BTMS

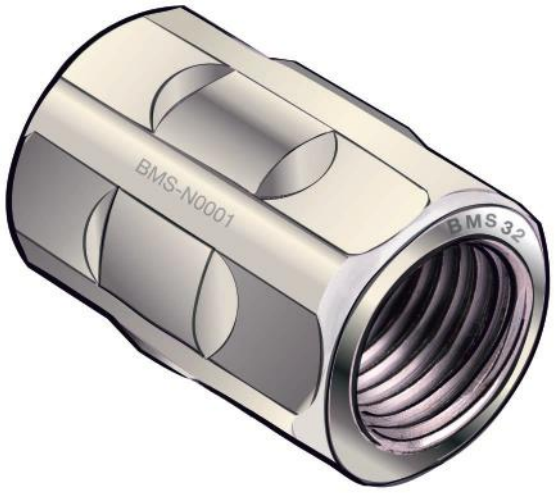
COUPLER

The World's Tallest !

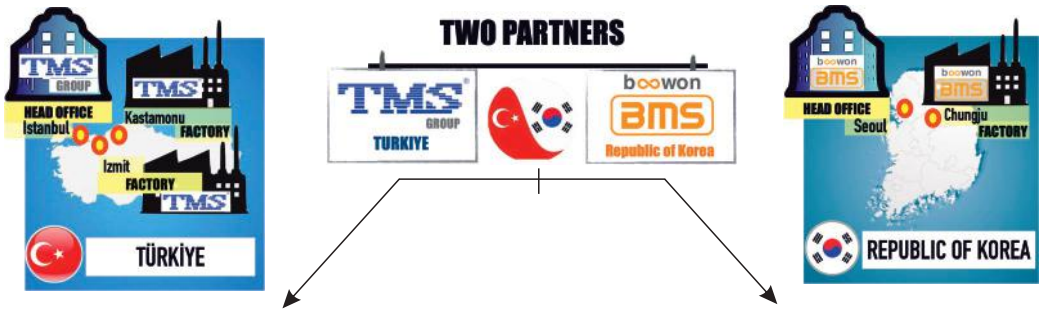
The World's Longest !

Built By The World's Best Mechanical Coupler!

REBAR COUPLER COMPANY FOUNDED BY BOOWON BMS & TMS

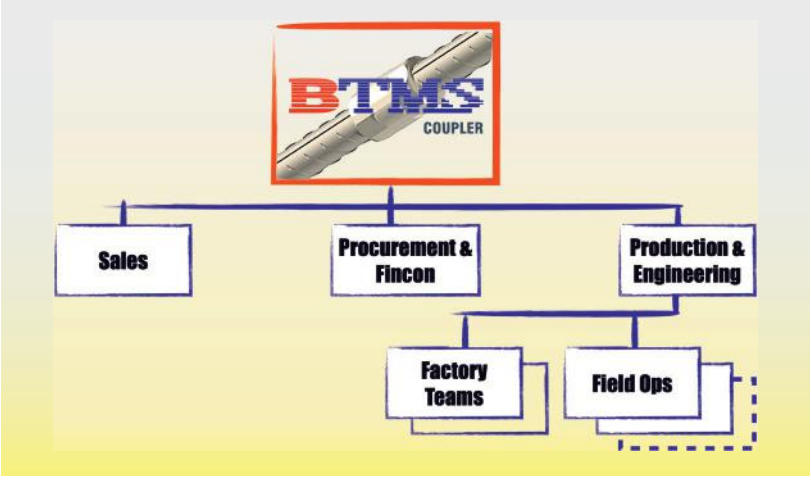


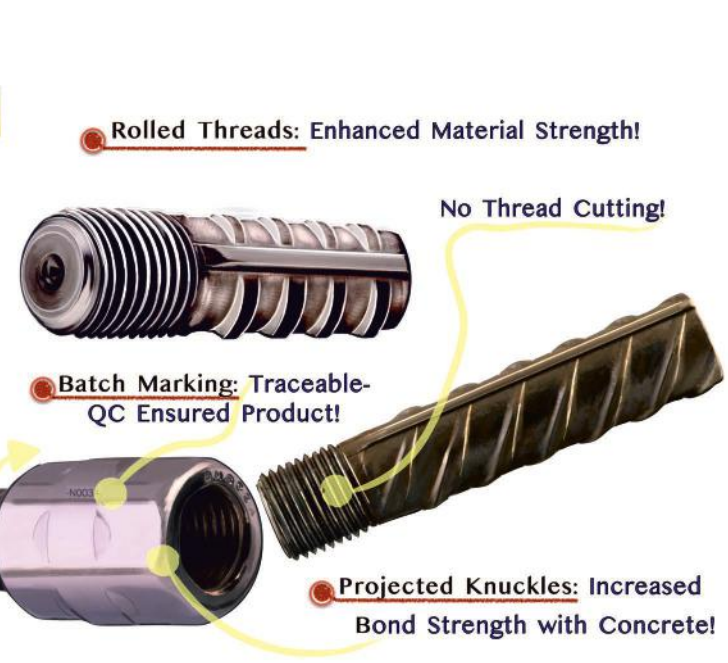
BTMS COUPLER, a co-partnered JV by BOOWON BMS Co., Ltd. of Korea & TMS of Turkey, to produce the very best reinforcing coupler system: "BMS Parallel Rolled Thread Mechanical Splice System"



TMS of Turkey, a multi-regional Company, operates within the Construction Industry to provide Formwork & Scaffolding products and related design services. TMS has a quality product range with an experienced Engineering Team capable of supplying innovative, safe and cost-effective solutions.

BMS of Korea is the leading supplier of rebar-couplers where quality and performance are the main priorities. BMS name can be found on many world-famous projects like Burj-Khalifa Tower, Barakah NPP, Istanbul's Third Bosphorus Bridge, Çanakkale Bridge of Türkiye, Qatar's Lusail Plaza Tower projects, and many so on.





The system utilizes a combination of 'cold forming' and 'cold thread rolling' to maximize the thread area potential and in doing so enlarges the thread area to provide bar failure away from the coupled joint when subjected to tensile load.

Force is ENSURED!

No heat applied, No upsetting, No thread cutting!

Through normal-temperature swaging, original stress-resistance in tension and compression force is ensured!

The couplers are designed to provide high tensile strength connections with external ribs or spanner flats for easy gripping by hand tools; such as spanner, pipe wrench, and chain wrench.

Projected Knuckles of the BMS Couplers increase the bond strength with concrete.

Couplers have smaller diameter and short length (compared to the others), which highly contributing to the concrete placement of the couplers and helps reducing the steel congestion in the concrete ratio, considerably.

The reinforcing ring at the center of the coupler adds strength to the coupler without increasing diameter. It is suitable for ultra high strength reinforcing steel bar.

The system is supplied to ISO standards for manufacture and bar end processing!

Boowon BMS is a UK CARES approved company, which holds **TA1-A** (one of only 4 systems worldwide to have this approval) & **TA1-B** approvals.

Projects requiring large numbers of couplers require a method of quick fixing. The BMS system introduces a 'two start' metric thread, which reduces fixing time to half that of a traditional single start thread. The BMS method allows the coupler to be fixed in ONLY 5 TURNS – at least, half the number of turns and twice as fast as every other competitor.

All products are marked with brand, size and production batch reference and are issued with the relevant material mill certificates.

Product is patented, unique and user friendly (Patent registration No. 0316435).

BMS MECHANICAL SPLICE RANGE

- Standard Couplers: A & B Types
- C Types (standard coupler with lock nut) for prefabricated cages & hooked bars
- Transitional Couplers
- Form-savers
- Weldable Couplers
- Terminators, Mechanical Anchorages
- Rebox System

MATERIAL

Reinforcing bar

- The reinforcing bar to execute thread processing splice shall be meet with the requirement in accordance with KS D 3504, BS 4449, ASTM A615 or A706, TS 708, GOST P 52544, etc…

Material of BMS BAR COUPLER

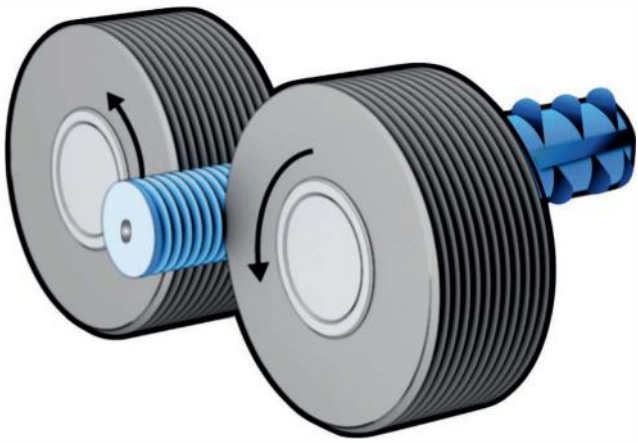
- The material to be used in the coupler for the splice with KS D 3592, KS D 3752, KS D 3517, SAE J404.

BMS REBAR THREADING SYSTEM MAKES THE DIFFERENCE: FAST,

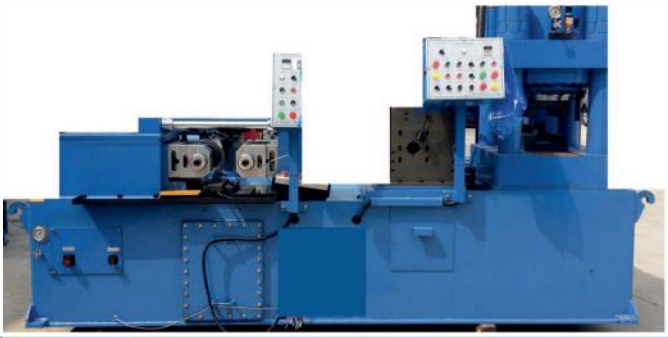
Rolling the Threads

The BMS system rolls the thread onto the bar-end. Thread Rolling enhances the material strength and is accepted as 'the norm' in most arduous industries such as aircraft, nuclear etc, where high performance connections are required.

It not only strengthens the material but also provides an extremely consistent and accurate thread form with added benefits in slip, fatigue and stress reversal conditions over cut form (upset system).

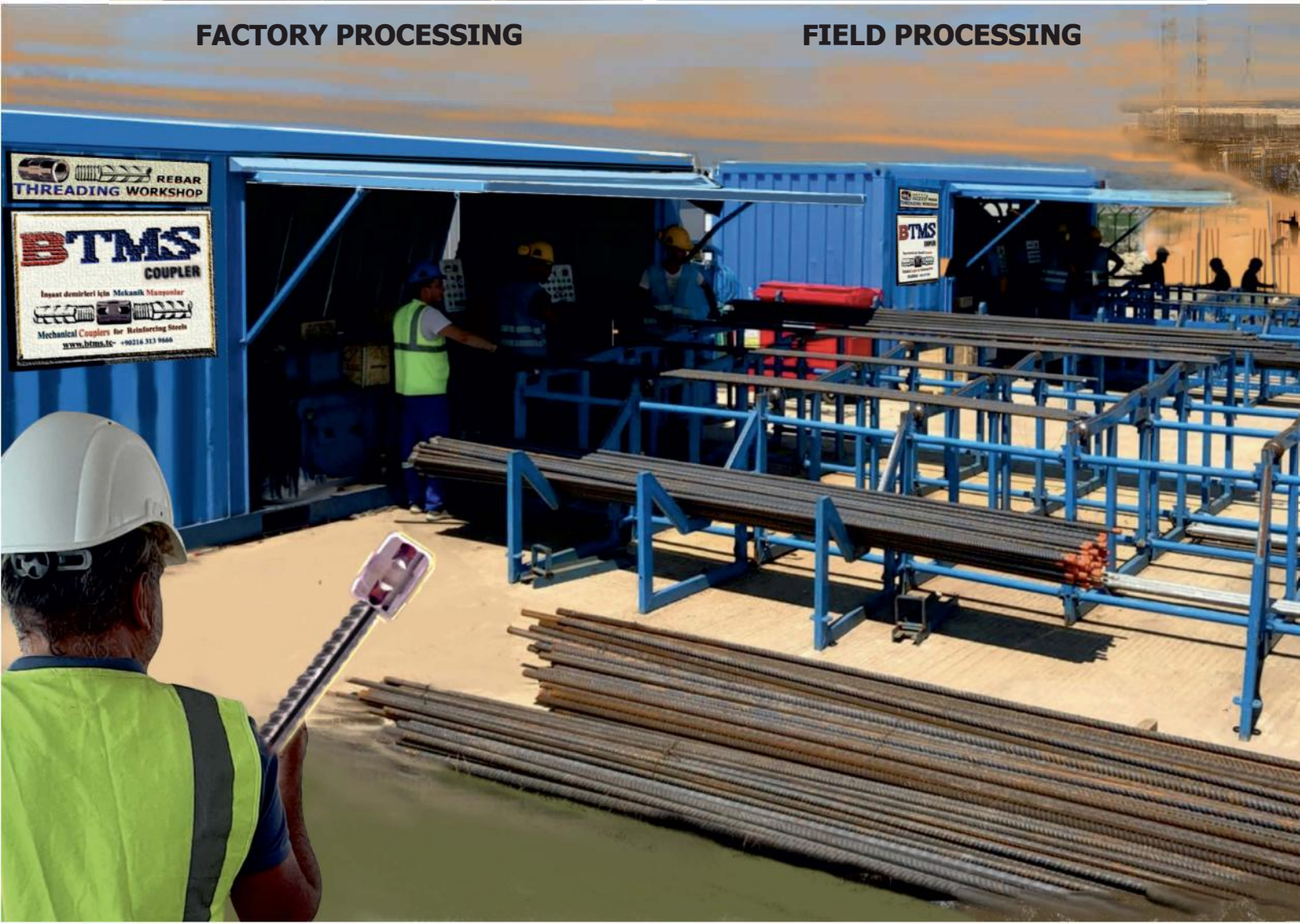


BMS COLD FORMING REBAR THREADING MACHINE



FACTORY PROCESSING

FIELD PROCESSING

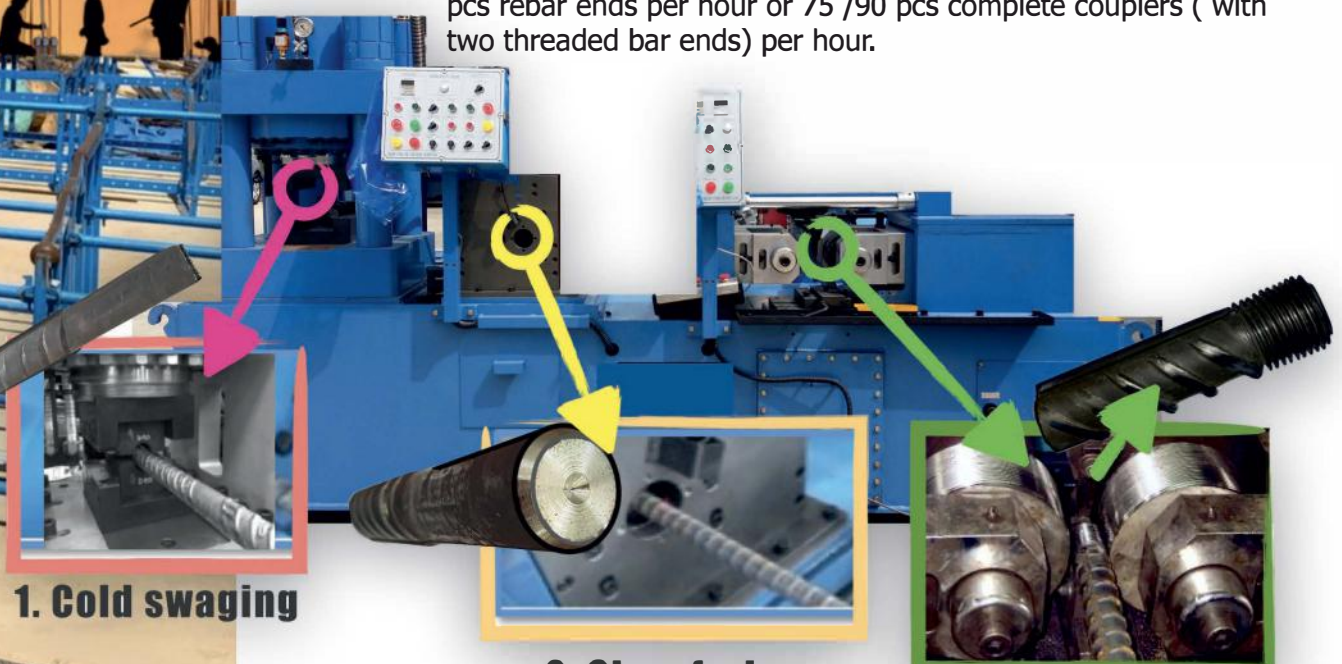


Extremely Low Downtime!

