

Gus Sirakis

From: Skghosh@aol.com
Sent: Wednesday, May 02, 2007 9:30 PM
To: sbhol@panynj.gov; felix@stressteel.com
Cc: ahmad.rahimian@wsps.com; Gus Sirakis
Subject: Re: Freedom Tower: 97 ksi Steel

Dear Saroj:

I definitely will - as soon as I get it from NC State, which should be in a matter of days.

S. K. Ghosh

In a message dated 5/2/2007 1:32:49 PM Central Daylight Time, sbhol@panynj.gov writes:

Please provide the final version of the report to the Department of Buildings, as requested, with a copy to me.

Thanks

Saroj Bhol, P.E.
Manager, Design Standards
Quality Assurance Division

S.K. Ghosh Associates Inc.
334 East Colfax Street, Unit E
Palatine, IL 60067
Phone: (847) 991-2700
Fax: (847) 991-2702
E-mail: skghosh@aol.com
Website: www.skghoshassociates.com

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5/3/2007

Gus Sirakis

From: Bhol, Saroj [sbhol@panynj.gov]
Sent: Wednesday, May 02, 2007 2:32 PM
To: felix@stressteel.com; Skghosh@aol.com
Cc: ahmad.rahimian@wspcs.com; Gus Sirakis
Subject: RE: Freedom Tower: 97 ksi Steel

Please provide the final version of the report to the Department of Buildings, as requested, with a copy to me.

Thanks

Saroj Bhol, P.E.
 Manager, Design Standards
 Quality Assurance Division

THE PORT AUTHORITY OF NY & NJ
 3 Gateway Center, 3rd Floor
 Newark, NJ 07102
 T: (973) 792 3930 F: (973) 792 3908
 email: sbhol@panynj.gov

-----Original Message-----

From: Gus Sirakis [mailto:ConstadinoS@bb.nyc.gov]
Sent: Wednesday, May 02, 2007 2:10 PM
To: Bhol, Saroj
Cc: ahmad.rahimian@wspcs.com; felix@stressteel.com; Skghosh@aol.com; Fatma Amer; Dan Eschenasy
Subject: RE: Freedom Tower: 97 ksi Steel

Saroj,

The Department would like to see the complete final version of the report from NC State (expected date of May 2007) that Dr. Ghosh mentions below regarding the 97 ksi steel.

Thank you,

Gus Sirakis
Project Engineer – NYC DOB
T: (212) 566-3810
constadinos@buildings.nyc.gov

From: Skghosh@aol.com [mailto:Skghosh@aol.com]
Sent: Tuesday, May 01, 2007 4:40 PM
To: Gus Sirakis; DanE@bb.nyc.gov
Cc: sbhol@panynj.gov; ahmad.rahimian@wspcs.com; felix@stressteel.com
Subject: Re: Freedom Tower: 97 ksi Steel

Dear Gus and Dan:

In regards to the report IS-06-16 "Bond Tests of High Strength SAS Threaded Bars", NCState is in the process of issuing a final version that will be dated May 2007. The attached table is from that report.

The difference between the numbers in the attached table and the corresponding

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numbers in the September 2006 draft is due almost entirely to one reason. The latest version calculates $u_{sub\ aci}$ using field-measured concrete cover for all splice beams. The September draft calculated $u_{sub\ aci}$ using the design cover. It was discovered after issuing the September draft that the as-built concrete cover in the beams varied from the design cover by 0.5 in. to 1 in. Since concrete cover is a primary factor controlling bond strength, the results for the splice beams were recalculated using the measured as-built cover in lieu of the design cover.

It should be noted that the 1.25 factor in Eq. 2 of AC 237 was put in there by me as an additional safety measure. Many would question whether this is strictly required by ACI 318. As should be clear from the attached table, this enhanced criterion was failed to be met in only five of the sixteen cases tested. It should be noted, however, that since both of the top bars were spliced at the same location in each test specimen, the splice length used, according to ACI 318, should have been 1.3 times the development length. The 1.3 factor was not used in the design and fabrication of the test specimens. This additional factor, if used, would doubtless have taken care of the "shortfalls" observed in the five cases. Thus I feel quite comfortable about the test results. You really need not feel any qualms about allowing lap splices with the Stressteel bars.

If I can clarify anything else, please do not hesitate to get in touch with me.

Thank you.

