

# CHAPTER 1: INTRODUCTION

## 1.1 Scope

Splices in reinforced concrete structures are commonly used due to the limitation of length of the reinforcing bars. Steel bars must be connected in the field to produce continuity of reinforcement according to design requirement. Splices in reinforcing bars can be achieved by welding, using mechanical connectors or by providing sufficient lap splices. The provisions for anchorage of straight bars and hooks sometimes present detailing problems due to the long required lap lengths and large bend diameters, particularly when large-diameter reinforcing bars are used. Occasionally, the requirements for straight bar anchorage and lap splices cannot be provided within the available dimensions of elements. Hooked bars can be used to shorten anchorage length, but in many cases, the bend of the hook will not fit within the dimensions of a member or the hooks create congestion problems and it would make this element difficult to construct. Similarly, mechanical anchorage devices can be used to eliminate lap splice lengths, but they usually require special construction operations and they are also more expensive.

Headed bars are a type of reinforcement steel not commonly used in the Arab world. The lap splice for headed bars can be shorter than hooked bars because the “*development*” of headed deformed bars means that the force in the bar is transferred to the concrete through a combination of a bearing force at the head and bond forces along the bar. The Egyptian code ECP 203 -2007<sup>[9]</sup>, and Eurocode 2-2004<sup>[10]</sup> do not include this type of splices. However, ACI 318-14<sup>[2]</sup> and Canadian Standards CSA A23.3-04<sup>[7]</sup>, include this type of splices and provide some provisions for their use.

Previous studies <sup>[3]</sup> showed that the anchorage capacity of headed bars increased with the increase of side concrete cover. Confining reinforcement improved concrete bearing capacity of the head and increased the ultimate load. Also, some previous studies <sup>[24]</sup> showed that the head shape had no significant effect on capacity. However, because head orientation cannot be controlled under field conditions, the choice of head shape should be based on detailing considerations such as clearance and congestion. In the present study, locally made welded headed bars with square head were used as headed bars are not available in Egypt.

In the present study, an experimental investigation was carried out to study the behavior and strength of reinforced concrete slabs with lap splice of headed bar tension steel reinforcement. Nine simply supported reinforced concrete one-way slabs of dimensions (2400 mm x 1000 mm x 120 mm) were tested to achieve such objective. The test results (ultimate load, deflection, shape of failure, strain energy) for all spliced specimens were compared with the results of non-spliced specimen. The studied variables were: the effected of lap splice length; confinement at the splice zone; debonding of the spliced bars in splice zone; and the effect of applying repeated loading.

## 1.2 Contents of the thesis

The contents of this thesis are as follows:

Chapter 1: Shows the thesis objectives and topics considered in the thesis.

Chapter 2: This chapter was divided in to two parts. The first part contains a literature review on the mechanism of bond, anchorage of bars, and the behavior of lap splices joint. Also, it includes the main equations and recommendations given by different international building codes for lap splices. These codes are ECP 203-2007<sup>[9]</sup>, ACI 318-2014<sup>[2]</sup>, Eurocode 2-2004<sup>[10]</sup>, and Canadian Standards CSA A23.3-04<sup>[7]</sup>. Also, this part contains a review of some of the previous experimental studies dealing with tension lap splices of conventional anchorage of reinforcing bars. The second part contains a description of the headed bars, the mechanism of headed bars, development length of headed bars and the behavior of lap splice. Also, it includes the main equations and recommendations given by the American code ACI 318-14<sup>[2]</sup> and Canadian Standards CSA A23.3-04<sup>[7]</sup>. Moreover, this part contains a review on some types of headed bar and the previous experimental studies dealing with the behavior of headed reinforcement bars and its application in reinforced concrete structures.

Chapter 3: This chapter includes details of the experimental work carried out in the present study. These include properties of the used materials, concrete mix, manufacturing of the specimens, instrumentation, measurements, and test procedure.

Chapter 4: This chapter outlines test results and discussion for the nine tested slabs in this study.

Chapter 5: It contains summary, conclusions, and recommendations for further research.

- References.
- Arabic summary.