The Fastest In The Market!

Thread Rolling is fast, cutting down time to a minimum [almost half of the time of our competitors in the market], and is used in every quality industry from auto, oil and gas, marine, aerospace & nuclear.

Typical capacity / output from machinery: on average; 150 /180 pcs rebar ends per hour or 75 /90 pcs complete couplers (with two threaded bar ends) per hour.

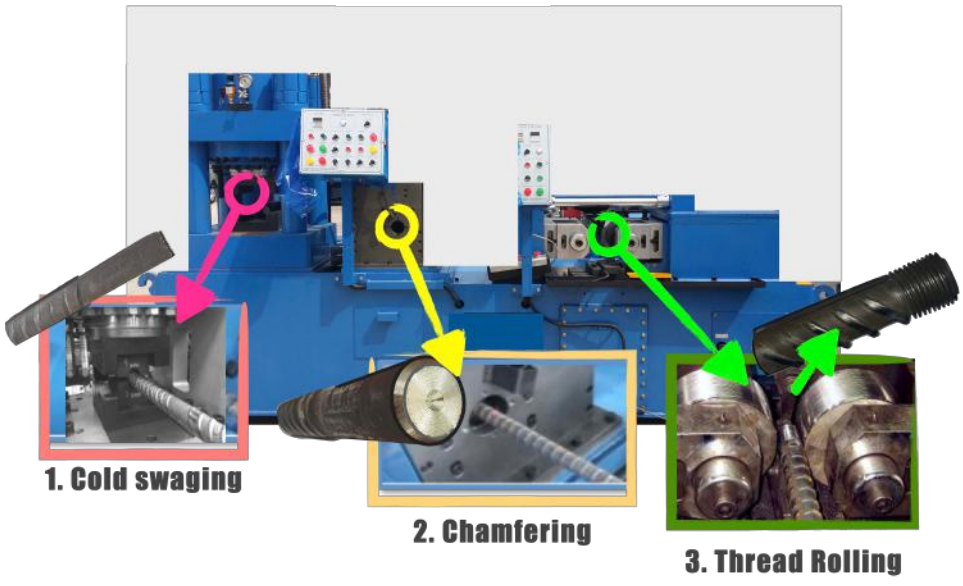


1. Cold swaging

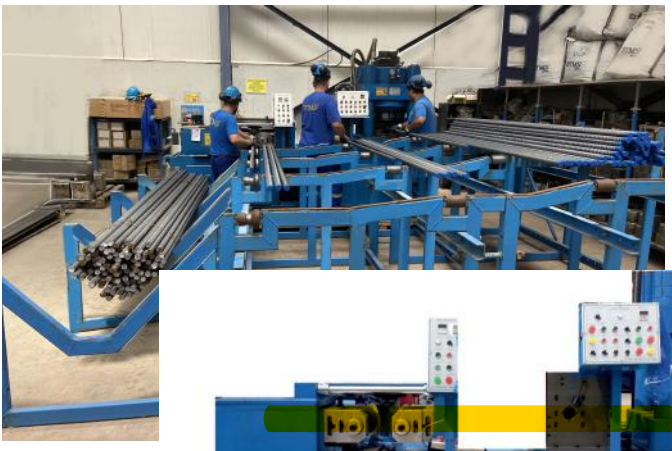
2. Chamfering

3. Thread Rolling

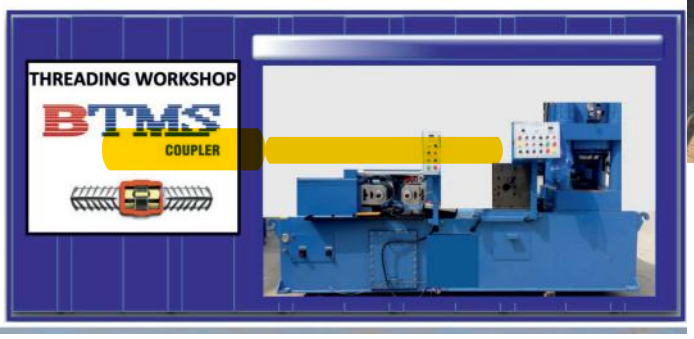
BMS COLD FORMING REBAR THREADING MACHINE



The Fastest In The Market!



FACTORY PROCESSING



JOBSITE PROCESSING

SUPERIOR REBAR COUPLERS: A PRODUCT OF PERFORMANCE!

boowon BMS

BMS SYTEM

VS

OTHER COMPETITORS

Re-bar end Swaging Type

Re-bar end Up-setting Type

Process #1: Cutting the end of rebar

Not a BMS system process!

Saves in rebar-end wastage!

No need to cut the delivered rebar from the steel mill.

Rebar-end wastage!

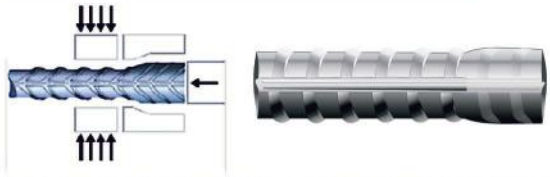
The bent or deformed rebar ends should be hand cut with a circular saw or by other means.

Process #2: Metal forming of the rebar-end

No rebar-end wastage!

Forming the deformed rebar end to be round shape by pressing/swaging the ribs & nodes. The malformed end part is automatically straightened through this process!

Rebar losses due to the upsetting!



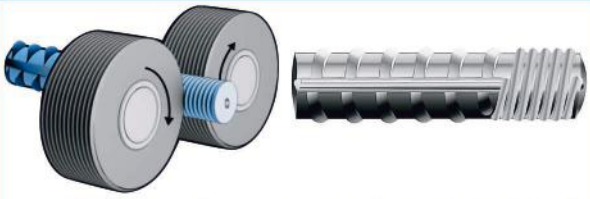
The rebar inserts into a cold forging m/c for enlarging to a predetermined dimensions. This operation increases the core diameter of the bar. Through this process the grain flow/ texture is broken already.
End-upsetting also causes loss in rebar!

Process #3: Rebar end process

Trimming & chamfering the face of the rebar-end part.

N/A

Process #4: Rebar threading



Roll threading: stronger thread structure!

Cut threading: weaker thread structure!

Process #5: Proof Loading

Not a BMS system process!

Due to the stronger thread structure: BMS System already ensures a successful slip performances; therefore this process is not a part of BMS System!

Extra process, extra cost & time !

As a result of cutting the thread, slip test [permanent elongation] performance is low! For successful slip performance, there should be a proof-loading/thread integrity process added to the threading process!

boowon BMS

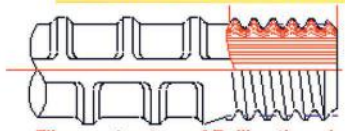
BMS SYTEM

V/S

OTHER COMPETITORS

Quality Assurance

Continuity of the grain flow!



Fibrous structure of Rolling thread

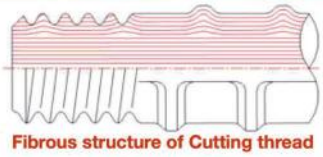
Rolled Thread: Fibre 'maintained'

Original Structure → After Swaging

Maintaining the mechanical properties of the reinforcement steel!

Cut-off in the midle of the grain flow!

Machined Thread: Fibre 'broken'



Fibrous structure of Cutting thread

Original Structure → After Upsetting

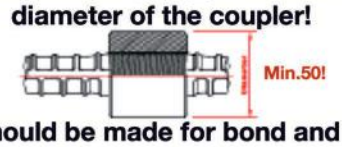
Decreased mechanical properties of the reinforcement steel!

External Diameter

Thanks to the comparatively smaller outer diameter of the coupler, it's easy to secure space for ensuring concrete flow & quality!

The Coupler dia of the D32 Rebar is 48!

Comparatively bigger external diameter of the coupler!

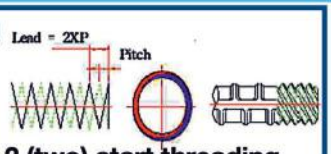


Consideration should be made for bond and flow of concrete. Coupler surface is smooth and difficult when securing with wrench!

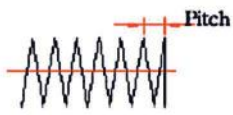
Faster connection

Reduced fixing time!

Only 50% of the others!



Thanks to the BMS 2 (two) start threading system, rotating the coupler ONLY 4.5 turns is enough to complete the connection of two re-bar threads.



The single pitch threading requires 10 rotations and more (dependent on supplier) to complete the connection.

Economic Feasibility , Superior Productivity!

800 Set/Day
(1600 Re-bar-end!)

300 Set/Day
(600 Re-bar-end!)

Max. 3 workers / Threading M/C

Min. 3-4 workers / Threading M/C

Saves Rebar!

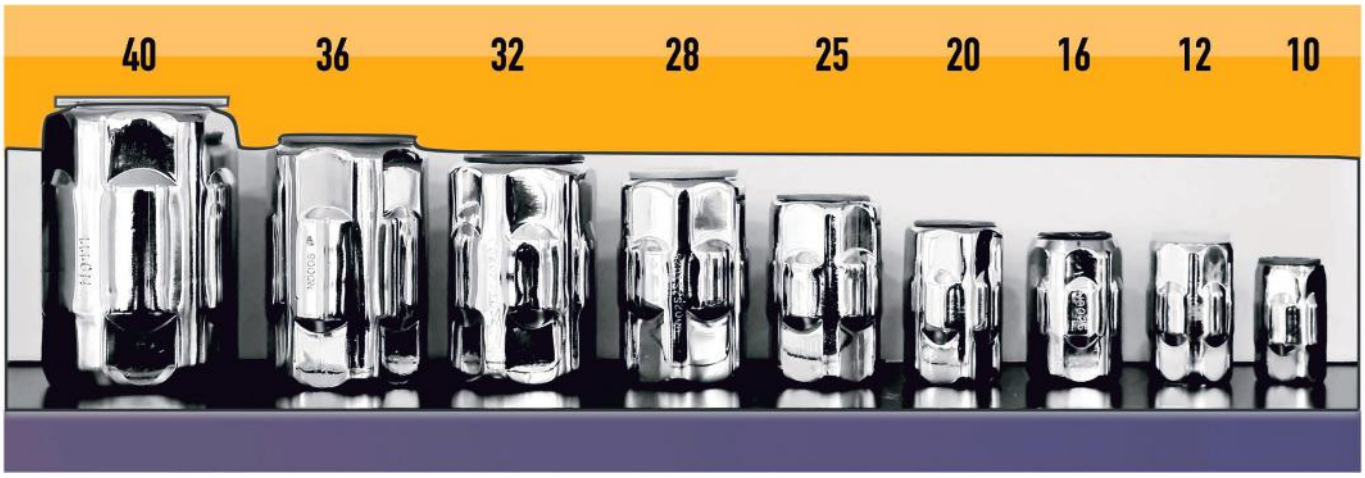
No Losses at all through BMS System processing!

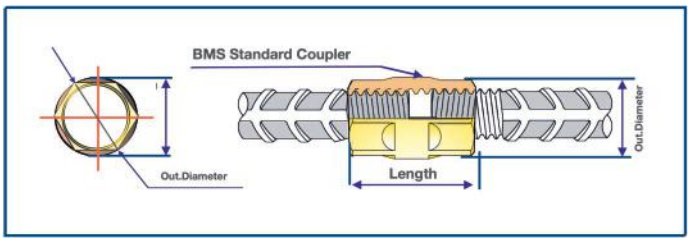
Cost not considered: Loosing at rebar!

As the upsetting process requires a flat surface, the bar end needs to be cut square prior to upsetting. Bar-end cutting and upsetting reduces the bar length by 0.1M (D32=0.62kg)!

BTMS brings savings...

BMS STANDARD COUPLER: ENSURED CONTINUITY!





STANDARD COUPLERS

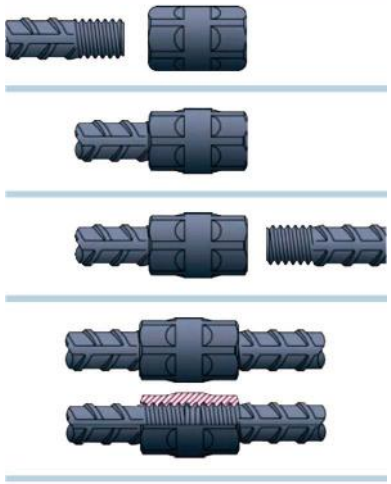
BS 4449-TS 500

Nominal Bar Size (Ømm)	10	12(13)	14	16	18	20	22	25	28(29)	32	36(35)	40	50
Coupler Diameter (mm)	18	20	21	23	28	31	33	38	43	48	51	60	75
Hexagon-B(mm)	17	19	19	21	26	29	30	35	40	45	48	56	70
Coupler Length	22	30	32	38	45	46	50	58	65	70	75	86	110

ASTM A615/A 615M

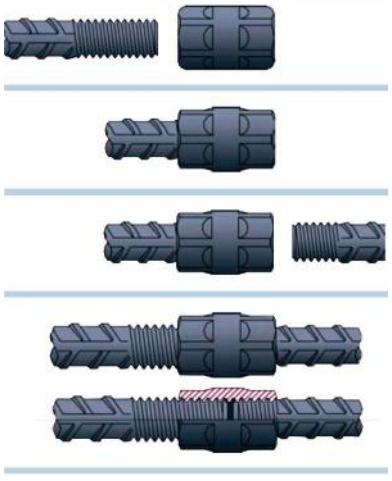
Bar Designation (#)	3(10)	4(13)	5(16)	6(19)	7(22)	8(25)	9(29)	10(32)	11(36)	14(43)	18(57)		
Coupler Diameter (mm)	18	20	23	28	33	38	43	48	55	65	85		
Coupler Length	22	30	38	45	50	58	65	70	78	95	125		

A TYPE:
TWO BMS SHORT THREAD + BMS STANDARD COUPLER



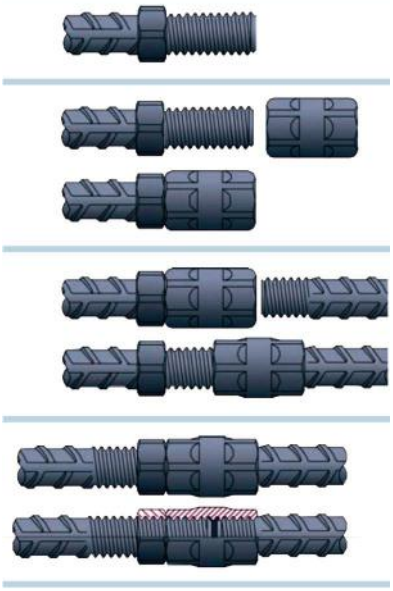
- Used where the continuity bar can be rotated (final tightening is by wrench, spanner, etc.)!
- Used for P.S.C. Box at the top of the bridge: ILM, FCM, MSS method of construction, 2nd application, Slip-Form construction, etc.
- Widely used for bars usually less than 6m long in vertical reinforcing bar application.