S. K. Ghosh

S.K. Ghosh Associates Inc.
334 East Colfax Street, Unit E
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Gus Sirakis

From: Skghosh@aol.com
Sent: Tuesday, May 01, 2007 1:01 PM
To: Gus Sirakis
Cc: sbhol@panynj.gov; ahmad.rahimian@wsps.com; felix@stressteel.com
Subject: Re: Freedom Tower: 97 ksi Steel

Dear Gus:

It was nice talking to you and Dan a short time ago. I have since been in touch with the testing team at NC State. As I fully expected, there's very good explanation as to why your numbers are different from the numbers I have. I regret that you were given an old, interim report. Anyway, I'll provide the explanation in writing - hopefully before I leave this afternoon.

I do not have Dan's e-mail address (although he gave me his card during my visit, I have managed to misplace it). Please forward this e-mail to him.

Thank you.

S. K. Ghosh

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Gus Sirakis

From: Gus Sirakis
Sent: Tuesday, May 01, 2007 11:37 AM
To: 'Skghosh@aol.com'
Cc: sbhol@panynj.gov; ahmad.rahimian@wspscs.com; felix@stressteel.com
Subject: RE: Freedom Tower: 97 ksi Steel

My apologies, I believe there was a typo in previous e-mail. My phone number is (212) 566-3810.

Gus Sirakis
Project Engineer – NYC DOB
T: (212) 566-3810
constadinos@buildings.nyc.gov

From: Skghosh@aol.com [mailto:Skghosh@aol.com]
Sent: Tuesday, May 01, 2007 11:20 AM
To: Gus Sirakis
Cc: sbhol@panynj.gov; ahmad.rahimian@wspscs.com; felix@stressteel.com
Subject: Freedom Tower: 97 ksi Steel

Dear Mr. Sirakis:

This concerns your e-mailed enquiry of April 12 to Saroj Bhol, which was eventually forwarded to me on April 25. Because of the ACI Convention in Atlanta last week and a major deadline yesterday, I could not sit down to responding until this morning. Please accept my sincere apologies.

As I read your e-mail more closely and compared your numbers with the splice test results I have, I found myself not understanding your question quite fully. I called the telephone no. in your e-mail (212/566-8310) twice, thinking that it would be best to seek clarification verbally. Each time a voice message told me that the number is out of service. If, upon receipt of this e-mail, you could please call me, I'd truly appreciate it. Alternatively, if you would send me your correct telephone number, I'll be happy to call you. Saroj, if you have the correct telephone number, it may help if you would send that to me as well.

I have to leave my office at 4.45 PM Eastern time today on a two-day trip. I am anxious to resolve whatever issues have arisen before then, if at all possible.

Thank yo.

S. K. Ghosh

S.K. Ghosh Associates Inc.
334 East Colfax Street, Unit E
Palatine, IL 60067
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E-mail: skghosh@aol.com
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5/3/2007

Gus Sirakis

From: Gus Sirakis
Sent: Thursday, April 12, 2007 9:25 AM
To: 'sbhol@panynj.gov'; Palmieri, Mario
Cc: Dan Eschenasy; Fatma Amer
Subject: Freedom Tower: 97 ksi steel
Follow Up Flag: Follow up
Flag Status: Yellow

After reviewing the test reports and other data submitted by the Port Authority to the Department of Buildings, we have some questions regarding the beam splice tests performed on the SAS Stressteel reinforcing. We need clarification on the results of the test performed by NC State on the No. 9 bar used in 12,000 psi concrete. The four test results based on equation 2 appear to be high (102%, 97%, 99%, and 103%, respectively). In addition four test results verifying compliance with equation 3 did not reach the expected values. We also have some questions regarding the tested concrete strengths versus the intended concrete strengths of the shear walls and the effect on the lap splice.

Please advise.

Feel free to contact me at (212) 566-8310 or via e-mail at constadinos@buildings.nyc.gov to discuss this or if we can be of any assistance.

Thank you,

Constadino "Gus" Sirakis PE, SECB

Project Engineer

New York City Department of Buildings - Technical Affairs Division

280 Broadway, 7th Floor, New York, NY 10007

T:(212) 566-3810 F:(212) 566-3796

E: constadinos@buildings.nyc.gov

5/3/2007

Gus Sirakis

From: Gus Sirakis
Sent: Thursday, March 08, 2007 2:37 PM
To: 'sbhol@panynj.gov'
Cc: Fatma Amer; Dan Eschenasy
Subject: Freedom Tower 97 ksi Reinforcing

Saroj,

We received your package regarding the use of 97 ksi reinforcing bars in the Freedom Tower concrete shear walls today (3/8/2007). We will review the information you submitted and send you our response as soon as possible.

