Increments in Gauge Length of Extensometer with Low Cost Approach : A Case Study

Dinesh Rathod
Associate Professor,
FET, MRIU, Faridabad, Haryana
dineshrathod.fet@mriu.edu.in

Harshit Arora
R&D Manager,
SPECTRO Laboratory, Okhla

B.S. Gill
Director,
MRIIC, Faridabad, Haryana
bsgill.fet@mriu.edu.in

Abstract: *In construction and fabrication industries, the TMT bars are required to test for permanent deformation within elastic limit. TheSpectro Lab needs the extensometer to test such jobs with 300mm gauge length. The cost and availability of 300mm gauge length extensometer is major concern for Spectro Lab. Hence, the Manav Rachna Innovation and Incubation Centre (MRIIC) provided the solution and modification on the problem faced by Spectro Lab. The fixture for holding the TMT bars and increments/extension to existing extensometer have been successfully developed and fabricated at MRIIC. The developed fixture and extension accessories found to be suitable and highly useful to the Spectro Lab by precise experimentation and commercial aspects in very reasonable cost.*

I. INTRODUCTION

The TMT (Thermo-Mechanically Treated) steel bars are often used for reinforcement and fabrication purposes in the construction and fabrication industries. Besides the required mechanical testing, the bars need to check for permanent deformation under the elastic regime, which is the requirement of some users. However, theoretically it is presumed that only elastic deformation could exhibit up to yield point load and permanent deformation within this limit could not possible. However, in actual practice the industries are in interest to know the permanent deformation (practically it is very less in some microns) within elastic limit up to the 60% load of the yield point load. For accurate measurement in elongation the extensometers have been used since last eight decades [1]. The accurate measurement in elongation can be carried with proper use of extensometer and fixing of its jaws or clamps on the work piece [1,2]. The majority of extensometers available in markets can be used with their specified gauge lengths only. Hence, the different extensometer should be used for the different gauge lengths. Some of commercially available extensometers with fixed gauge length and clamping fixtures are shown in Figure 1 and Figure 2 and are belongs to SHIMADZU and MTS brand companies respectively. Meline [3] has patented the extensometer with multiple gauge length but its use observed to be very complicated in the study. The costs of such extensometers are very high therefore, the device with reasonable accuracy in cost effective way is highly demanded in the market of NCR Delhi.

The requirement of the user who demands the instrument development in cost effective manner is to use 300mm gauge length of as received TMT steel bars. The diameter of test TMT bars needs to test is in range of 8 – 40mm diameter. The grooved bars are not allowed by user to machine for holding in the jaws or fixing of the extensometer clamps. The test specimens required to test in as it is condition with 500mm length. The use of 25 – 50mm gauge length extensometer is very often. The extensometer with 300mm gauge length is significantly very costlier than the 25-50mm gauge length extensometers.

Therefore, the Spectro Lab, Okhala (user) needs the fixture to hold the bars and fixing the existing extensometer of 50mm gauge length. The some modifications were made by Spectro Lab themselves to sort out the problem. The existing jaws of extensometer were removed and accessories have been fitted on the device. But, unfortunately the angle designed for jaws in initial arrangement of the device was calibrated with jaws length which is changed hence, the instrument has observed with the erroneous results. By considering the