B TYPE:
ONE SHORT & ONE LONG THREAD + BMS STANDARD COUPLER



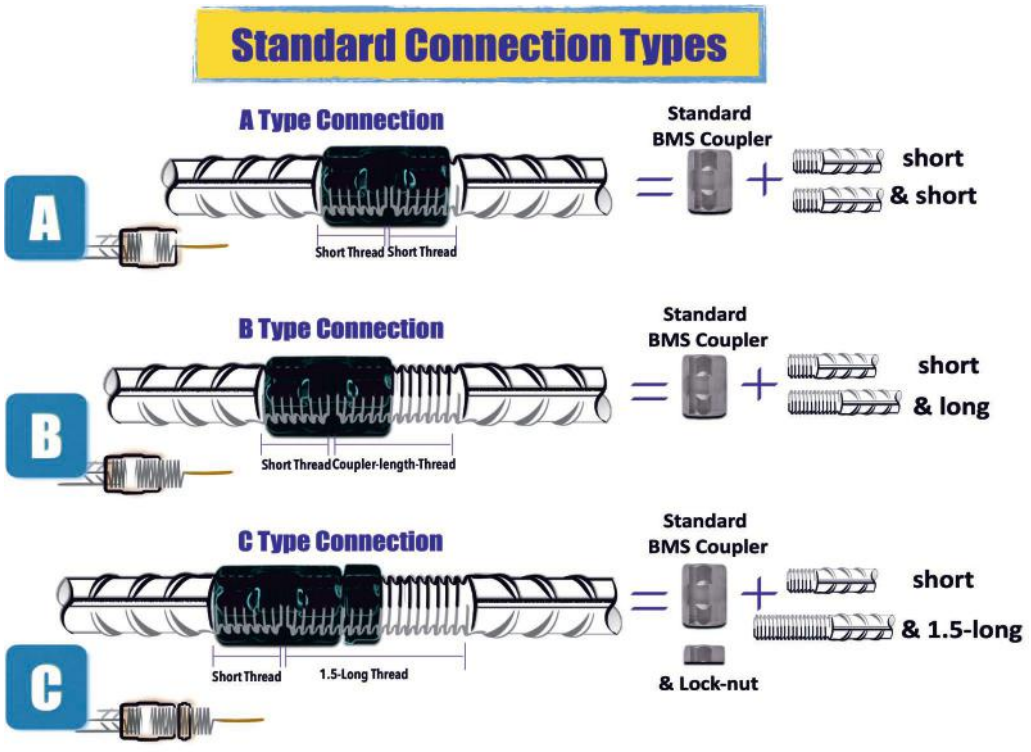
- Used in application of long bars (over 6m) and large dia bars (for slip-form, column, post applied in the site) where they can be rotated but may be difficult to do so.

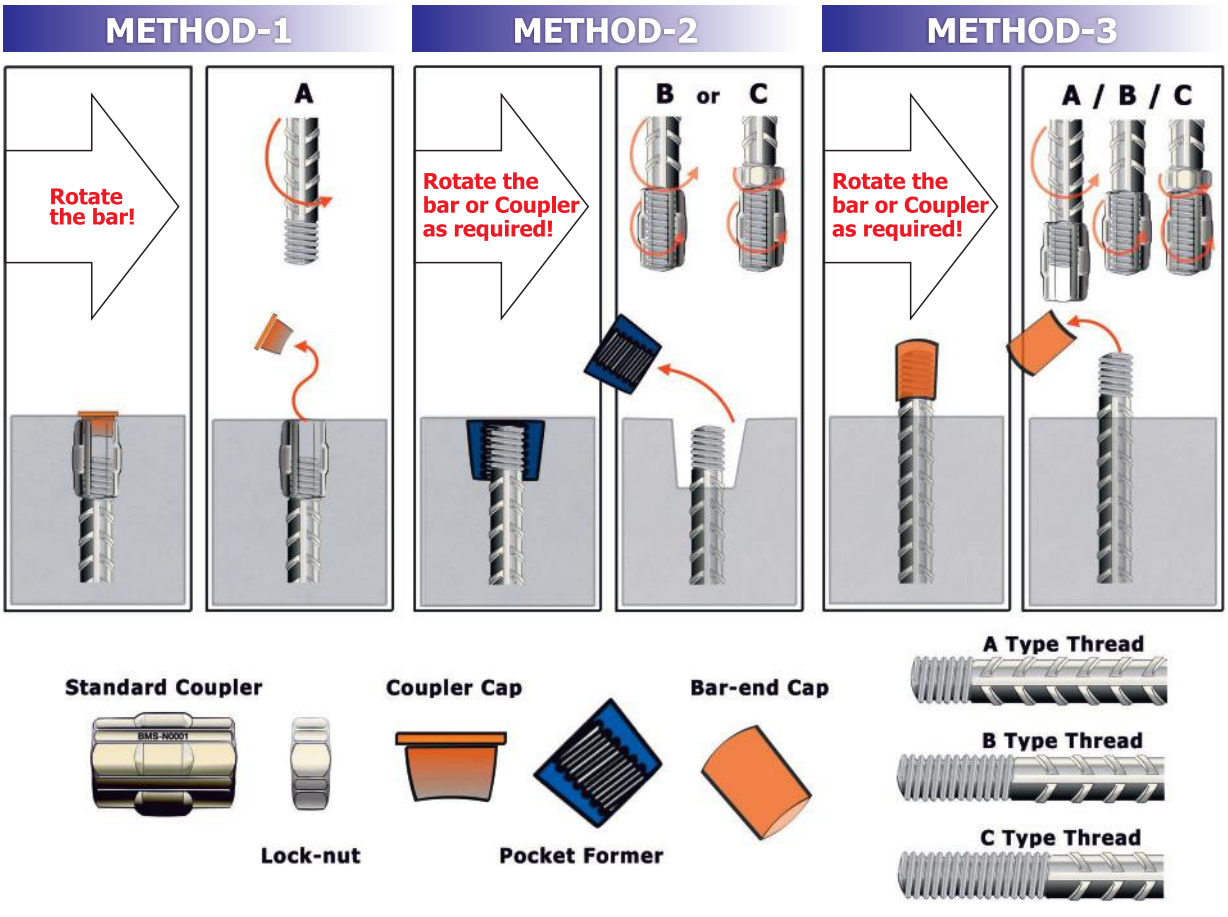
C TYPE:
ONE SHORT & ONE 1.5 LONG THREAD + BMS STANDARD COUPLER & LOCK-NUT



- Used for construction of prefabricated cages or fixing hooked/cranked bars.

METHOD OF APPLICATION





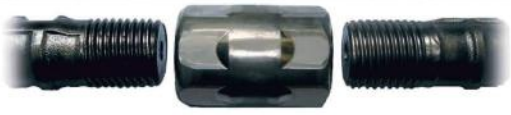
A-A Type Reinforcing Splice

The purpose of using:

The typical type to be used in short reinforcing bars in the perpendicular member the tensile and compressive force are influenced.
Applying to the construction by turning the reinforcing bar.
Applying when the column-rebar is constructed in the second displacement part, the engineering works and the construction.

Construction order

1



The reinforcing bar and coupler for splicing.

2

Assemble the coupler to the first reinforcing bar.

3

The coupling construction by turning the reinforcing bar to splice.

4

After the first coupling to place two reinforcing bars on the straight line, mark at the coupler and reinforcing bar on the tightened location at the same time.

5

Suitable pipe-wrench

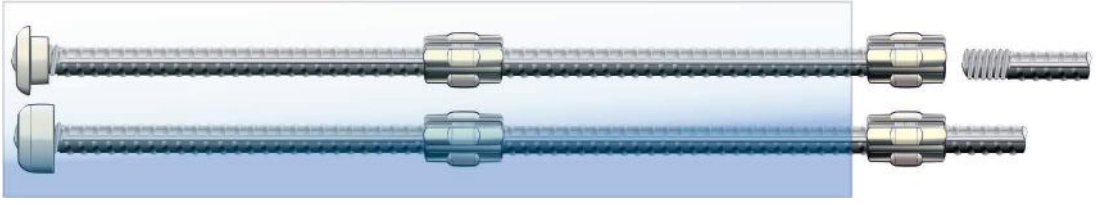
Regulated torque wrench

Apply suitable-force per diameter of the bar & coupler with a sizable pipe wrench (i.e. with a suitable pipe wrench of 24 inch for D25 and above!) or tighten at the regulated torque (per minimum torque setting Table) by using a torque wrench.

Watch for not applying excess force on to the smaller diameters!

6

After the completion of splicing construction, confirm the marking line crossed to confirm whether the torque is applied to the splicing construction by eye.



METHOD OF APPLICATION

A-B Type Reinforcing Splice

The purpose of using:

The typical type to be used in long reinforcing bars in the perpendicular member the tensile and compressive force are influenced.
To be used in the perpendicularity construction(beam, pillar, slab) in the large/long reinforcing bar and reinforcing bar net prefabricated by using Pre-fab method of construction.

Construction order

1

The reinforcing bar and coupler for splicing.

2

Assemble the coupler to the long threaded reinforcing bar.

3

Splice construction by turning the coupler toward the short thread.

4

After the first coupling to place two reinforcing bars on the straight line, mark at the coupler and reinforcing bar on the tightened location at the same time.

5

Suitable pipe-wrench

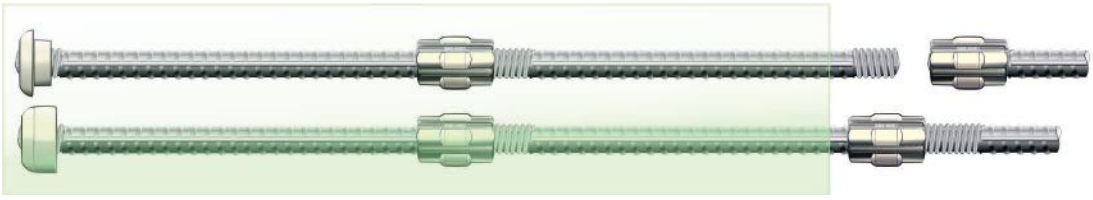
Regulated torque wrench

Apply suitable-force per diameter of the bar & coupler with a sizable pipe wrench (i.e. with a suitable pipe wrench of 24 inch for D25 and above!) or tighten at the regulated torque (per minimum torque setting Table) by using a torque wrench.

Watch for not applying excess force on to the smaller diameters!

6

After the completion of splicing construction, confirm the marking line crossed to confirm whether the torque is applied to the splicing construction by eye.



A-C Type Reinforcing Splice

The purpose of using:

The type to be used in the directional reinforcing bar's construction such as a anchor part and a round reinforcing bar.
To be used in the bar mat's prefabricated construction using the Pre-fab method of the tensile member.
Applied to the splice of the anchor or the round reinforcing bar and the construction by the prefabrication when it can not construct by turing the reinforcing bar.

Construction order

1

The reinforcing bar and coupler for splicing.

2

After assembling locking nut and coupler to the long thread splice, place two reinforcing bars to be tightened each other.

3

Splice construction by turning the locking nut and coupler toward the short thread.

4

After the first coupling to place two reinforcing bars on the straight line, mark at the coupler and the lock nut or coupler and reinforcement on the tightened location at the same time.

5

Suitable pipe-wrench

Regulated torque wrench

Apply suitable-force per diameter of the bar & coupler with a sizable pipe wrench (i.e. with a suitable pipe wrench of 24 inch for D25 and above!) or tighten at the regulated torque (per minimum torque setting Table) by using a torque wrench.

Watch for not applying excess force on to the smaller diameters!

6

After the completion of splicing construction, confirm the marking line crossed to confirm whether the torque is applied to the splicing construction by eye.

BMS TERMINATORS (END-ANCHORAGE)

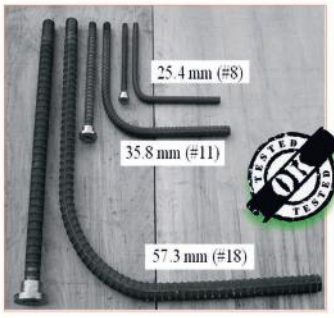
WHY BMS TERMINATOR?

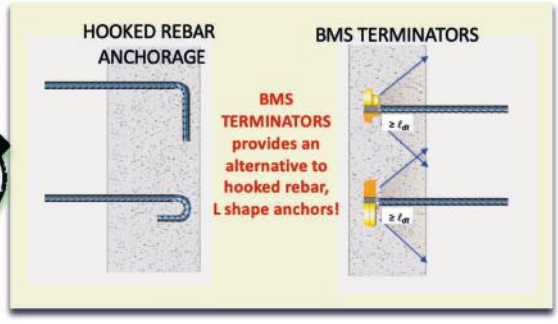
- Eliminates rebar hook
  - Simplifies bar placement
- Saves costs
  - Saves lap costs of larger bars
- Minimizes development lengths
  - Reduces congestion
- Simplifies concrete placement
  - Better concrete consolidation
- More embedment options
  - Greater design flexibility
- Faster installation
  - Lowers in-place cost
- Standard product dimensions
  - Minimal detailing required

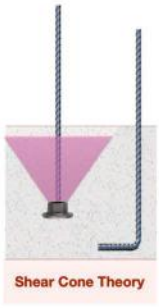
VS.

WHY NOT REBAR HOOKS?

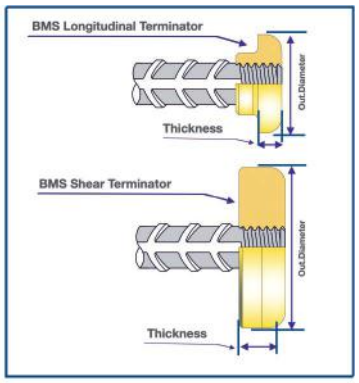
- Requires longer development lengths
  - Increases rebar congestion
  - Restricts flow of concrete
- More Costly
  - The larger the bar, the longer the lap!
- Inhibits rebar placement
  - Increases rebar placing costs
- Restricts removal of column forms and shaft casings
  - Labor intensive
- Jeopardizes job site safety
  - Increases safety hazards through exposed rebar







Shear Cone Theory



TERMINATORS (END ANCHORAGES)

For Longitudinal Re-bars

Bar Size		12(13)	14	16	18	20	22	25	28(29)	32	36(35)	40	50
BS 4449-TS 500	Diameter	29	32	36	41	45	50	56	65	72	79	90	112
	Thickness	6	7	7	7	8	9	9	10	10	12	18	20
Bar Designation (#)		3(10)	4(13)	5(16)	6(19)	7(22)	8(25)	9(29)	10(32)	11(36)	14(43)	18(57)	
ASTM A615/A 615M	Diameter	22	29	36	43	50	57	65	73	81	97	129	
	Thickness	5	6	7	8	8	9	10	10	12	20	22	

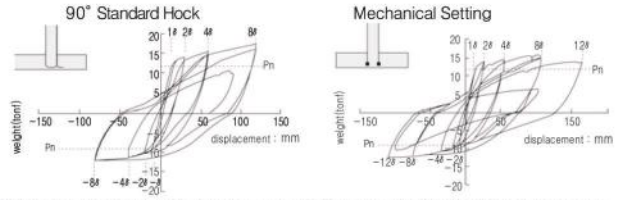
For Shear Re-bars

Bar Size		12(13)	14	16	18	20	22	25	28(29)	32	36(35)	40	50
BS 4449-TS 500	Diameter	32	45	51	57	64	70	80	89	102	114	127	159
	Thickness	6	8	8	8	10	12	14	16	18	19	22	26
Bar Designation (#)		3(10)	4(13)	5(16)	6(19)	7(22)	8(25)	9(29)	10(32)	11(36)	14(43)	18(57)	
ASTM A615/A 615M	Diameter	31	41	51	61	71	81	91	103	114	136	182	
	Thickness	6	8	8	10	12	14	16	18	20	24	30	

** The dimensions may be subject to change for the performance improvement!*

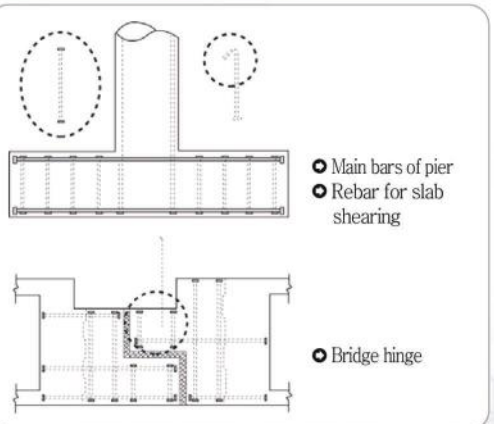
Test Results of the Connection between Beam and Column

Weight-Displacement Curve



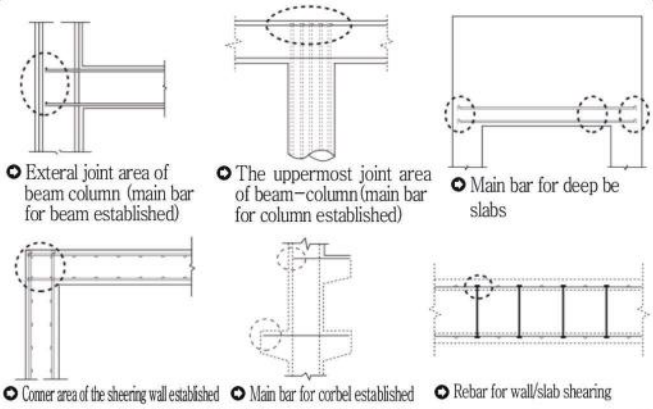
- Compression bar buckled during+8δγ 3rd cycle.
- Sufficient resistance design secured.
- Very stable movement (no pinching state)
- Compression bar buckled during+12δγ 2nd cycle.
- Excellent transformation performance (ductility).
- Sufficient resistance design secured.
- Very stable movement (no pinching state)