Please feel free to contact DOB if you have any further information or questions.

Thank you,

Constadino "Gus" Sirakis PE, SECB

Project Engineer

New York City Department of Buildings - Technical Affairs Division

280 Broadway, 7th Floor, New York, NY 10007

T:(212) 566-3810 F:(212) 566-3796

E: constadinos@buildings.nyc.gov

5/3/2007

Gus Sirakis

From: Bhol, Saroj [sbhol@panynj.gov]
Sent: Tuesday, February 27, 2007 3:10 PM
To: Gus Sirakis
Cc: Fatma Amer
Subject: RE: Freedom Tower 97ksi Reinforcement
Attachments: concurrence-97ksi steel.doc

Gus,
 Here's a draft letter to Fatma. Please let me know if it's ok with her. After I hear from you, I will finalize it for signature and send with the items you have requested.

Thanks

Saroj

Saroj Bhol, P.E.

Manager, Design Standards

Quality Assurance Division

THE PORT AUTHORITY OF NY & NJ

3 Gateway Center, 3rd Floor

Newark, NJ 07102

T: (973) 792 3930 F: (973) 792 3908

email: sbhol@panynj.gov

-----Original Message-----

From: Gus Sirakis [mailto:ConstadinoS@buildings.nyc.gov]
Sent: Thursday, February 22, 2007 3:11 PM
To: Bhol, Saroj
Cc: Fatma Amer; Dan Eschenasy; Terrence Lin; Manher Shah
Subject: Freedom Tower 97ksi Reinforcement

Saroj,

To facilitate our response to the request to use 97 ksi reinforcing steel in the Freedom Tower, we request the following:

1. Indicate the specific areas of use for the reinforcing.
2. Standard governing material properties (ASTM Standard, DIN German Standard, etc.).
3. Copy of test reports & results for the various tests described at our meeting.
4. Approvals for use in other projects (Buildings in Miami and California were mentioned by Mr. Ferrer).
5. Sample calculations for an area of intended use (e.g. forces being resisted by a shearwall segment on lower floor).
6. Construction details for the area of intended use referenced by calculations (reinforcing bar layout of shearwall showing confinement reinforcement provided, erection column clearances, etc.).

Please feel free to contact us if you have any questions.

Thank you,

Constadino "Gus" Sirakis PE, SECB

Project Engineer

New York City Department of Buildings - Technical Affairs Division

280 Broadway, 7th Floor, New York, NY 10007

T:(212) 566-3810 F:(212) 566-3796

5/3/2007

E: constadinos@buildings.nyc.gov

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5/3/2007

DRAFT

February xx, 2007

Hon. Fatma M. Amer, P. E.
Deputy Commissioner Technical Affairs & Chief Code Engineer
NYC Department of Buildings
280 Broadway, 7th Floor
New York, NY 10007

Re: World Trade Center – Freedom Tower – 97 ksi Reinforcing Steel in Concrete
Shear Walls

Dear Commissioner Amer:

Thank you for the meeting on February 16, 2007. As discussed at the meeting, the Port Authority has received a request from WSP Cantor Seinuk, the structural engineer for the Freedom Tower, for permission to use 97 ksi reinforcing steel in concrete shear walls. Dr. Ahmad Rahimian from WSP Cantor Seinuk and Dr. S. K. Ghosh, who is a member of the ACI 318 committee and is well known for his contributions in concrete research, presented to you at the meeting the details of the research and testing done on high strength reinforcement and explained that current ACI 318 has not yet caught up with the recent research and limits the maximum yield strength of reinforcing bars to 80 ksi. In the interim, a number of jurisdictions including City of Miami, Los Angeles, San Diego and Las Vegas have approved the use of higher strength bars for high-rise buildings.