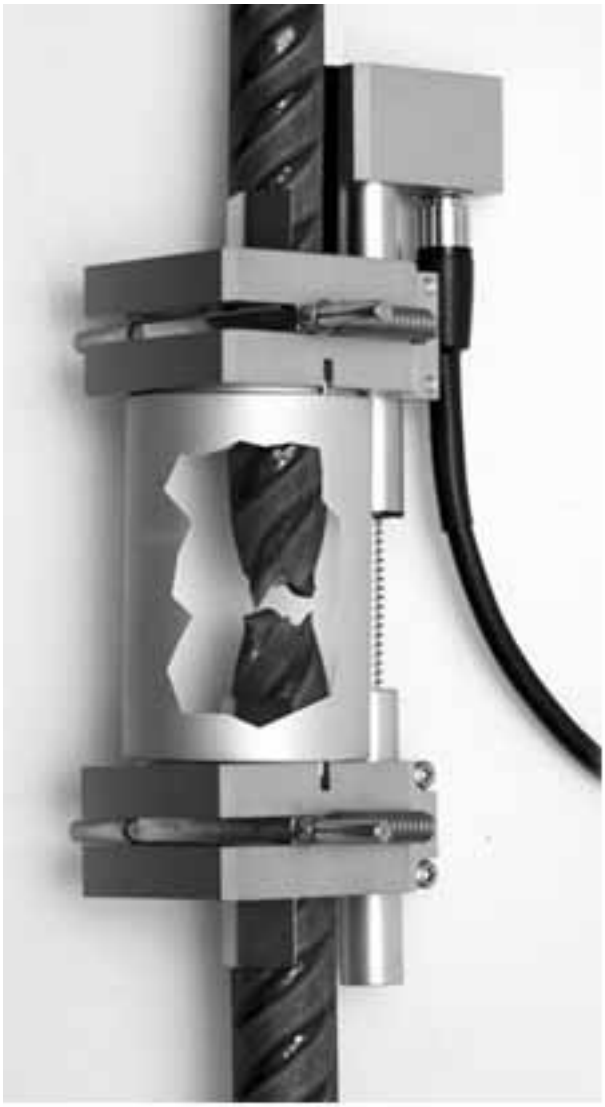

Fig. 1: Existing extensometer available in market

problems faced by Spectro labs and other researchers [4-6], the modifications in this extensometer have been made without compromising the initial condition of the instrument or extensometer device. The further extension or increments in gauge length and clamping fixture has been fabricated and successfully tested in ManavRachna Innovation and Incubation Centre, Faridabad.

II. MATERIALS USED IN STUDY

The test materials used in this study were 18mm and 30mm as received grooved TMT bars in the length of 500mm. The fixture for holding the TMT bars was fabricated with 20mm thick EN31 die steel. The fabrication of fixture was employed using Wire Cut Electric Discharge Machining (EDM) for accurate and ease of machining. The extension strips were used of aluminum alloy 6063 in 3mm thickness and 12mm width.

Fig. 2: Available Extensometer in other Test Labs used for test

The strip material selected based on similar metal to that of existing strip or jaw material of extensometer. The case hardened M10 and M8 size nut and bolts have been used for clamping purpose.

III. FABRICATION DETAILS AND METHODS

Fig. 3 shows an existing extensometer of 50mm gauge length used in the study to get increment or extension of additional 250mm for 300mm gauge length. The initial jaws and strips with the extensometer are clearly visible from the figure. Combining existing gauge length for modified version will give 300mm gauge length by employing aluminum strip extension of 250mm at both sides. The 3mm thick aluminum strip was provided with offset of thickness. Therefore, the each strip contributed 125mm extension on both side of extensometer.

The ends of each strip were bent in 90^{o} in opposite directions. One end was drilled with hole to fix the strip on initial extensometer strip end by M3 type stainless steel nuts and bolts using spring washers. As discussed earlier, angle formed due to movement of initial strips of device have not compromised and the extension provided on strip not on the strain gauge leads of

Fig. 3: An Existing Extensometer with 50mm gauge length

extensometer. Another bent on extension strip was decided to use for clamping on fixture which is required to on TMT bars. The Photograph of the extension strip provided on instruments are shown in Fig. 4. The complete arrangement of fixture to hold the TMT bar and extension on extensometer is shown in Fig. 4.