Practical Application of Mechanical Anchor (Civil Engineering)



- Main bars of pier
- Rebar for slab shearing
- Bridge hinge

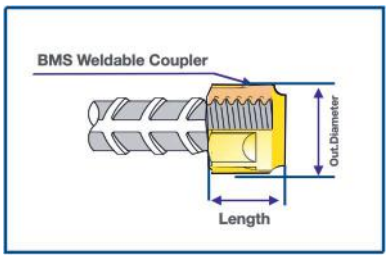
Practical Application of Mechanical Anchor (Architectural Engineering)



- Exteral joint area of beam column (main bar for beam established)
- The uppermost joint area of beam-column (main bar for column established)
- Main bar for deep be slabs
- Conner area of the sheering wall established
- Main bar for corbel established
- Rebar for wall/slab shearing

WELDABLE COUPLERS

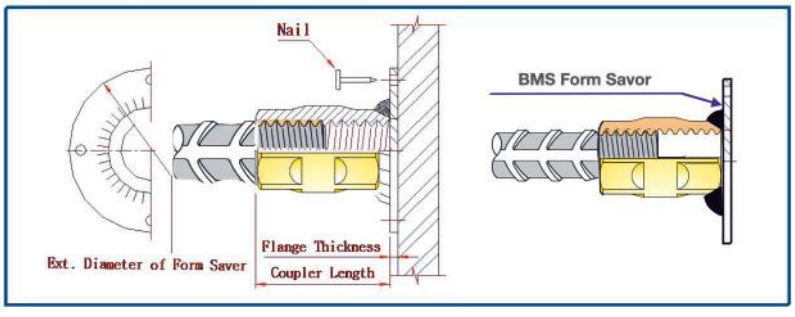
Weldable couplers allow unrestricted and easy placing of re-bar to steel piles, forms, steel beams etc…

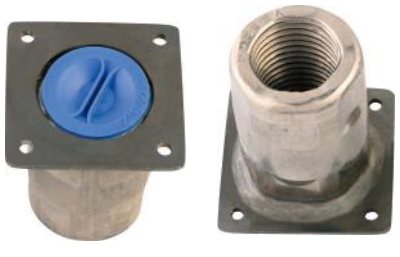


WELDABLE COUPLERS												
BS 4449												
Bar Size	12(13)	14	16	18	20	22	25	28(29)	32	36(35)	40	50
Coupler Diameter	20	21	23	28	31	33	38	43	48	51	60	75
Coupler Length	18	19	22	26	26	28	32	36	38	41	48	60
ASTM A615/A 615M												
Bar Designation	3(10)	4(13)	5(16)	6(19)	7(22)	8(25)	9(29)	10(32)	11(36)	14(43)	18(57)	
Coupler Diameter	18	20	23	28	33	38	43	48	55	65	85	
Coupler Length	14	18	22	26	28	32	36	38	44	53	68	

** The dimensions may be subject to change for the performance improvement!*

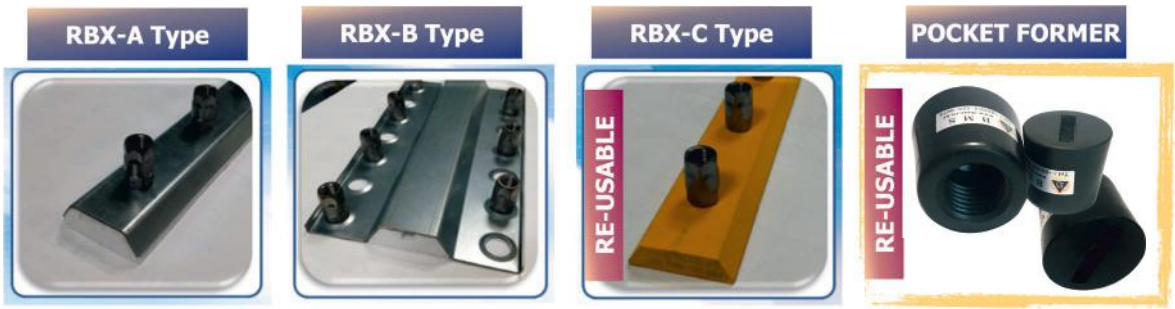
FORM SAVER

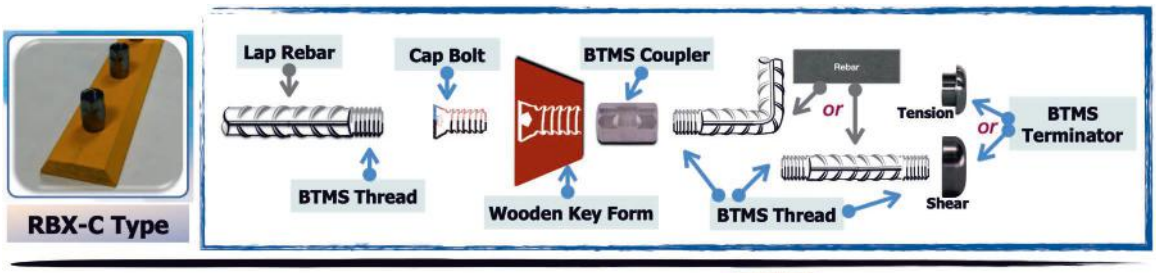




- Couplers has an attached nail plate for accurate and easy fixing to plywood form surface.
- Eliminates drilling of expensive forms
- Form work easy to remove and re-usable
- Enables slip forming / climbing form work
- Built in thread cover protects thread against concrete paste contamination
- Provides job site safety by eliminating protruding dowels

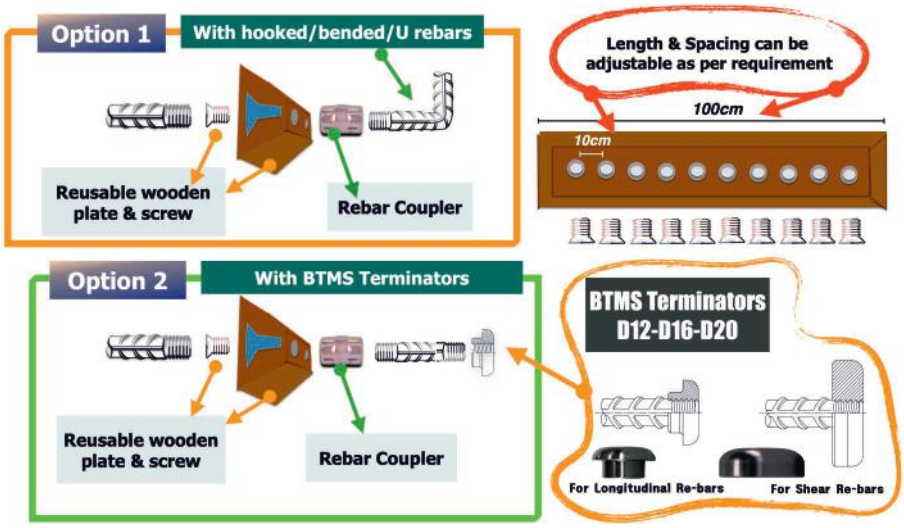
BMS REBOX SYSTEM & ACCESSORIES

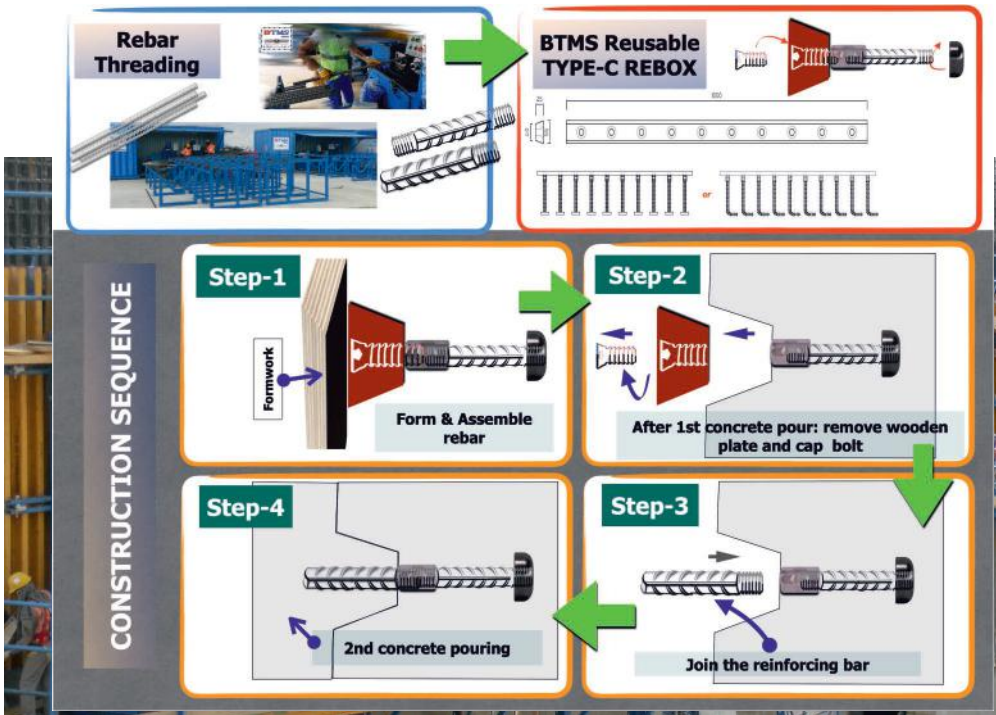




BTMS Couplers
D12-D16-D20

BMS Re-box System enables slip forming or climbing forms work smoothly by eliminating dowels with an safer and more ensured rebar continuity than dowel boxes and the similar solutions.





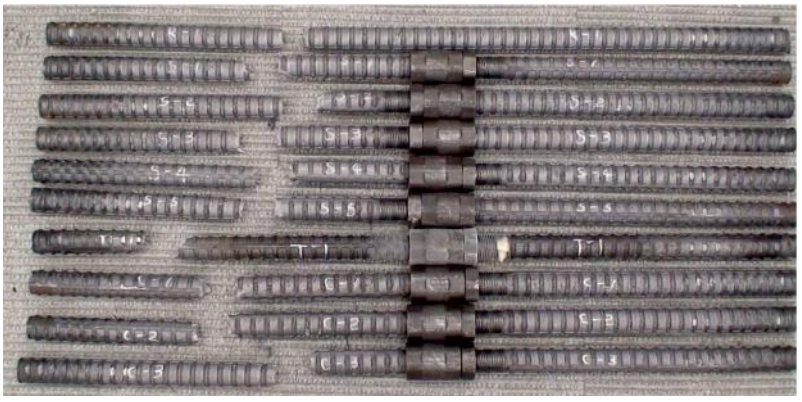
BMS COUPLERS ARE ALWAYS STRONGER THAN REBAR

TEST REPORTS TO BREAK BMS COUPLERS WITH HIGH-STRENGTH DYWIDAG BARS

Table 1: Tensile Testing (Load vs. Extension curves was attached)

Specimen Reference (Coupled Rebar)	Yield Load (N)	Yield Stress (N/mm²)	Max. Load (N)	Ultimate Tensile Stress (N/mm²)	Mode of Failure
T40-1	-	-	1164559	**927**	Coupler Break
T40-2	-	-	1161468	**924**	Coupler Break
T32-1	-	-	718161	**893**	Coupler Break
T32-2	-	-	706701	**879**	Coupler Break
T25-1	-	-	485750	**990**	Coupler Break
T25-2	-	-	472597	**963**	Coupler Break
T20-1	-	-	288246	**918**	Coupler Break
T20-2	-	-	291582	**928**	Coupler Break
T13-1	-	-	147734	**1113**	Coupler Break
T13-2	-	-	143981	**1085**	Coupler Break

Technically Superior by Design boowon BMS



BAR-BREAK BMS COUPLERS!

CERTIFICATES

CERTIFICATE OF APPROVAL

Technical Approval Certification - Reinforcement Coupler System — Page 1 of 3

This is to certify that

Boowon BMS Co. Ltd.

at its establishment at

590 Yongtan Dong, Chungju City, Chung-Cheong Bukdo Province, Chung-Cheong Bukdo Province, 380-250, Korea, Republic of

has satisfied the Authority that it operates a quality management system that complies with the requirements of BS EN ISO 9001 and the relevant CARES Quality and Operations Assessment Schedules. Where appropriate, and as listed below, it has further satisfied the Authority that it manufactures and/or supplies products that conform with the stated product standards and is entitled to use the CARES marks on its products using the processes and procedures registered with the Authority.

Scope of certification:
Product Conformity Certification of the mechanical coupler / anchor systems as stated on the attached appendices

This certificate remains the property of the Authority and is issued subject to the Regulations of the Authority. This certificate is uncontrolled when printed. To check the validity of this certificate please scan the above Static QR Code with the CARES Cloud App or contact us on +44 1732 450000.

CERTIFICATE NUMBER	FIRST APPROVAL	ISSUE DATE	EXPIRY DATE
5016	November 2007	01 January 2022	31 December 20XX

SIGNED FOR UK CERTIFICATION AUTHORITY FOR REINFORCING STEELS

Lee Brankley
Chief Executive Officer

The use of the Accreditation Mark indicates accreditation in respect of those activities covered by the accreditation certificate number 0002.
UK Certification Authority for Reinforcing Steels, Pembroke House, 21 Pembroke Road, Sevenoaks, Kent, TN13 1XR, UK
A Company Limited by Guarantee. Registered in England No. 1762448.
Cert. Ref: ARC112010 46401 804 v03

TECHNICAL APPROVAL

PRINTED ON 15/02/2022 FROM UKCARES.COM

APPENDIX TO CARES CERTIFICATE NO. 5016

BOOWON BMS CO. LTD.
590 YONGTAN DONG, CHUNGJU CITY, CHUNG-CHEONG BUKDO PROVINCE
CHUNG-CHEONG BUKDO PROVINCE, 380-250, KOREA, REPUBLIC OF

Technical Approval Certification - Reinforcement Coupler System — Page 2 of 3

TA 01A - Couplers to BS 5400 Part 10

Scope of certification:
BMS Type A, B and C parallel threaded mechanical couplers tested in accordance with and complying with BS8597 and additional requirements of CARES Appendix TA1-A for use in accordance with Technical Approval Report TA1-A&B-5016 issue 3

This certificate remains the property of the Authority and is issued subject to the Regulations of the Authority. This certificate is uncontrolled when printed. To check the validity of this certificate please scan the above Static QR Code with the CARES Cloud App or contact us on +44 1732 450000.

CERTIFICATE NUMBER	FIRST APPROVAL	ISSUE DATE	EXPIRY DATE
5016	November 2007	01 January 2022	31 December 20XX

SIGNED FOR UK CERTIFICATION AUTHORITY FOR REINFORCING STEELS

Lee Brankley
Chief Executive Officer

The use of the Accreditation Mark indicates accreditation in respect of those activities covered by the accreditation certificate number 0002.
UK Certification Authority for Reinforcing Steels, Pembroke House, 21 Pembroke Road, Sevenoaks, Kent, TN13 1XR, UK
A Company Limited by Guarantee. Registered in England No. 1762448.
Cert. Ref: ARC112010 46401 804 v03

TECHNICAL APPROVAL

PRINTED ON 15/02/2022 FROM UKCARES.COM

APPENDIX TO CARES CERTIFICATE NO. 5016

BOOWON BMS CO. LTD.
590 YONGTAN DONG, CHUNGJU CITY, CHUNG-CHEONG BUKDO PROVINCE
CHUNG-CHEONG BUKDO PROVINCE, 380-250, KOREA, REPUBLIC OF

Technical Approval Certification - Reinforcement Coupler System — Page 3 of 3

TA 01B - Couplers and Anchors to BS 8110 and EN 1992-1-1

Scope of certification:
BMS Type A, B and C parallel threaded mechanical couplers tested in accordance with and complying with BS8597 and additional requirements of CARES Appendix TA1-B for use in accordance with Technical Approval Report TA1-A&B-5016 issue 3

This certificate remains the property of the Authority and is issued subject to the Regulations of the Authority. This certificate is uncontrolled when printed. To check the validity of this certificate please scan the above Static QR Code with the CARES Cloud App or contact us on +44 1732 450000.