The following documents that provide the technical background are enclosed:

- WSP cantor Seinuk Letter dated, January 17, 2007
- S. K. Ghosh Associates Inc. letter dated January 4, 2007
- S. K. Ghosh Associates Report – High strength Threaded Bars as Reinforcing Steel in Building Applications – April 2005
- NC State University Technical Report - Bond Tests of high strength Treaded Bars-September 2006
- CTL Group Report – Testing of Mechanical Connectors –December 2005
- Information on 2 projects in Miami where 97 ksi reinforcing bars are used
- Sample calculations for an area of intended use
- Sample construction details for an area of intended use

The Port Authority has reviewed the technical background and is of the opinion that the use of 97 ksi reinforcing bars will relieve the congestion in the heavily reinforced shear walls and improve the workability of concrete pouring as well as quality of construction. It is also worth noting that IBC 2003 Section 104.11 permits use of alternate materials. The Building Code of the City of New York also has similar provision in Section 27-133.

The Port Authority would like to allow 97 ksi reinforcing bars in the concrete shear walls, if the Department of Buildings concurs. I would appreciate your signing and returning a copy of this letter to me, if you concur.

Very truly yours,

Saroj Bhol, P. E.
Manager, Design Standards

Concurred:

Fatma M. Amer, P. E.
Deputy Commissioner
Technical Affairs

Cc:
Constadino "Gus" Sirakis, PE, SECB
Project Engineer
New York City Department of Buildings - Technical Affairs Division

Gus Sirakis

From: Bhol, Saroj [sbhol@panynj.gov]
Sent: Friday, January 19, 2007 1:59 PM
To: Fatma Amer
Cc: Gus Sirakis; Lin, C. John; Lombardi, Frank; Passeri, Carl; Palmieri, Mario; Sandiford, Raymond; Zipf, Peter; Rahimian, Ahmad
Subject: Freedom Tower - 97 ksi Reinforcing steel
Follow Up Flag: Follow up
Flag Status: Yellow
Attachments: WSPCS-Letter-on 97ksi rebars-v1.pdf; freedom tower Bhol.doc

Fatma,

We have a request from the structural engineer for the Freedom Tower for using 97 ksi reinforcing steel for columns and shear walls. Dr. S. K. Ghosh, who is a member of the ACI 318 committee and is well known for his contributions in concrete research, discussed with us about the research and testing done on high strength reinforcement. In a letter to me, he has summarized the technical details and advantages of using high strength reinforcing in high strength concrete. The current ACI 318 has not yet caught up with the recent research and limits the maximum yield strength of reinforcing bars to 80 ksi.

The Port Authority is of the opinion that the use of 97 ksi reinforcing bars will relieve the congestion in the heavily reinforced columns and shear walls and improve the workability of concrete pouring as well as quality of construction. We would like to allow 97 ksi reinforcing bars, if the Department of Buildings concurs. I mentioned about this to Gus Sirakis yesterday. Please let me know your thoughts on this. I am told that the City of Miami has permitted 97 ksi steel for a recent project there.

I am attaching copies of the letters from Ahmad Rahimian, structural engineer for the Freedom Tower, and from Dr. S. K. Ghosh. I can invite Ahmad Rahimian and Dr. S. K. Ghosh for further discussion at the Department of Buildings, if necessary.

<<WSPCS-Letter-on 97ksi rebars-v1.pdf>> <<freedom tower Bhol.doc>>

Thanks
Saroj

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5/3/2007



WSP CANTOR SEINUK
STRUCTURAL ENGINEERS

January 17, 2007

Mr. Saroj Bhol
Manager Design Standards Unit
Quality Assurance Division
Engineering Department
3 Greenway Center, 3rd Floor – 100 Mulberry Street
Newark, NJ 07102

Re: High-strength threaded bars ($F_y=97\text{ksi}$)
World Trade Center – Tower One

Dear Saroj:

We would like to request PANY&NJ permission to use high strength reinforcing with 97ksi minimum yield strength for column and shear wall elements on the World Trade Center Tower One project.

Our request is based upon review of S.K. Ghosh Associates, Inc. technical report dated April 2005, on high strength rebar ($F_y=97\text{ksi}$) manufactured by SAS Stressteel, Inc. and S.K. Ghosh Associates letter dated January 4, 2007 on the same issue.

We concur with SK Ghosh's recommendation to use 97ksi rebar for columns and shear wall elements.

According to NYC Building Code and IBC-2003, the Tower One structure is under moderate seismic design category (Seismic Design Category –B per IBC-2003).

Our structural document will specify that the high strength bars shall not be welded. Also, the high strength bars shall not be bent for bars larger than No.14 (43mm dia.).

