the printout for following materials.
 - i. Steel section (I-section and ISA)
 - ii. Mortar of proportion 1:6 and 1:4
 - iii. Cement concrete mix of 1:2:4, 1:3:6 and 1:4:8.
- c. Collect the technical brochures of following construction materials.
 - i. Ordinary Portland Cement
 - ii. Vitrified flooring tiles.
 - iii. Particle boards used for aluminum partitions.
 - iv. Paints.
- d. Undertake a market survey for the cost and technical specification of different brands of following construction Materials and prepare comparison chart.
 - i. Cement
 - ii. Tiles
 - iii. Glass
 - iv. Paints.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Construction Materials	Ghose, D. N.	Tata McGraw Hill, New Delhi, 2014 ISBN: 9780074516478
2	Building Materials	Varghese, P.C.	PHI learning, New Delhi, 2014 ISBN: 8120328485
3	Engineering Materials	Rangwalla, S.C.	Charator publisher, Ahemdabad, 2015, ISBN: 9789385039171
4	Civil Engineering Materials	Somayaji, Shan	Pearson education, New Delhi, 2015 ISBN: 9788131766316
5	Engineering Materials	Rajput, R.K	S. Chand and Co., New Delhi, 2015 ISBN 8121919606
6	Engineering Materials	Sharma	PHI Learning, New Delhi, 2015 ISBN: 812032448X
7	Building Materials	Duggal, S. K.	New International, New Delhi, 2014 ISBN: 8122414354

14. SOFTWARE/LEARNING WEBSITES

- a. <https://www.quora.com/What-is-geocement>
- b. <http://apis-cor.com/en/about/blog/geocement-new-generation-hightech-material>

- c. <http://www.nbmcw.com/concrete/10827-geopolymer-concrete-a-new-eco-friendly-material-of-construction.html>
- d. <https://www.youtube.com/watch?v=1fc4NVP9wXk>
- e. <https://www.youtube.com/watch?v=m8U76Bm8kDY>
- f. <https://www.youtube.com/watch?v=lORIZ1shRIM>
- g. <https://www.youtube.com/watch?v=Xf89KDibIFE>