CERTIFICATE NUMBER	FIRST APPROVAL	ISSUE DATE	EXPIRY DATE
5016	November 2007	01 January 2022	31 December 20XX

SIGNED FOR UK CERTIFICATION AUTHORITY FOR REINFORCING STEELS

Lee Brankley
Chief Executive Officer

The use of the Accreditation Mark indicates accreditation in respect of those activities covered by the accreditation certificate number 0002.
UK Certification Authority for Reinforcing Steels, Pembroke House, 21 Pembroke Road, Sevenoaks, Kent, TN13 1XR, UK
A Company Limited by Guarantee. Registered in England No. 1762448.
Cert. Ref: ARC112010 46401 804 v03

TECHNICAL APPROVAL

PRINTED ON 15/02/2022 FROM UKCARES.COM

Patent Certificate

Europäisches Patentamt | European Patent Office | Office européen des brevets

Urkunde | Certificate | Certificat

Es wird hiermit bescheinigt, dass für die in der Patentschrift beschriebene Erfindung ein europäisches Patent für die in der Patentschrift bezeichneten Vertragsstaaten erteilt worden ist.

It is hereby certified that a European patent has been granted in respect of the invention described in the patent specification for the Contracting States designated in the specification.

Il est certifié qu'un brevet européen a été délivré pour l'invention décrite dans le fascicule de brevet, pour les Etats contractants désignés dans le fascicule de brevet.

Europäisches Patent Nr. / European Patent No. / Brevet européen n°

0947642

Patentinhaber / Proprietor of the Patent / Titulaire du brevet

Chung, Gyeng Ok
881-34, Shihungbon-dong
Kumcheon-ku, Seoul 153-039/KR

München, den / Munich, / Fait à Munich, le 31.05.06

Alain Pompidou
Président des Europäischen Patentamts
President of the European Patent Office
Président de l'Office européen des brevets

EPA/EPO/OEB Form 2031 08.05

Patent Certificate

Office de la propriété intellectuelle du Canada / Canadian Intellectual Property Office

Brevet canadien / Canadian Patent

BREVET CANADIEN 2,365,878 CANADIAN PATENT

Canada

特許証

特許第3780209号

中嶋 誠

THE REGISTRY OF PATENTS SINGAPORE

THE PATENTS ACT (CHAPTER 221)

CERTIFICATE OF GRANT OF PATENT

中華民國專利證書

局長 陳明邦

CERTIFICATE OF APPROVAL

Quality Management System Certification

Page 1 of 2

Beowon BMS Co. Ltd.

590 Yongtan Dong, Chungju City, Chung-Cheong Bukdo Province, Chung-Cheong Bukdo Province, 380-330, Korea, Republic of

has been approved by the Authority to the following management system standard using the processes and procedures registered with the Authority.

BS EN ISO 9001: 2015

Scope of certification:
Quality Management System Certification as stated on the attached appendix

APPENDIX TO CARES CERTIFICATE NO. 1151

BOOWON BMS CO. LTD.
590 YONGTAN DONG, CHUNGJU CITY, CHUNG-CHEONG BUKDO PROVINCE
CHUNG-CHEONG BUKDO PROVINCE, 380-330, KOREA, REPUBLIC OF

Quality Management System Certification

Page 2 of 2

CPAS - ISO 9001:2015 QMS only

Scope of certification:
Production of BMD Type A, B and C parallel threaded mechanical couplers to reinforcing steel for use in accordance with Technical Approval report TA5016.

CERTIFICATE NUMBER 1151 | FIRST APPROVAL November 2007 | DUE DATE 04 June 2021 | EXPIRY DATE 04 June 20XX

UKAS

QUALITY SYSTEM CERTIFICATE

Certificate Number : DN-302

Company Name : BOO WON B.M.S Co., Ltd.
Address : 185, Chungjusandan 2-ro, Chungju-si, Chungcheongbuk-do, Korea

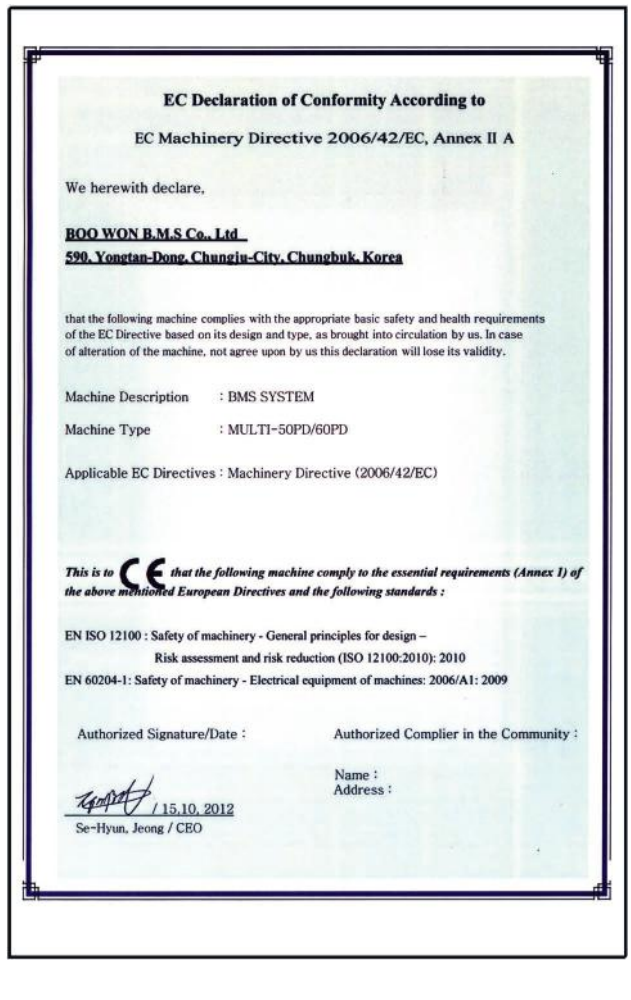
This is to certify that the above company has established and maintained proper quality system program for the scope shown below in accordance with the applicable requirements of Korea Electric Power Industry Code.

Applicable Code : KEPIC-SN
Certification Date : May 4, 2022
Expiration Date : May 3, 2025
Scope :
- Material organization manufacturing sleeve for rebar splice(Including utilization of unqualified source material, qualification of material organizations, and approval and control of suppliers of source material and services) and supplying ferrous material(Including utilization of unqualified source material, qualification of material organizations, and approval and control of suppliers of source material and services)

kepic

대한전기협회장

Chairman of Korea Electric Association



EC Declaration of Conformity According to

EC Machinery Directive 2006/42/EC, Annex II A

We herewith declare,

BOO WON B.M.S Co., Ltd
590, Yongtan-Dong, Chungju-City, Chungbuk, Korea

that the following machine complies with the appropriate basic safety and health requirements of the EC Directive based on its design and type, as brought into circulation by us. In case of alteration of the machine, not agree upon by us this declaration will lose its validity.

Machine Description : BMS SYSTEM

Machine Type : MULTI-50PD/60PD

Applicable EC Directives : Machinery Directive (2006/42/EC)

This is to CE that the following machine comply to the essential requirements (Annex I) of the above mentioned European Directives and the following standards :

EN ISO 12100 : Safety of machinery - General principles for design – Risk assessment and risk reduction (ISO 12100:2010): 2010

EN 60204-1: Safety of machinery - Electrical equipment of machines: 2006/A1: 2009

Authorized Signature/Date : / 15.10. 2012
Se-Hyun, Jeong / CEO

Authorized Complier in the Community :
Name :
Address :

3RD PARTY TESTS

İSTANBUL TEKNİK ÜNİVERSİTESİ – İNŞAAT FAKÜLTESİ
YAPI MALZEMESİ LABORATUVARI
34469 MASLAK / İSTANBUL TEL: (0212) 285 3757-58 FAX: (0212) 285 6587

Strength, Ductility & Slip Tests [BTMS Coupler with B500C Bars]

Report No/Date: 0015/09.01.2018
Application No/Date:321232 /05.01.2018

BTMS MECHANICAL CONSTRUCTION EQUIPMENT

According to your application letter dated 04.01.2018, tensile/slip tests were performed on the rebar samples which are connected to each other with couplers. It was stated in your application letter that the couplers are planned to be used in **"1915 Canakkale Bridge Project"** which is constructing by **DLSY – JV.** The results are shown in below table.

Table 1.

Sample Code*	Nominal Rebar Diameter (mm)	Coupler	Yield Strength (MPa)	Tensile Strength (MPa)	Permanent Elongation after 3 times loading to 300 MPa (0,6Fy) (*Slip Value*) (mm)	Result/Observations
-	Φ25	NO	559	667	-	-
BMS-N007/1		Yes	545	662	0,02	BAR BREAK (Samples were not failed from the couples)
BMS-N007/2			546	663	0,03	
BMS-N007/3			548	664	0,02	
-	Φ32	NO	552	670	-	
BMS-N0162/1		Yes	550	671	0,04	BAR BREAK (Samples were not failed from the couples)
BMS-N0162/2			554	673	0,04	
BMS-N0162/3			553	672	0,08	

*Sample codes were declared in your application letter.

Civil Engineer

Assoc. Prof. Dr.
Director of Laboratory

TESTED OK BAR-BREAK

Environmental Scientifics Group Ltd
Acrewood Way, St Albans
Hertfordshire, AL4 0JY
Telephone: +44 (0) 1727 840580
Fax: +44 (0) 1727 816700

ESG Environmental Scientifics Group

TEST REPORT

UK CARES
Pembroke House
21 Pembroke Road
Sevenoaks
Kent
TN13 1XR

Your Ref: 12706
Our Ref: 11/265
Date: 06.06.11

Cares Report No. 12141 - Reference No. 18625

STEEL COUPLER ASSEMBLIES TO UK CARES SPECIFICATION TA1-B (Issue 7 January 11)

Certificate Number 38620/C

Date of Receipt 09.05.11 Date of Test 06.06.11

Operator C Y Jeong **(Boowon BMS Co. Ltd., Chungju, Korea)**
Coupler Type BMS 32
Coupler Batch No. SA59669/N0078(Coupler) - SB74771/0002 (Nut)
Material BS 4449:1997 Grade 460B - 32 mm Diameter - Cast 20-2934

Sample Identity	Control	No. 1	No. 2	No. 3
Area (nominal) mm²	804	804	804	804
Yield (0.2% rp) MPa	487	489	492	486
Load at 2.0% rt kN	405.2	490.4	477.6	480
Stress at 2.0% rt MPa	504	610	594	597
Maximum Stress MPa	637*	637*	645*	637*

* Ductile in bar fracture

Permanent extension after loading/unloading to 0.65_{fy} - (299 MPa x 804 mm² = 240.4 kN)

Sample No. 1 = 0.042 mm
Sample No. 2 = 0.020 mm
Sample No. 3 = 0.003 mm

Slip Values

Tested in accordance with BS EN ISO 6892-1:2009/BS 4449:2005
Test apparatus calibrated in accordance with BS EN ISO 7500-1:2004

PASSED PASSED PASSED

BAR-BREAK

Senior Mechanical Test Engineer

End of Report

Page 1 of 1
(Doc15660)

ISTANBUL TECHNICAL UNIVERSITY
FACULTY OF CIVIL ENGINEERING
CIVIL ENGINEERING DEPARTMENT
34469, Maslak, ISTANBUL

Strength, Ductility & Slip Tests [BTMS Coupler with B420C Bars]

Application No/Date:999106 /07.12.2021

Table 1. Tensile Test Results

Sample Code	Nominal Rebar Diameter (mm)	Connection with Coupler	Yield Strength (MPa)	Tensile Strength (MPa)	Total elongation at maximum force A_{gt} (%)	Static Slip Value (mm)	Result/Observations
Reference Bar	D12	Bar Only	496	594	9,9	-	-
BMS Coupler Type A	D12	Yes	471	576	13,1	0.01	Bar Break (outside coupling zone – L)
BMS Coupler Type A	D12	Yes	480	584	9,5	0.01	Bar Break (outside coupling zone – L)
BMS Coupler Type B	D12	Yes	473	579	10,4	0.03	Bar Break (outside coupling zone – L)
Reference Bar	D16	Bar Only	494	589	10,2	-	-
BMS Coupler Type A	D16	Yes	486	593	10,5	0.01	Bar Break (outside coupling zone – L)
BMS Coupler Type A	D16	Yes	485	590	12,9	0.02	Bar Break (outside coupling zone – L)
BMS Coupler Type B	D16	Yes	475	589	10,4	0.01	Bar Break (outside coupling zone – L)
Reference Bar	D20	Bar Only	479	602	15,3	-	-
BMS Coupler Type A	D20	Yes	463	595	15,5	0.01	Bar Break (outside coupling zone – L)
BMS Coupler Type A	D20	Yes	464	596	13,5	0.02	Bar Break (outside coupling zone – L)
BMS Coupler Type B	D20	Yes	470	598	14,3	0.01	Bar Break (outside coupling zone – L)
Reference Bar	D25	Bar Only	472	626	13,7	-	-
BMS Coupler Type A	D25	Yes	468	622	13,5	0.05	Bar Break (outside coupling zone – L)
BMS Coupler Type A	D25	Yes	465	620	16,1	0.02	Bar Break (outside coupling zone – L)
BMS Coupler Type B	D25	Yes	466	619	10,5	0.01	Bar Break (inside coupling zone – L)

Table 2. Strength values

Sample diameter (mm)	Yield strength of reference bar (MPa)	Limit value of tensile strength (MPa)
D12	496	570.4
D16	494	568.1
D20	479	550.9
D25	472	542.8

Since all the results of tensile strength are over limit values, then it may be concluded that the test results of the specimens used in testing comply with the strength criteria of ISO 15835-1.

TESTED OK TESTED

Singapore Test Services
A company of ST Kinetics

TESTED OK BAR-BREAK

Report No: 10107-0715-02602-MEME
Date of Report: 24 July 2015

Page 3 of 8

Test Results:

Table 1: Permanent Set and Tensile Testing (Load vs. Extension curves were attached)

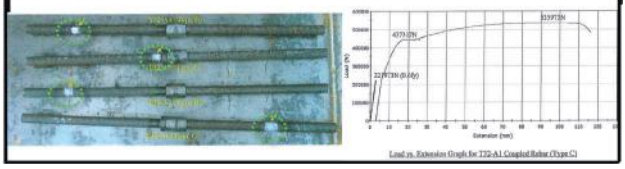
SPECIMEN NO.	PERMANENT SET (mm) Zero kg	GL (mm)	YIELD LOAD (N)	YIELD STRESS (N/mm²)	MAX LOAD (N)	UTS (N/mm²)	MOF
T32-A1 (Type C)	0.005	250	437317	544	535973	666	BB
T32-A2 (Type B)	0.015	250	452688	563	546668	680	BB
T32-A3 (Type C)	0.030	250	457295	569	549021	683	BB(ET)
T32-A4 (Type B)	0.030	250	450915	561	544657	677	BB
BS 8110 Requirements	0.1 max.	-	-	-	-	497 min.	-
LTA Requirements	0.1 max.	-	-	-	-	529 min.	-

Table 2: Tensile Testing (Load vs. Extension curves were attached)

SPECIMEN NO.	YIELD LOAD (N)	YIELD STRESS (N/mm²)	MAX LOAD (N)	UTS (N/mm²)	MOF
T32-A1 – Control Bar	447251	556	541925	674	BB
T32-A2 – Control Bar	451393	561	543176	675	BB
T32-A3 – Control Bar	450124	560	540263	672	BB
T32-A4 – Control Bar	454937	566	543088	675	BB
Requirement	-	460 min.	-	-	-

Legend : GL - Gauge Length
UTS - Ultimate Tensile Stress
MOF - Mode of Failure

BB - Bar Break
BB(ET) - Bar Break (At Extension Thread)



Load vs. Extension Graph for T32-A1 Coupled Rebar (Type C)

CARES, TYPE 2 COUPLER ASTM BAR & VARIOUS TESTS

UK Certification Authority for Reinforcing Steels

Pembroke House,
21 Pembroke Road
Sevenoaks, Kent TN13 1XR
Tel: Direct 01732 468131
Office 01732 450000
Email:leebrankley@ukcares.com

Ref: CC6103pr

6th June 2007

Mr. [redacted]
Export Manager
Boowon BMS Co. Ltd.
590 Yongtan Dong
Choongju City
Chung-Cheong Bukdo Province
380-250
Korea

Dear [redacted]

re: Summary of product testing results - Boowon BMS couplers (Application 1038)

I am pleased to provide you with a summary of the product testing performed at the recent assessment of Boowon BMS under CARES report number 8810

Process route	Diameter / mm	Comments
Type A parallel threaded couplers	16, 25, 32	Mechanical testing satisfactory
Type B parallel threaded couplers	16, 20, 25, 32, 40	Mechanical testing satisfactory
Type C parallel threaded couplers	16, 20, 25, 32, 40	Mechanical testing satisfactory

It will be necessary to perform a Follow-up inspection to determine the effectiveness of the corrective and preventive actions to the non compliance reports issued at the assessment.