Please let me know if you have questions or if I can be of any assistance.

Very truly yours,
WSP Cantor Seinuk

Ahmad Rahimian, Ph.D., PE, SE
President

CC: Kenneth A. Lewis, SOM

Silvian Marcus, P.E.
Chief Executive Officer

Dr. Ahmad Rahimian, S.E., P.E.
President

Jeffrey Smilow, P.E.
Executive Vice President

Kamran Moazzami, P.E.
Director, WSP Cantor Seinuk, UK

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Bart Sullivan, P.E.

Charles Guerrero
Director of CADD Operations

Associates:
Mihaela Cismigiu
Yoram Eilon
Susan Harnos
Cynthia Liu



S. K. Ghosh Associates Inc.
Seismic and Building Code Consulting

January 4, 2007

Mr. Saroj Bhol
Manager Design Standards Unit
Quality Assurance Division
Engineering Department
3 Greenway Center, 3rd Floor – 100 Mulberry Street
Newark, NJ 07102

Subject: Use of high-strength threaded bars on New York's Freedom Tower project

Dear Saroj:

This is to follow up on the productive meeting we had at the offices of the Port Authority of New York and New Jersey in Newark on December 18, 2007.

I would like to wholeheartedly endorse the use of high-strength reinforcement on the Freedom Tower project because high-strength concrete and high-strength steel represent a logical combination of materials that offers at least three significant advantages: (1) columns and shear walls become more economical to construct, (2) construction becomes easier because congestion is relieved, (3) more usable space is freed up within a building.

The meeting of December 18 was specifically about threaded reinforcing bars formed from high-strength steel, distributed by SAS Stressteel, Inc. These bars have the following unique characteristics:

1. The steel has a minimum yield strength of 97,000 psi (670 MPa), significantly higher than the 60,000 psi (420 MPa) strengths typically available.
2. The deformations are oriented in a threaded pattern, for connections to mechanical splices and anchorages.
3. The maximum available bar diameter, 2.5 inches (63.5 mm), is slightly larger than the maximum 2.257 inch (57.3 mm) diameter referenced in ASTM A615.

The ICC Evaluation Service (ICC-ES), a subsidiary of the International Code Council, the publisher of the International Building Code (IBC), has issued proposed acceptance criteria (AC 237 – revised January 2007) to establish procedures for high-strength threaded steel reinforcing bars to be recognized in an ICC-ES evaluation report under the 2006 International Building Code. Basis of recognition is IBC Section 104.11, Alternative materials, design and methods of construction and equipment.

334 East Colfax Street, Unit E, Palatine, IL 60067

phone (847) 991-2700 • fax (847) 991-2702 • e-mail skghosh@aol.com

West coast: 25332 Shadywood, Laguna Niguel, CA 92677 • phone (949) 249-3739

www.skghoshassociates.com

AC 237 applies to high-strength threaded steel reinforcing bars as longitudinal and transverse reinforcement in building applications, subject to the following restrictions:

1. The high-strength bars shall not be used in beams or slabs.
2. The high-strength bars shall not be used in buildings assigned to Seismic Design Category D, E, or F.
3. The high-strength bars shall not be welded.
4. The high-strength bars shall not be bent, if the nominal bar size exceeds No. 14 (43-mm dia.).

I would like to elaborate on Items 1 and 4 above.

1. ICC-ES AC 237 was developed with the application of Stressteel bars in reinforced concrete shear walls in mind. We chose to exclude beams and slabs in order not to get involved in issues that do not pertain to shear walls. As far as technical aspects go, my concerns were two-fold: deflections and crack control. Since a beam reinforced with Grade 97 bars would have less reinforcement because of the higher strength of the reinforcement, the cracked I (based on transformed section) would be lower. Obviously, this would lead to larger deflections. I am now convinced that this can be taken care of by invoking Footnote b) to ACI 318 Table 9.5(a). However, in the case of a footing, mat or pile cap, deflections simply should not be a concern. As far as crack control is concerned, Section 10.6.4 of ACI 318 is applicable only to "beams and one-way slabs," and not to footings, mats, or pile caps. Thus, I have no reservation about the use of Grade 97 Stressteel bars in footings, mats, or pile caps.

