PIETRA SERENA MINING IN FIESOLE. PART III: STRUCTURAL-MECHANICAL CHARACTERIZATION AND MINING

M. Coli, E. Livi, and C. Tanini

The large and deeply exploited quarry district of the Pietra Serena at Fiesole (Florence, Italy) was worked out through centuries with no design or any preliminary investigation. In this paper, we characterize the Macigno stratigraphic succession outcropping in the Fiesole hills in terms of geostructural setting and geomechanical properties. We performed stability analysis to verify the safety of slopes of open pits and underground openings, as well as retrospective review of the methods to provide safe environment for Pietra Serena mining.

Quarry, dimension stone, mining, physicomechanical properties of rocks

PREFACE

This paper is the third of a series dedicated to the “Pietra Serena”, a traditional dimension stone that was quarried since the Etruscan period to the middle of the 20th century in Fiesole, north of Firenze, Italy.

The first part [1] envisaged the historical and cultural aspects, the second [2] the geological setting, this one is devoted to the geostructural and geomechanical characterization of this old and tradition type of quarrying activity. Next studies will regard the historical techniques of cultivation.

At the quarrying time no design, neither preliminary investigation were in use, throughout history all this traditional and outstanding quarrying activity was designed in an intuitive way. But to-day, in order to understand the “why” and “how” of the old quarrying techniques, we need to develop a complete geostructural and geomechanical characterization of the Pietra Serena rock mass.

INTRODUCTION

The “Pietra Serena” is the dimension stones quarried from the best-grade arenaceous beds of the Macigno, a quartz-feldspatic turbiditic sandstone, Oligocene-Early Miocene in age, largely outcropping in the Fiesole area (Fig. 1). In the frame of 650 m of the outcropping sequence, only a few arenaceous beds were cultivated as dimension stones (Pietra Serena) thanks to their thickness, strength, stiffness and composition.

In the Fiesole hills the Macigno outcrops in a monocline setting dipping a few degrees (15–25°) towards North, some transversal (SW-NE trending) faults cross-cut and differentially uplifted the Macigno bodies (Fig. 2). Geostructural and geomechanical survey were performed according to the recommendations [3–8].

Dipartimento di Scienze della Terra, Università di Firenze, E-mail: coli@unifi.it, Florence, Italy. Translated from Fiziko-Tekhnicheskie Problemy Razrabotki Poleznykh Iskopаемых, No. 1, pp. 84-94, January-February, 2006. Original article submitted April 20, 2004.

1062-7391/06/4201-0074 ©2006 Springer Science + Business Media, Inc.

74
Fig. 1. Macigno succession outcropping in the Fiesole area. Litotypes: 1 — coarse sandstones; 2 — thin bedded turbidites; 3 — marls; 4 — shales; 5 — calcarenites; 6 — quarried beds

GEOSTRUCTURAL SETTING

The Macigno succession can be subdivided into more alternating assemblage with different geostuctural and geomechanical characters, as referring to:

**Type 1** are thin bedded, fine arenaceous turbidites (TBT), alternating with medium arenaceous beds (Ta-e, Tb-e) less than 1 m thick, rarely up to 2 m thick.

**Type 2** are thin to coarse arenaceous turbidites in bed more than 1 m thick, often up to 3 m in thickness, with an interlayer of TBT.

**Type 3** are medium to coarse arenaceous turbidites (Ta-e) in beds some meters thick; these are the quarried layers for ornamental purpose.

**Type 4** are marls and shales, with rarely interlayered TBT and fine to medium arenaceous turbidites (Ta-d).

Pietra Serena come from the thick beds of the Type 3, but in order to follow both laterally and down-dip the cultivating beds it was necessary to uncover a large portion of the slope, usually constituted by the Type 2 and Type 3 (Fig. 3).

The Macigno body is affected by more main discontinuity system (Fig. 4). The subvertical ones are joints, which resemble slight variations in their trend in dependence with the diverse litofacies types and bed thickness [9 – 15]. The gently dipping one is bedding.