CARES would be able to perform the Follow Up inspection week commencing 25th June.

Please do not hesitate to contact me if you require any further information.

Yours sincerely,

[redacted]
Operations Manager

Bureau Veritas Materials Science
Arewood Way, St Albans, Hertfordshire AL4 0JY
T: + 44 (0) 1727 810980 F: + 44 (0) 1727 810710

BUREAU VERITAS

TEST REPORT

UK Certification Authority
Pembroke House
21 Pembroke Road
Sevenoaks
Kent
TN13 1XR

Your Ref: 7543
Our Ref: 07/121
Date: 31.05.07

Cares Report No. 8810 - Project No. 1038

STEEL COUPLER ASSEMBLIES TO UK CARES SPECIFICATION TA1-B Issue 5

Certificate Number 33741/C

Date of Receipt 16.04.07 Date of Test 19.04.07

Operator Mr M Precious (Boowon BMS Co Ltd. Choongju, Korea.)
Coupler Type BMS 16 Type A
Coupler Batch No. BW 0704-01
Material BS 500 - 16 mm Diameter - Cast No. Not Advised

Sample Identity	Control	No.1	No.2	No.3
Area (nominal) mm²	201	201	201	201
Yield (0.2% rp) MPa	487	485	482	483
Load at 2.0% rt kN	103.1	113.2	113.8	115.4
Stress at 2.0% rt MPa	513	563	566	574
Maximum Stress MPa	667*	671*	667*	671*

* Normal ductile fracture occurred in bar.

Permanent extension after loading/unloading to 0.6Fy - (300 MPa x 201 mm² = 60.3 kN)

Sample No. 1 = 0.010 mm
Sample No. 2 = 0.028 mm
Sample No. 3 = 0.015 mm

Tested in accordance with BS EN 10002-1:2001 / BS 4449:2005
Test apparatus calibrated in accordance with BS EN ISO 7500-1:2004

[redacted]
Senior Mechanical Test Engineer

End of Report

Page 1 of 1
(Doc8480)

Singapore Test Services
A company of ST Kinetics

Main Office:
249 Jalan Boon Lay Singapore 619523
Tel: (65) 6660 7377 / (65) 6660 7322
Fax: (65) 6261 2917
Website: www.test.com.sg
E-mail: sts@stengg.com
(Regn. No.: 199004218D)

Branch Office:
601 Rifle Range Road Singapore 588308
Tel: (65) 6460 9171 Fax: (65) 6469 3042

Block 4010 Ang Mo Kio Avenue 10
TECHPLACE 1 #01-11 & 03-08 - 03-12
Singapore 569628
Tel: (65) 6854 3571 / 3567 Fax: (65) 6854 3568

Report No: 07113-0514-01501-MEME
Date of Report: 26 May 2014

Page 2 of 17

Customer's Test Requirements:
a) To meet SS2: Part 3: 1987 & BS 8110: Part 1: 1997 Section 3.12.8.16.2 requirements and Singapore Land Transport Authorities Requirements.
b) Failure to occur in the bar clear of joints and grips.

Test Procedure:
I) Permanent Set Test
Coupled specimen was placed in the tensile loading machine and 4in1 measuring apparatus assembled around it at the specified gauge length. The specimen was then loaded to 0.6 of the characteristic yield load (0.6fy, fy- 460 N/mm²) then to zero. The permanent set was recorded on return to zero and was measured to an accuracy of 2 microns.
II) Tensile Test
The specimen was then loaded to failure recording: Yield load, Yield stress, Ultimate load, Ultimate tensile strength and mode of failure with a plot of load against extension.

All test specimens met the requirements...

Remarks:
1. All test specimens met the requirements of BS 8110: Part 1: 1997 Section 3.12.8.16.2 for permanent set (should not exceed 0.1mm), tensile strength requirement (greater than 497 N/mm²) and Singapore Land Transport Authorities (LTA) Requirements for permanent set (should not exceed 0.1mm), tensile strength requirement (greater than 529 N/mm²).
2. Failure occurred in the bar in every case clear of splice and grips.

Singapore Test Services
A company of ST Kinetics

Report No: 07113-0514-01501-MEME
Date of Report: 26 May 2014

Page 17 of 17

Test Results

Table 1: Permanent Set and Tensile Testing (Load vs. Extension curves were attached)

SPECIMEN NO.	PERMANENT SET (mm) Zero kg	GL (mm)	YIELD LOAD (N)	YIELD STRESS (N/mm²)	MAX LOAD (N)	UTS (N/mm²)	MOF
T40-A1 - 'A'	0.005	200	787499	583	932012	726	BB
T40-A2 - 'A'	0.004	200	720601	573	933413	743	BB
T32-A1 - 'A'	0.028	250	462339	574	547755	681	BB
T32-A2 - 'A'	0.025	250	446627	548	541939	674	BB
T32-B1 - 'B'	0.030	250	420970	541	542326	674	BB
T32-B2 - 'B'	0.015	250	444228	552	542364	674	BB (ET)
T25-A1 - 'A'	0.011	200	282907	587	339008	682	BB
T25-A2 - 'A'	0.011	200	284187	579	351393	716	BB
T25-B1 - 'B'	0.020	200	298891	583	349837	713	BB (ET)
T25-B2 - 'B'	0.015	200	285368	577	350154	681	BB
T20-A1 - 'A'	0.020	158	180652	599	232397	799	BB
T20-A2 - 'A'	0.030	158	186614	575	215755	687	BB
BS 8110 Requirements LTA Requirements	0.1 max.	-	-	-	-	497 min.	-
	0.1 max.	-	-	-	-	529 min.	-

Table 2: Tensile Testing (Load vs. Extension curves were attached)

SPECIMEN NO.	YIELD LOAD (N)	YIELD STRESS (N/mm²)	MAX LOAD (N)	UTS (N/mm²)	MOF
T40-A1 - Control Bar	715187	568	913568	727	BB
T40-A2 - Control Bar	729948	571	933496	743	BB
T32-A1 - Control Bar	442879	550	541789	674	BB
T32-A2 - Control Bar	440667	573	545200	678	BB
T32-B1 - Control Bar	452065	562	542631	675	BB
T32-B2 - Control Bar	447829	557	544616	677	BB
T25-A1 - Control Bar	287060	585	335714	684	BB
T25-A2 - Control Bar	276523	563	347998	708	BB
T25-B1 - Control Bar	295364	598	354111	721	BB
T25-B2 - Control Bar	296728	600	335474	681	BB
T20-A1 - Control Bar	183109	584	216822	688	BB
T20-A2 - Control Bar	190198	605	222915	707	BB
Requirement	-	440 min.	-	-	-

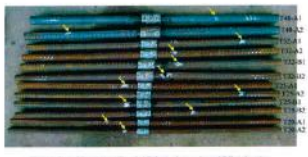


Photo 1: Tested Specimens (Coupled Rebar) - Arrow showed failure location

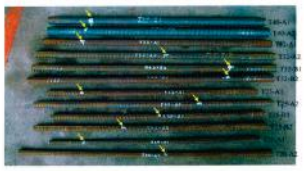


Photo 2: Tested Specimens (Control Bar) - Arrow showed failure location

---

KCL

TEST REPORT

PASSED

No : CT19-068686

7. **TEST RESULTS**

1) **BMS32 Terminators & Standard Couplers with ASTM A706 Grade 80 rebars**

Test Item(s)	Unit	Test Method	Test Results	Remark
Tensile strength	N/mm²	(1)	773	-

2) BMS32-BT-01

Test Item(s)	Unit	Test Method	Test Results	Remark
Tensile strength	N/mm²	(1)	770	-

3) BMS32-BT-02

Test Item(s)	Unit	Test Method	Test Results	Remark
Tensile strength	N/mm²	(1)	771	-

4) BMS32-BT-03

Test Item(s)	Unit	Test Method	Test Results	Remark
Tensile strength	N/mm²	(1)	769	-

5) BMS32-BT-04

Test Item(s)	Unit	Test Method	Test Results	Remark
Tensile strength	N/mm²	(1)	767	-

6) BMS32-BH-01

Test Item(s)	Unit	Test Method	Test Results	Remark
Tensile strength	N/mm²	(1)	777	-
Elongation	%	(1)	19	-

7) BMS32-BH-02

Test Item(s)	Unit	Test Method	Test Results	Remark
Tensile strength	N/mm²	(1)	774	-
Elongation	%	(1)	21	-

※Manufacturer : BOOWON B.M.S
※Project Name : Chacao Bridge Construction Project / Chile
※Contractor : HYUNDAI ENGINEERING & CONSTRUCTION
※Steel bars : Steel bars in accordance with ASTM A706/706M Grade 80(32 mm) / Cross-sectional area - 819 ㎟
※Joint Type : 2),3),4),5)- TYPE B / 6),7)-TYPE A
※Test Evaluation : 2),3),4),5)- ACI 318 Type 2 / 6),7)- ASTM A 970 Class B
※ Dimension : Coupler 2),3),4),5) / Ext. Diameter(D) - 48mm, Length(L) - 70mm
Terminator 6),7) / Ext. Diameter(D) - 74mm, Ext. Diameter(D1) - 48mm
Length(L) - 35mm

—— End of Report ——

Page 2 of 2 QP-20-01-08(5)

İSTANBUL TEKNİK ÜNİVERSİTESİ – İNŞAAT FAKÜLTESİ
YAPI MALZEMESİ LABORATUVARI
34469 MASLAK / İSTANBUL TEL: (0212) 285 3757-58 FAX: (0212) 285 6587

Strength & Ductility Tests [BTMS Coupler with B420C Bars]

Manşonlu Birleşim Çekme Deneyi
Rapor no/Tarih: 297/07.05.2018
Başvuru No/Tarih:399085/02.05.2018

REC ULUSLAR ARASI İNŞ. YAT. SAN. VE TİC. A.Ş.

İlgili dilekçeniz ile birlikte laboratuvarımıza getirdiğiniz ve dilekçenizde "İ.U.F.M. T. Vakıflar Bankası T.A.O Genel Müdürlük ve Hizmet Binası" projesinde kullanılmasının planlandığını beyan ettiğiniz manşon ile birleştirilmiş Φ30 ve Φ32 mm çaplı nervürlü çelik çubukları üzerinde çekme deneyleri yapılmıştır. Elde edilen sonuçlar aşağıda verilmiştir.

Tablo 1. Manşonlu birleşimler üzerinde yapılan çekme deneyi sonuçları.

Numune No	Anma Çapı (mm)	Manşon Birleşimi	Akma Dayanımı (kN)	Akma Dayanımı MPa	Çekme Dayanımı (kN)	Çekme Dayanımı MPa	Gözlem
1	Φ30	Var	326,6	462	434,9	615	Kopma, çelik çubukta meydana gelmiştir.
2	Φ30		326,5	462	435,1	616	
3	Φ32		372,0	463	498,1	619	
4	Φ32		371,4	462	502,6	625	

İnş. Yük. Müh. [redacted]

Yapı Malzemesi Laboratuvarı Sorumlusu [redacted]

İSTANBUL TEKNİK ÜNİVERSİTESİ – İNŞAAT FAKÜLTESİ
YAPI MALZEMESİ LABORATUVARI
34469 MASLAK / İSTANBUL TEL: (0212) 285 3757-58 FAX: (0212) 285 6587

Strength & Ductility Tests [BTMS Coupler with B420C Bars]

Çekme Deneyi
Rapor No/Tarih:747/20.09.2016
Başvuru No/Tarih:3580/19.09.2016

BTMS MEKANİK YAPI ELEMANLARI SAN. VE TİC. A.Ş.

19.09.2016 tarihli dilekçeniz ile birlikte laboratuvarımıza teslim ettiğiniz ve dilekçenizde "Tekfen Mot Tower – Bakü/Azerbaycan" projesinde kullanılacağını ve BTMS Coupler ile birleştirildiğini belirttiğiniz birer adet Φ16, Φ20, Φ22 ve Φ32 mm nervürlü betonarme çelik çubuk numuneleri üzerinde ve birer adet aynı çapta manşon birleşimi içermeyen çelik çubuk numuneleri üzerinde çekme deneyi yapılmıştır. Deney sonuçları aşağıda verilmiştir.

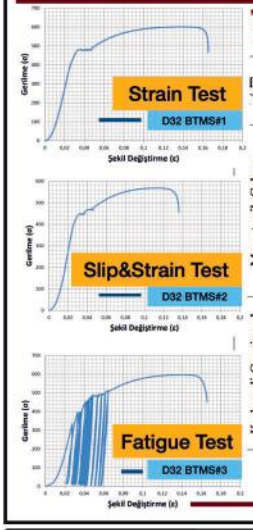
Tablo 1. Çekme deneyi sonuçları

Anma Çapı (mm)	Manşon Birleşimi	Akma Dayanımı (kN)	Akma Dayanımı MPa	Çekme Dayanımı (kN)	Çekme Dayanımı MPa	R_m/R_e	Gözlem
Φ16	Var	94,6	471	117,5	584	1,24	Kopma çelik çubukta meydana gelmiştir.
Φ20		140,1	446	171,6	546	1,22	
Φ22		179,8	473	223,1	587	1,24	
Φ32		376,1	468	482,2	600	1,28	
Φ16	Yok	95,4	474	119,3	593	1,25	-
Φ20		141,6	451	170,3	542	1,20	
Φ22		180,5	475	222,3	585	1,23	-
Φ32		397,7	494	495,3	616	1,25	-

Araş. Gör. [redacted]

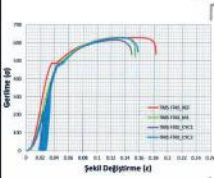
Laboratuvar Sorumlusu Yardımcısı
Doç. Dr. [redacted]

Tension, Slip & Fatigue Test Results by A.U. Turkey Labs



ANADOLU ÜNİVERSİTESİ
YAPI MÜHENDİSLİĞİ LABORATUVARI

TEST TÜRÜ		YIELD STRESS AKMA GERİLMESİ YÜK(kN)	YIELD STRESS σ_y(MPa)	ULTIMATE STRESS ÇEKME GERİLMESİ YÜK(kN)	ULTIMATE STRESS σ_U(MPa)	ELONGATION ε_U(%)	σ_U / σ_y	SIYRILMA ≤ 1mm SLIP	Düktilite ≥%70 ε_U	ŞARTNAME UYGUNLUK 1.25 f_y	4%	test
Monotonik Çekme Deneyi	BMS_Ø32_REF	383	479	483	600	16.5	1.25	-	11.6	E	E	BAŞARILI
	BMS Ø32_MANSON	371	457	476	591	14.5	1.29	0	E	E	E	BAŞARILI
	BMS Ø32_MANSON_SLIP	360	446	457	566	13.6	1.27	0.03	E	E	E	BAŞARILI
Kademeli Çevrimsel Çekme Deneyi	BMS Ø32_MANSON_CYC	373	477	480	596	16	1.25	0	E	E	E	BAŞARILI



TEST TÜRÜ		YIELD STRESS AKMA GERİLMESİ YÜK(kN)	YIELD STRESS σ_y(MPa)	ULTIMATE STRESS ÇEKME GERİLMESİ YÜK(kN)	ULTIMATE STRESS σ_U(MPa)	ε_U(%)	σ_U / σ_y	SIYRILMA ≤ 1mm SLIP	Düktilite ≥%70 ε_U	ŞARTNAME UYGUNLUK 1.25 f_y	4%	test
Çekme Deneyi	REF	609	485	790	629	18.3	1.30	-	12.81	E	E	BAŞARILI
	BMS D40_1	603	480	790	629	15.3	1.31	-	E	E	E	BAŞARILI
	BMS D40_2	593	472	773	615	14.9	1.30	0.06	E	E	E	BAŞARILI
	BMS D40_3	606	482	788	627	15.7	1.30	0.07	E	E	E	BAŞARILI

ISO 15835 - S2 TESTS

R-TECH MATERIALS

BTMS Mechanical Construction Equipment
BTMS Yapi Elemanlari Sanayi Ve Ticaret A.S.
Ibrikdere Mah. D-100 Karayolu CAD.446
41255 Kartepe-Kocaeli
Turkey

Low Cycle Fatigue [S2] Tests with BMS Couplers [D25]

For the attention of: Mr Dogan Fatih Kucuk

11th January 2018

Laboratory Test Report No. 180021

Client's order No. To be advised

Client's project reference Canakkale Bridge-DLSY JV-Turkey.