4. Stahlwerk Annahuette, manufacturer of Stressteel, has conducted bend tests on Grade 97 Stressteel bars up to 43 mm or No. 14 in diameter. The No. 14 bars were bent 180 deg at a bend diameter of 8.4 times the bar diameter. There was no break or cracking. Based on their testing, Stahlwerk Annahuette initially recommended a bend diameter of 10 times the bar diameter for 35-mm dia. or No. 11 bars, to be absolutely on the safe side. They feel that, if necessary, a bend diameter of 9 times the bar diameter would also be acceptable. Very recent tests on No.11 (35-mm dia.) bars have shown even a bend diameter of 6 bar diameters to be safe.

Three areas of primary focus were identified for AC 237:

1. The applicability of ACI 318 Chapter 12 (development and splice length) equations to Grade 97 steel embedded in high-strength concrete must be validated.
2. The couplers must meet suitable acceptance criteria

3. Devices used to anchor the large-diameter (>35 mm dia.) bars must also meet suitable acceptance criteria.

The remainder of this report is on results of testing on Stressteel bars, which SAS Stressteel would like to get approved by the Port Authority of New York and New Jersey and the City of New York for use on the Freedom Tower project. Based on its location and intended occupancy, the Tower is in a seismic design category lower than D.

Reinforcing Bar Properties

SAS Stressteel has ample test data to show that their bars, including the largest No. 20 (63.5- mm dia.) bars, meet the acceptance criteria in Section 3.2.2 of AC237 minimum yield strength of 97,000 psi (670 MPa), minimum tensile strength of 116,000 psi (800 MPa), and minimum elongation (over an 8 in. or 400 mm gage length) of 6%. ACI 318-05 Section 3.5.3.2 requires that for bars with specified yield strength exceeding 60 ksi (420 MPa), the yield strength shall be taken as the stress corresponding to a strain of 0.35 percent. Stressteel bars, unlike some other high-strength bars, attain a minimum yield strength of 97,000 psi (670 MPa) at a strain of 0.35 percent.

Couplers under Cyclic Loading

CTL Group, Skokie, IL, has performed cyclic load and ultimate strength tests on three Stressteel bars of each available bar size, including the largest No. 20 (63.5- mm dia.) bars, in compliance with the ICC ES Acceptance Criteria for Steel Bar Reinforcement (AC133), as required by Section 3.4.1 of AC 237. In all cases, the measured ultimate load far exceeded the load corresponding to 125% of the specified yield strength, as is required for Type 1 mechanical splices by Section 12.14.3 of ACI 318.

Bond: Beam-End Tests

Beam-end tests in accordance with ASTM A944, involving No. 6, No. 9, No. 14, and No. 20 (18-mm, 28-mm, 43-mm, and 63.5-mm dia.) Stressteel bars embedded in 6000 psi as well as 12,000-psi concrete, have been carried out at the Constructed Facilities Laboratory, Department of Civil, Construction, and Environmental Engineering, North Carolina State University, Raleigh, NC. The acceptance criterion in Section 3.1.2 of AC 237 was satisfied in each test.

Bond: Splice Beam Tests

Four splice specimens have been tested with No. 9 bars in 6000 psi concrete. The splice lengths were determined in accordance with Equation 12-1 of ACI 318. The amount of transverse reinforcement was determined by using Section 7.10.5 of ACI 318. Three transverse reinforcement configurations were used in the region of the spliced bars: no

transverse reinforcement, minimum transverse reinforcement, and twice the minimum transverse reinforcement. Two specimens were cast with the minimum transverse reinforcement. The spliced reinforcing bars in all the specimens were able to attain their yield strength before the splices failed. The test sequence was repeated for No. 9 bars in 12,000 psi concrete and No. 20 bars in 12,000 psi concrete. The acceptance criterion in Section 3.1.2 of AC237 was satisfied in each test.

Conclusion

Based on fairly extensive testing at the Construction Technology Laboratories, Skokie, IL and North Carolina State University, Raleigh, NC, there does not appear to be any reason not to permit the use of Grade 97 Stressteel bars in the columns, shear walls and footings, pile caps or mats of buildings assigned to a seismic design category no higher than C, provided it is understood that the bars shall not be welded and that bars in shear walls or columns, which are larger than No. 14 (43-mm dia.) in size, shall not be bent.

If you have any question about the contents of this letter, please feel free to contact me.

Sincerely,

S. K. Ghosh

cc. Ahmad Rahimian
Ray Sandiford
Felix Ferrer