EVALUATION OF TECHNICAL REPORT

Report Title: Assessment of the Effects of Nicked Reinforcing Steel

Report No. SD & DD 77, Rev. 1

Author: H. Singh
Sargent & Lundy Engineers
Chicago, Illinois

Date of Report: November 1981

References:

1. "Probabilistic Analysis on nicking on Rebars at Clinton Power Station" by M. Amin and T. Y. Su, Sargent and Lundy Engineers, SAD-295, April 1982

2. "Influence on Nicking on Rebar Ductility at Byron and Braidwood Stations" by M. Amin and T. Y. Su, Sargent and Lundy Engineers, SAD-398, March 1982

Reviewer: S. P. Chan, NRC/SEB

Date of Review: June 15, 1982

SUMMARY

In the course of study to assess the effect of nicked reinforcing steel with the tungsten carbide drill bit during the installation of concrete expansion anchors, two major concerns were addressed on the effect of nicked steel bars; reduction in bar ductility and reduction in bar strength.

Tests at the Illinois Institute of Technology in 1978 demonstrated a ductility reduction to 2.2% in nicked bars with report mill ductility of 9.4%. Ever since it has been assumed that the bar ductility after nicking would be approximately 2%. Additional information on probabilistic analysis is contained in References 1 and 2 which indicated that more than 94% of all nicked bars at Byron and Clinton plants will have ductilities greater than 5.5%.

This report presents the analytical approach for assessing the required bar ductility in both flexural members and shear walls at ultimate load. The analytical approach demonstrates that the minimum required bar ductility for flexural members designed to: (a) ultimate loads in accordance with ACI 318 is 4.5% and (b) for impact loads is 5.5%. Appendix A to the report provides supporting calculations for these results. Design charts for flexural members and shear walls have been developed to assess the capacity of nicked reinforcing steel, showing no-nick zones of the concerned structure and the additional reinforcements required.

ATTACHMENT D

Appendix B to the report provides information of additional tests on the effects of nicked reinforcing steel and excerpts of a paper entitled, "Experience with Concrete Anchors on Northeast Utilities Construction Projects" presented at ASCE Specialty Conference on Construction Practices at Penn State University, September 16-18, 1981. The paper concludes that nicked reinforcing steel does not affect the ultimate strength of the bar.

DISCUSSION

The NSL report deals with the analytical approach used in calculating the required ductility in flexural elements at ultimate loads considering moment redistribution and other requirements of ACI 318. The ductility or ultimate strain is calculated from the moment/curvature relationship established by the proposed method of analysis and basic assumptions. The effect of strain hardening of steel reinforcement is considered only for determining the area where plastic hinge is formed and not for strength calculation. We feel that this analytical approach is reasonable and acceptable.

In case that the reduced ductility of a nicked bar is thought to be less than the calculated required ductility, the strength of the area should be re-analyzed by incapacitating the suspicious bar.

The report addresses, in Appendix B, the test results of rebars drilled with carbide bits. Four drill bit sizes (3/8", 1/2", 3/4", and 1") and five bar sizes (Nos. 5, 6, 11, 14, and 18) were used in the test program. Three specimens for each combination pair provided a total of 60 tests. A control specimen of each bar size was taken from the same bar as the other specimens. The control bars were not drilled but tensile tested for comparison purpose and baseline data. Drilling was done in a downward, vertical position with continuous pressure for not less than 15 seconds. The following observations had been made:

1. Reduction in ultimate strength due to drilling ranged from 0% to 2% for all bars except that of N5 rebars from 0% to 6%.

2. All bars broke above the specified yield and ultimate strengths. The control bar had an ultimate strength 25% greater than was required.

3. The deepest penetration into the body of the bar was approximately 1/8" while the defect diameters ranged from 7/16" to 9/16".

The test results reported in Appendix B have identified the largest nick which can be inflicted on reinforcing steel by a tungsten carbide drill bit. The utility recommendation, of 4/29, that 1/2" dia. x 1/8" deep defects should be acceptable.

These tests and observations, reported in Appendix B, were performed for Millstone III Project and were similar to those at the Clinton and Grand Gulf sites. Justification has been established that the test results are applicable to LaSalle.

CONCLUSION

The analytical model and assumptions used in this report for the assessment of bar ductility are reasonable and logical. The proposed method of analysis is consistent with the requirement of ACI Code 318 and is acceptable. The minimum required bar ductility for flexural members as calculated by this analytical approach (viz., 4.5% for ultimate non-impact loads and 5.5% for impact loads), are also acceptable and may be used as guidelines for estimating ductility requirements in case of moment redistribution.

We believe that the effects of nicked reinforcing steel by the tungsten carbide drill bit are negligibly small and will not have any significant effect on the structure integrity of reinforced concrete flexural and shear wall elements.

Attachment 5

12/12/79
Date

MORRISON CONSTRUCTION COMPANY
LaSalle County Station

Form No. PC-139
Rev. 0 / 12-79

TORQUE WRENCH CALIBRATION CERTIFICATION

DATE 4/30/80 (1)

MCCo ID No. of Torque Wrench E35-131 1/2" DR INCH POUNDS

MCCo ID No. of Torque Wrench Tester BMTT 1067

TYPE OF TORQUE WRENCH: (X) Clicker Type ( ) Torqometer

TORQUE TESTER SETTINGS	WRENCH READINGS		ERROR	
	Clockwise	Counterclockwise	Clockwise	Counterclockwise
30 (7)	29 (3)	28.7 (4)	1 (5)	1.3 (6)
70	70	68	0	2
110	112	108	2	0
150	155	150	5	0
190	200	190	10	0

TOLERANCES

Clicker-Type

Clockwise = + 4%
Counterclockwise = ± 6%

Torqometer

Clockwise = + 2%
Counterclockwise = ± 2%

Instrument certification was accomplished by use of: Calibrated torque tester BMTT-1067 per procedure PC-31C Rev-0

Comments: = = MCCO

Q.C. ACCEPTANCE
DATE 4/30/80 BY (9)

(8)

(10) TEST CONDUCTED BY

(11) WITNESSED BY

(12) P.237T