Specimen identification

Three mechanical splices in reinforcing bars to TS 708 grade B500C.

Splice type: BMS D25 mm
Splice markings: Splice ID (shown in table below)
Legibility of Batch ID: Good
Operator: [redacted]
Details of assembly: Torqued to 300Nm

Specimens identified as in the table below:

Laboratory ID	Sample ID	Diameter (mm)	Splice ID
180021/1/1	N0007/1	25	N0007
180021/1/2	N0007/2	25	N0007
180021/1/3	N0007/3	25	N0007

Tests conducted

Spliced assemblies tested according to the requirements of ISO 15835-2:2009 alternating tension and compression test of large strains in the mechanical splice (S2).

Note: ISO 15835-2 incorrectly defines the slope S (Fig. 7). R-Tech Materials' documented in-house procedure corrects this anomaly.

Date of test 9th January 2018

Tested by J Chapman

Testing House, Kenfig Industrial Estate, Margam, Port Talbot, SA13 2PE, UK
T: +44 (0)1656 748 000 | E: info@r-techmaterials.com | W: www.r-techmaterials.com
Registered Office: R-TECH Services Ltd. Registered Office: 22 Dan-y-Bryn Avenue, Radyr, Cardiff, CF15 8DD, UK
Company No. 4547830 | VAT No. 800 7699 50

UKAS TESTING 2594

R-TECH MATERIALS

Mechanical splice tensile test results

Specimen Identification	Splice Diameter/ Length (mm)	Failure Load, Fm (kN)	Failure Stress, Rm (MPa)	U4 (mm)	U8 (mm)	Failure Location
180021/1/1	39/58	330.6	674	0.162	0.240	Parent bar
180021/1/2	39/58	328.2	669	0.162	0.261	Parent bar
180021/1/3	39/58	329.2	671	0.168	0.245	Parent bar

Extensometer gauge length used for measurement of strain was 300 mm.

Plots of load versus extension during the test are given in Appendix A to this report.

Statements of compliance

The mechanical splices tested met the S2 test requirements of ISO 15835-1:2009.

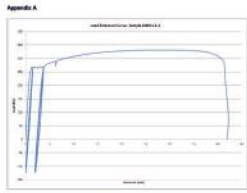
Test report authorised by:

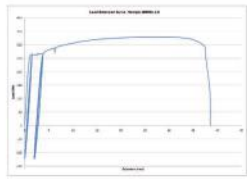
[redacted]
Laboratory Manager

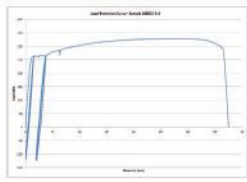
End of report

R-TECH MATERIALS

Appendix A







R-TECH MATERIALS

BTMS Mechanical Construction Equipment
BTMS Yapi Elemanlari Sanayi Ve Ticaret A.S.
Ibrikdere Mah. D-100 Karayolu CAD.446
41255 Kartepe-Kocaeli
Turkey

Low Cycle Fatigue [S2] Tests with BMS Couplers [D32-40]

For the attention of: Mr Dogan Fatih Kucuk

8th March 2019

Laboratory Test Report No. 190030

Client's order No. To be advised

Client's project reference 1915 Canakkale Bridge-DLSY JV-Turkey.

Specimen identification

Three mechanical splices in reinforcing bars to TS 708 grade B500C.

Splice type: BMS 40/32 Transitional
Splice markings: Splice ID (shown in table below)
Legibility of Batch ID: Good
Operator: [redacted]
Details of assembly: Not supplied
Specimens identified as in the table below:

Laboratory ID	Diameter (mm)	Cast No.	Splice ID
190030/1/1	40/32	1806410550/1811453650	BMS 40/32-N015
190030/1/2	40/32	1806410550/1811453650	BMS 40/32-N015
190030/1/3	40/32	1806410550/1811453650	BMS 40/32-N015

Tests conducted

Spliced assemblies tested according to the requirements of ISO 15835-2:2009 alternating tension and compression test of large strains in the mechanical splice (S2).

Note: ISO 15835-2:2009 incorrectly defines the slope S (Fig. 7). R-Tech Materials' documented in-house procedure corrects this anomaly.

Date of test 1st March 2019

Tested by I Miles

Testing House, Kenfig Industrial Estate, Margam, Port Talbot, SA13 2PE, UK
T: +44 (0)1656 748 000 | E: info@r-techmaterials.com | W: www.r-techmaterials.com
Registered Office: R-TECH Services Ltd. Registered Office: 22 Dan-y-Bryn Avenue, Radyr, Cardiff, CF15 8DD, UK
Company No. 4547830 | VAT No. 800 7699 50

ilac-MRA UKAS TESTING 2594

R-TECH MATERIALS

Mechanical splice tensile test results

Specimen Identification	Splice Diameter/ Length (mm)	Failure Load, Fm (kN)	Failure Stress, Rm (MPa)	U4 (mm)	U8 (mm)	Failure Location
190030/1/1	60/78	574.1	714	-0.042	0.013	32 mm bar, 136 mm from coupler
190030/1/2	60/78	558.7	695	0.063	0.125	32 mm bar, 78 mm from coupler
190030/1/3	60/78	563.9	701	0.118	0.182	32 mm bar, 110 mm from coupler

Extensometer gauge length used for measurement of strain was 400 mm.

Plots of load versus extension during the test are given in Appendix A to this report.

Statements of compliance

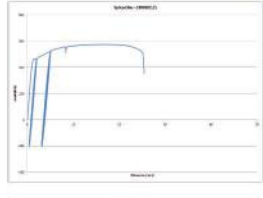
The mechanical splices tested met the S2 test requirements of ISO 15835-1:2009.

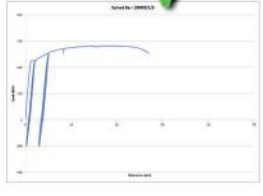
Test report authorised by:

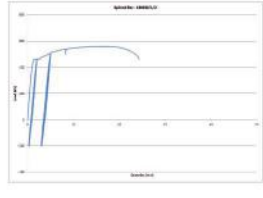
[redacted]
Technical Manager

End of report

R-TECH MATERIALS







LOW CYCLE FATIGUE TESTS

Holmes Solutions

Level 2, 254 Montreal Street
Christchurch Central 8013
PO Box 6718
Upper Riccarton, Christchurch 8442
holmessolutions.com

Low Cycle Fatigue [S2] Tests with BMS Couplers

NAME OF TEST LABORATORY:	Holmes Solutions LP
NOMINAL BAR DIAMETER:	40mm and 32mm
CUSTOMER REFERENCE:	On behalf of BTMS, Istanbul, Turkey
CLIENT REFERENCE:	1915 Canakkale Bridge DLSY JV-Turkey
PRODUCT NAME:	BMS Transitional Coupler
PRODUCT DESCRIPTION:	Reinforcing bars to TS 708 Grade B500C 40mm and 32mm End Threaded
REINFORCING STEEL CLASS:	B500C
COUPLER BATCH NUMBER:	BMS40-32
STEEL CAST NUMBER:	Not supplied
TEST DESCRIPTION:	Mechanical Splice, High Strain Low Cycle Fatigue Testing (S2 category)
TESTING DATE:	20/02/2019
GAUGE LENGTH (L):	250 mm ± 2 mm
FREE LENGTH:	400mm
TESTING STANDARDS:	AS1391:2007, ISO 15835-1:2009 and ISO 15835-2:2009
NOTES:	Samples supplied by client. Couplers assembled as per client instructions. All samples aged at 100°C for 1 hr and then air cooled. The Tensile strength in the below chart refers to the 32mm bar only.

Low Cycle Fatigue 40MM TO 32MM	u4 (mm)	u8 (mm)	Tensile Strength R_m (MPa)	Failure Location	Failure Type
Requirement (Min)	-	-	-	-	-
Requirement (Max)	0.3	0.6	-	-	-
Specimen 1	0.07	0.08	715	Outside Mechanical Splice	Ductile
Specimen 2	0.06	0.08	711	Outside Mechanical Splice	Ductile
Specimen 3	0.07	0.09	691	Outside Mechanical Splice	Ductile
AVERAGE	0.07	0.08	706	-	-

The results presented above are a true and accurate record obtained from the tested samples supplied by the client. This report shall not be reproduced except in full, without approval of this laboratory.

[redacted]

Checked By:

[redacted]

Holmes

Mechanical Splice Low Cycle S2 Test Certificate - IMBMS Reducer coupler 40mm-32mm
Page 1 of 3

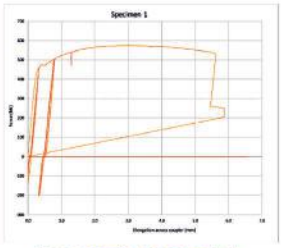


Figure 1: Load cycle diagram for specimen 1

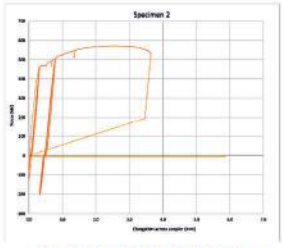


Figure 2: Load cycle diagram for specimen 2

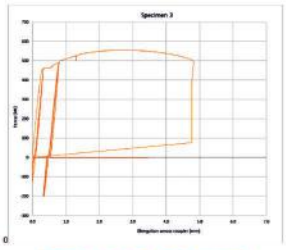


Figure 3: Load cycle diagram for specimen 3

Figure 4: Couplers after testing

Testing House Kenfig Industrial Estate Margam Port Talbot SA13 2PE UK
tel: +44 (0)1656 748 000 fax: +44 (0)1656 670 130
email: info@r-techservices.co.uk web: www.r-techservices.co.uk

R-TECH SERVICES LIMITED

Boowon B.M.S. Co. Ltd.,
31-15, Samsung-Dong,
Gangnam-Gu,
Seoul,
135-867 Korea.

Low Cycle Fatigue [S2] Tests with BMS Couplers [D40]

28th January 2015

Laboratory Test Report No. 150073

Client's order No. BW-2015-01-001_Rev.01

Specimen identification

Two mechanical splices in grade B500B reinforcing bars.

Splice type: Boowon BMS 40 type A
Splice markings: N0037-2 and N0037-3
Legibility of Batch ID: Good
Operator: [redacted]
Details of assembly: Date of assembly = 23rd January 2015
Applied torque = 320 Nm
Temperature during assembly = 17.5°C
Splice diameter: 60 mm
Splice length: 86 mm

Specimens identified as in the table below:

R-Tech Reference	Testing Lab ID	Diameter (mm)	Cast No.	Splice ID	Coupler No.	Reinforcement No.
150073/1/2	BMS BB 40B	40	A197482	N0037-2	10	1 + 6
150073/1/3	BMS BB 40C	40	A197482	N0037-3	11	8 + 3

Photographs of the specimens before and after testing are attached to this report as Appendix B

Tests conducted

Spliced assemblies tested according to the requirements of ISO 15835-2:2009 alternating tension and compression test of large strains in the mechanical splice (S2).

Note: This test is outside the scope of the laboratory, and was sub-contracted to another laboratory.

Date of test 23rd January 2015

Report No. 150073
Page 1 of 9

Registered Office
22 Dan-y-Bryn Avenue Radyr Cardiff CF15 8DD UK

Company Registered No. 4547830
VAT Registration No. 800 7618 50

R-TECH SERVICES LIMITED

Mechanical splice S2 test results

Specimen Identification	Failure Load, Fm (kN)	Failure Stress, Rm (MPa)	U4 (mm)	U8 (mm)	Failure Location
150073/2/1	906	721	0.1	0.2	Parent bar 228mm from coupler
150073/2/2	899	715	0.2	0.3	Parent bar 106mm from coupler
Specification			≤0.3	≤0.6	≥80

Plots of load versus extension during the S2 test are given in Appendix A to this report.

Statement of compliance

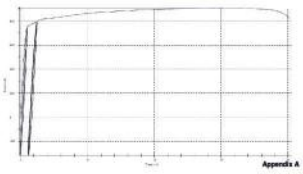
The spliced assemblies tested met the requirements of the ISO 15835-1:2009 S2 test.

Test report authorised by:

[redacted]

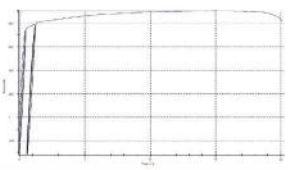
Laboratory Manager

S2 test sample 150073/1/3



Appendix A

S2 test sample 150073/1/2



LOW CYCLE AND HIGH CYCLE FATIGUE TESTS

Testing House Kenfig Industrial Estate Margam Port Talbot SA13 2PE UK
tel: +44 (0)1656 748 000 fax: +44 (0)1656 670 130
email: info@r-techservices.co.uk web: www.r-techservices.co.uk

R-TECH SERVICES LIMITED

Low Cycle Fatigue [S2] Tests with BMS Couplers [D20]

Test conducted:
Mechanically spliced assemblies tensile tested to ISO 15835-2:2009, Section 5.2, 5.3 and 5.5.2
Category S2 requirements and reference bar tensile tested to ISO 15630-1:2009.

Samples are identified as in table below:

Laboratory Sample ID	Reinforcing bar size (mm)	Reinforcing bar cast No.	Splice batch ID(s)
140141/1/22	20	A197482	NO 019
140141/1/24	20	A197482	NO 019
140141/1/25	20	A197482	NO 019
140141/1/26	20	A197482	NO 019
140141/1/27	20	A197482	NO 019
140141/1/28	20	A197482	NO 019

RESULTS

Date(s) of test(s): 27th February 2014
Name of laboratory operator: R E Kemp

Reference bar test results

Laboratory sample ID	140141/1/62R
Extensometer Gauge Length (mm)	240
Area, nominal (mm²)	314.2
Yield, 0.2% Proof Stress (Rp0.2) (MPa)	609
Tensile stress Rm (MPa)	726
Ratio of Rm/Rp	1.19
Elongation Agt (%)	8.7

Mechanical splice test results

Boowon BMS 20

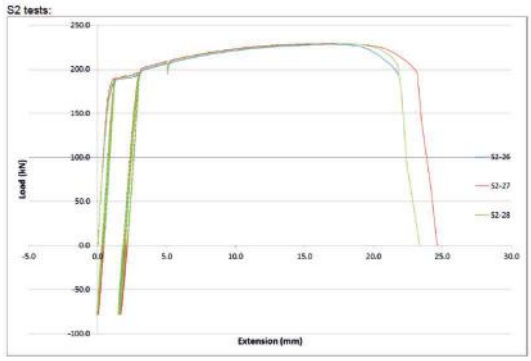
	Laboratory Sample ID		140141/1/22	140141/1/24	140141/1/25
SLIP	Extensometer Gauge Length (mm)		240	240	240
	Option used for slip measurement (1 or 2)		1 and 2	1 and 2	1 and 2
	Force used for upper limit in slip measurement (kN)		94.2	94.2	94.2
	Slip measurement (mm)	Option 1	0.006	0.022	-0.003
		Option 2	0.027	0.035	0.015
TENSILE	Maximum load achieved, F_{max} (kN)		229.3	230.6	230.8
	Measured tensile strength, R_m (MPa)		730	734	735
	A_{gt} (%)		7.5	9.4	7.7
	Location of failure		Outside splice length	Outside splice length	Outside splice length

	Laboratory Sample ID	140141/1/26	140141/1/27	140141/1/28
S2	Extensometer Gauge Length (mm)	240	240	240
	Residual elongation after 4 cycles, u_4 (mm)	0.073	0.050	0.127
	Residual elongation after 8 cycles, u_8 (mm)	0.130	0.100	0.195
	Maximum load achieved, F_{max} (kN)	228.1	229.3	228.8
	Measured tensile strength, R_m (MPa)	726	730	728
	Location of failure	Outside splice length	Outside splice length	Outside splice length

Testing House Kenfig Industrial Estate Margam Port Talbot SA13 2PE UK
tel: +44 (0)1656 748 000 fax: +44 (0)1656 670 130
email: info@r-techservices.co.uk web: www.r-techservices.co.uk

R-TECH SERVICES LIMITED

S2 tests:



Summation of results / Statement of compliance

The results shown above indicate that the product complies with the requirements of ISO 15835-1:2009 Annex C with category B and category S2 classification.