Fig. 4: Holding fixture and increment accessories on existing extensometer

The fixture was designed to hold the TMT bars from 8 – 40mm diameter. The internal hole of fixture was made with 44mm diameter to hold the maximum 40mm diameter test specimens. The fixture was divided in four equal segments on the periphery. One segment consists of the clamping notch to accommodate the 3mm thick extension strip. The notch was mage 18mm deep to insert the strip by 15mm in the notch. To obtain the springing action, at the end of notch 8mm diameter hole was drilled and clamping achieved by fastening with M8 case hardened nut and bolts. The same thing can be observed in the Fig. 4. The remaining three segments were tapped with M10 size to accommodate M10 size nut and bolt to hold and tightened the TMT bar inside the fixture as shown in figure 4. The clamping force by three bolts could be possible with larger diameter specimens. As specimen diameter reduces, the clamping could effective with top bolt while other two would confirm the location and alignment of specimen inside the fixture. This can be observed from the Fig. 5 and Fig. 6. To ensure the 300mm gauge length and respective fixing of specimen in fixture, one wooden template was made. This template is used to confirm the distance of 300mm (gauge length) between the two fixtures of holding TMT bars. For alignment and ease of clamping the TMT bars in fixture, the wooden template proven very convenient. In the Fig. 4, 5 and 6, the red color base of the fixture is wooden template.

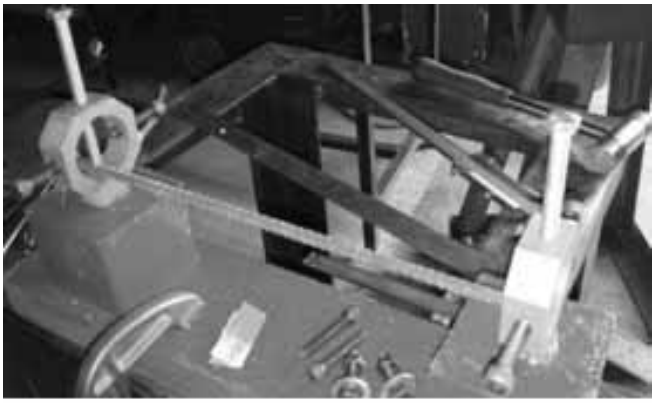

Fig. 5: Fabricated fixture holding 8mm diameter TMT bar with predefined 300mm gauge length

Fig. 6: Fabricated fixture holding 30mm diameter TMT bar with predefined 300mm gauge length

IV. TESTING AND RESULTS

The arrangement shown in figure 4 and figure 6 is used for testing the applicability of fixture and extension to the extensometer. The operator has been asked to clamp the TMT bars in fixture with M10 size case hardened bolts with full pressure that can applied by a healthy man. The alignment of TMT bar in both fixtures was confirmed and remaining M10 bolts were again tightened. To avoid the slippage due to backlash in tapped hole and bolts, the additional nut of M10 size was provided from the outside of fixture. This is require to tighten all the nuts from outside so that while minor reduction in diameter of test bar should not loosen the fixture. Proper clamping force should ensure that the strain energy in specimen and bolt should be enough to avoid loosening of the test bar from the fixture. Initially the M8 type Allen bolts of 70mm length were used. But, those were not sufficient to provide required strain energy and looses during test. Hence, the M10 type case hardened bolts with lock nut are recommended for the application.

The testing was done on 500KN capacity hydraulic Universal Testing Machine. The requirement of user is to test the bar at 60% load of yield point load for the permanent deformation after unloading. Hence, the bar of 18mm diameter was tested for 65-80KN and the bar with 30mm diameter for 110-120KN loading. During loading, no loosening of fixture and undesirable movement was noticed in the fixture and extension of extensometer. The observed results were checked and compared with the earlier valid test results (results with Spectro Lab) and found to be in good agreement.

Hence, the fixture and modified extension to extensometer is successfully completed the test for which this is designed. The fixture and extension to extensometer can be used commercially with reasonable accuracy and very significant reduction in cost. Therefore, the low cost approach is proved feasible to employ the modified instrument (extensometer) in service.

V. CONCLUSION

1. Extension in gauge length of existing extensometer could be possible only without disturbing the initial arrangement of extensometer.

2. TMT bar clamping in fixture should be tightened enough so that it should not loose during testing owing to reduction in size of test bar.
3. The fixture and extension/increments to the extensometer can be used with required accuracy in commercial applications.

4. Modifications made in instrument costs approximately 20 times lesser than the new instrument with specific gauge length in the market.

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