Test report prepared by:

[redacted]
Development Engineer

Test report authorised by:

[redacted]
Laboratory Manager

End of report

Report No. 140141 Issue 2

Testing House Kenfig Industrial Estate Margam Port Talbot SA13 2PE UK
tel: +44 (0)1656 748 000 fax: +44 (0)1656 670 130
email: info@r-techservices.co.uk web: www.r-techservices.co.uk

R-TECH SERVICES LIMITED

11th February 2016

High Cycle Fatigue Tests with BMS Couplers [D25 & D32]

Laboratory Test Report No. 160088

Client's order No. 19534 Client's project No. 2370

Client's report No. 16594 Client's reference No. 28986

Specimens supplied by Boowon BMS Co. Ltd., Chungju, Korea.

Specimen identification

Three (3) off 16 mm Ø QST mechanically spliced reinforcing bar specimens to BS 4449:2005 grade B500B approximately 1 m in length.

Splice Type: BooWon BMS 16 mm 'Type B'

Fatigue test results

Fatigue class D – Stress ratio = 0.2

Specimen Identification	Bar ID No.	Stress Range (MPa)	No of Cycles X10⁶	Frequency (Hz)	Position of Failure	Comments
160088/1/1	1	89	3.5	114	n/a	Test stopped at 3.5 x 10⁶ cycles
160088/1/2	2	135	1.0	112	n/a	Test stopped at 1.0 x 10⁶ cycles
160088/1/3	3	170	0.5	114	n/a	Test stopped at 0.5 x 10⁶ cycles

Statement of compliance

This batch of specimens complied with the 'D class' fatigue requirements of CARES Appendix TA1-A Issue 4.

Laboratory Test Report No. 160089

Client's order No. 19534 Client's project No. 2370

Client's report No. 16594 Client's reference No. 28987

Specimens supplied by Boowon BMS Co. Ltd., Chungju, Korea.

Specimen identification

Three (3) off 32 mm Ø QST mechanically spliced reinforcing bar specimens to BS 4449:2005 grade B500B approximately 1 m in length.

Splice Type: BooWon BMS 32 mm 'Type B'

Fatigue test results

Fatigue class D – Stress ratio = 0.2

Specimen Identification	Bar ID No.	Stress Range (MPa)	No of Cycles X10⁶	Frequency (Hz)	Position of Failure	Comments
160089/1/1	1	89	3.5	119	n/a	Test stopped at 3.5 x 10⁶ cycles
160089/1/2	2	135	1.0	120	n/a	Test stopped at 1.0 x 10⁶ cycles
160089/1/3	3	170	0.5	119	n/a	Test stopped at 0.5 x 10⁶ cycles

Statement of compliance

This batch of specimens complied with the 'D class' fatigue requirements of CARES Appendix TA1-A Issue 4.

Testing House Kenfig Industrial Estate Margam Port Talbot SA13 2PE UK
tel: +44 (0)1656 748 000 fax: +44 (0)1656 670 130
email: info@r-techservices.co.uk web: www.r-techservices.co.uk

R-TECH SERVICES LIMITED

High Cycle Fatigue Tests with BMS Couplers [D40]

UK CARES,
Pembroke House,
21, Pembroke Road,
Sevenoaks,
Kent,
TN13 1XR.

For the attention of: Mr Peter Roughley

3rd February 2016

Laboratory Test Report No. 160090

Client's order No. 19534 Client's project No. 2370

Client's report No. 16594 Client's reference No. 28988

Specimens supplied by Boowon BMS Co. Ltd., Chungju, Korea.

Specimen identification

Three (3) off 40 mm Ø QST mechanically spliced reinforcing bar specimens to BS 4449:2005 grade B500B approximately 1 m in length.

Splice Type: BooWon BMS 40 mm 'Type B'

Fatigue test results

Fatigue class D – Stress ratio = 0.2

Specimen Identification	Bar ID No.	Stress Range (MPa)	No of Cycles X10⁶	Frequency (Hz)	Position of Failure	Comments
160090/1/1	1	89	3.5	126	n/a	Test stopped at 3.5 x 10⁶ cycles
160090/1/2	2	135	1.0	127	n/a	Test stopped at 1.0 x 10⁶ cycles
160090/1/3	3	170	0.5	123	n/a	Test stopped at 0.5 x 10⁶ cycles

Statement of compliance

This batch of specimens complied with the 'D class' fatigue requirements of CARES Appendix TA1-A Issue 4.

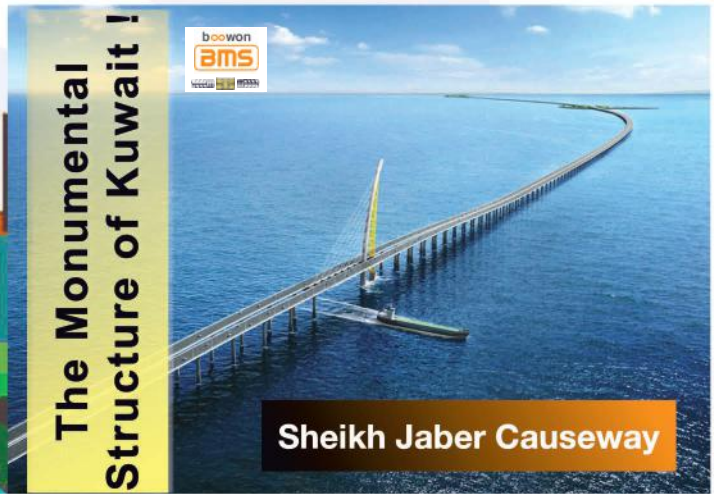
Test report authorised by:

[redacted]
Laboratory Manager

End of report

The World's Longest

The World's Tallest !



!


Central Bank, Azerbaijan


MOT Tower, Azerbaijan


US Embassy, Ankara


Vakıf Tower, Istanbul


Komurhan Bridge


Marmara Highway


Bomonti Tower, Izmir


Qatar-Qatara Tower


Qatar-Lusail Plaza


Qatar-Dream Hotel


Qatar-Nakilat Shipyard


Qatar-Military Hospital

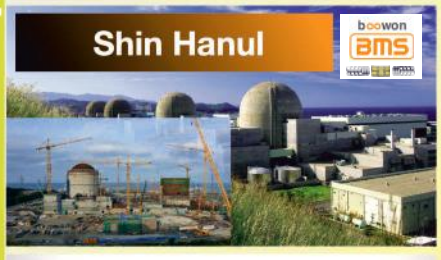

Qatar-Mushareb Road

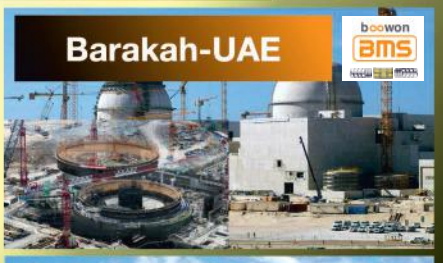

Seoul's Metro

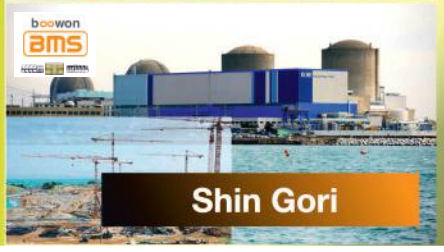

Machang Bridge, Korea

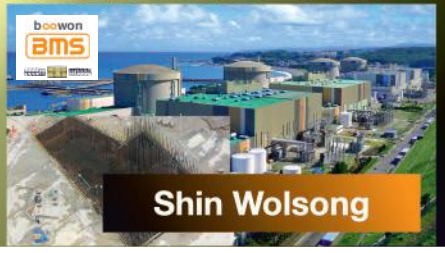
Nuclear Power Plant Projects supplied by Boowon BMS

Sangram Dong Seoul


Shin Hanul


Barakah-UAE


Shin Gori


Shin Wolsong

BMS Couplers in Concrete Tests

holmessolutions

Figure 37 - TB01 Test beam at the conclusion of all test loading.

Test Beam Specimen ID	Coupler Componentry		
	Type	Qty / Arrangement	Coupler Placement
TB01	Ø 25 mm BMS Type A	Qty 7 x 1 @ 184 mm nominal bar centers	At beam-column interface
TB02	Ø 25 mm BMS Type C	Qty 7 x 1 @ 184 mm nominal bar centers	At beam-column interface
TB03	Ø 25 mm BMS Type A	Qty 7 x 1 @ 184 mm nominal bar centers	Welds on test beam element, nominally 300 mm from the beam-column interface

Table 1 - Specimen identification and specification.

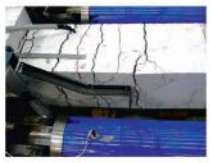


Figure 21 - TB01 Test beam at the conclusion of all test loading.

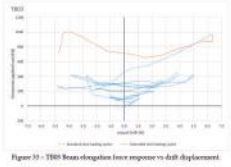


Figure 35 - TB03 Beam elongation force response vs drift displacement.

Figure 22 - TB01 Post-test removal of the concrete surrounding the reinforcing couplers confirms coupler and reinforcing bar integrity.

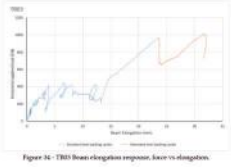


Figure 34 - TB03 Beam elongation response, force vs elongation.

6 SUMMARY

All specimens tested completed the standard test loading protocol without sudden reduction of system stiffness or load carrying capacity. Extended loading was carried out on all specimens and it was observed that in all test cases a progressive reduction in system stiffness occurred as the extended loading profile progressed. Strain gauge data collected during testing indicated that system yielding occurred on average at a drift level of 2%. For all specimens, post-test exposure and inspection of the coupling elements confirmed that their integrity remained.

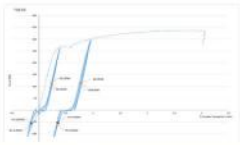
The results of the testing indicate that the coupled reinforcing bars meet the required performance characteristic required for an uncoupled reinforcing bar in a similar location, with no detrimental performance or failure mechanism noted.

BMS Couplers Low Cycle Fatigue Tests

holmessolutions

Figure 17 - Specimen T03-03 prior to testing.

Figure 18 - Specimen T03-03 after testing.



SPECIMEN DETAILS				RESULTS					
ID	Coupler Type	Reinforcing Bar Ø (average)	Coupler Length (average)	Residual Elongation ε_{res}		UTS	Comparison with acceptance criteria	Physical Failure Mode
		mm	mm	min.	max.	MPa	Pass / Fail	
T02-07	Type A	24.18	59.29	0.014	0.054	774	Pass	Bar break outside splice region
T02-06	Type A	25.00	58.83	-	-	(Invalid)		Bar break outside splice region
T02-08	Type A	25.04	59.06	0.031	0.065	753	Pass	Bar break outside splice region
T03-02	Type C	25.09	73.72	0.148	0.197	736	Pass	Bar break outside splice region
T03-02	Type C	25.08	73.62	0.276	0.305	756	Pass	Bar break outside splice region
T03-05	Type C	25.08	73.95	0.23	0.283	752	Pass	Bar break outside splice region

Table 20 - Low Cycle Fatigue Testing summary of results.

Table 21 - Slip Testing summary of results.

5.3 Summary

All Low Cycle Fatigue Testing specimens met the elongation requirement of the acceptance criteria.

Every Slip Testing specimen attained the elongation requirements of the acceptance criteria.

Ultimate tensile tests demonstrated that all specimens tested to failure achieved a UTS greater than the minimum required, and all specimens had breakages that occurred in the reinforcing bar material located between the grip jaw and the end of the mechanical splice region.

A summary of Low Cycle Fatigue Testing and Slip Testing results are listed below in Table 20 and Table 21 respectively.

Figure 36 - Specimen T04-05 after testing.

Property	Result
Average reinforcing bar Ø (mm)	25.07
UTS (MPa)	743
Physical failure mode	Bar break outside splice region

Table 16 - Specimen T04-05 test properties

Figure 37 - Specimen T03-01 after testing.

Property	Result
Average reinforcing bar Ø (mm)	25.07
UTS (MPa)	745
Physical failure mode	Bar break outside splice region

Table 17 - Specimen T03-01 test properties

Figure 38 - Specimen T04-01 after testing.

Property	Result
Average reinforcing bar Ø (mm)	25.02
UTS (MPa)	742
Physical failure mode	Bar break outside splice region

Table 18 - Specimen T04-01 test properties

Figure 39 - Specimen T04-02 after testing.

Property	Result
Average reinforcing bar Ø (mm)	25.08
UTS (MPa)	744
Physical failure mode	Bar break outside splice region

Table 19 - Specimen T04-02 test properties

OPUS

8 August 2017

HD32 Coupled Reinforcing Bars ISO 15835 Slip Testing, Tensile Testing, and Low-Cycle Loading Testing!

Opus International Consultants Ltd
P +64 4 587 0600
Opus Research
33 The Esplanade, Petone
PO Box 30 845, Lower Hutt 5040
New Zealand

Mr [redacted]
Iron Man Bar-Coupler Mechanical Splice
PO Box 38-509
Wellington Mail Centre

Ref: 524E75-4.17.353

Results of Testing

Table 1: Permanent Set and Tensile Testing
(Force vs Extension Graphs taken between machine grips and Stress vs Strain Graphs taken over 150mm are presented in Figures 1 to 20)

DATE OF TESTING	SPECIMEN NO. (Ø32mm Coupled Rebar)		PERMANENT SET [mm] Zero kg	ELONGATION AT 0.6FY [mm]	GL [mm]	YIELD LOAD [N]	YIELD STRESS [N/mm²]	MAX LOAD [N]	UTS [N/mm²]	MOF	POF
21/07/2017	Type C	1/1	0.02	0.59	350	402,000	499	522,000	649	BB	OSL
	Type C	1/2	0.00	0.50	350	408,000	507	525,000	652	BB	OSL
	Type C	1/3	0.00	0.54	350	403,000	501	524,000	652	BB	OSL
	Type C	1/4	0.01	0.55	350	428,000	532	546,000	679	BB	OSL
31/07/2017	Type C	1/5	0.01	0.51	350	403,000	501	523,000	651	BB	OSL
	Type A	1/11	0.00	0.53	350	405,000	504	525,000	653	BB	OSL
	Type A	1/12	0.01	0.54	350	407,000	506	529,000	658	BB	OSL
1/08/2017	Type A	1/13	0.01	0.56	350	410,000	509	526,000	654	BB	OSL
	Type A	1/14	0.02	0.58	350	412,000	512	525,000	653	BB	OSL
	Type A	1/15	0.03	0.61	350	424,000	528	541,000	673	BB	OSL
AVERAGE			0.01	0.55	-	410,200	510	528,600	657	-	-
ISO 15835-1:2009E Requirements			0.10 max.	-	-	-	-	-	575 min.	-	-

Legend: GL - Gauge Length; UTS - Ultimate Tensile Stress; MOF - Mode of Failure; BB - Bar Break clear of splice & Grips; POF - Position of Failure; OSL - Outside Splice Length

Table 4: Tensile Testing and Residual Elongations
(Force vs Extension Graphs taken with the dual displacement apparatus over 450mm are presented in Figures 23 to 32)

DATE OF TESTING	SPECIMEN NO. (Ø32mm Coupled Rebar)		GL [mm]	MAX LOAD [N]	UTS [N/mm²]	MOF	POF	U4 [mm]	U8 [mm]
2/08/2017	Type C	1/6	350	529,000	658	BB	OSL	-0.01	0.11
		1/7	350	530,000	659	BB	OSL	0.03	0.07
		1/8	350	525,000	653	BB	OSL	0.04	0.17
		1/9	350	526,000	654	BB	OSL	0.01	0.08
		1/10	350	547,000	681	BB	OSL	0.06	0.12
3/08/2017	Type A	1/16	350	550,000	684	BB	OSL	0.05	0.11
		1/17	350	545,000	678	BB	OSL	0.05	0.12
		1/18	350	530,000	659	BB	OSL	0.07	0.16
		1/19	350	546,000	679	BB	OSL	0.07	0.14
		1/20	350	528,000	656	BB	OSL	0.02	0.11
AVERAGE			-	535,600	666	-	-	0.04	0.12
ISO 15835-1:2009E Requirements			-	-	575 min.	-	-	0.30 max	0.60 max

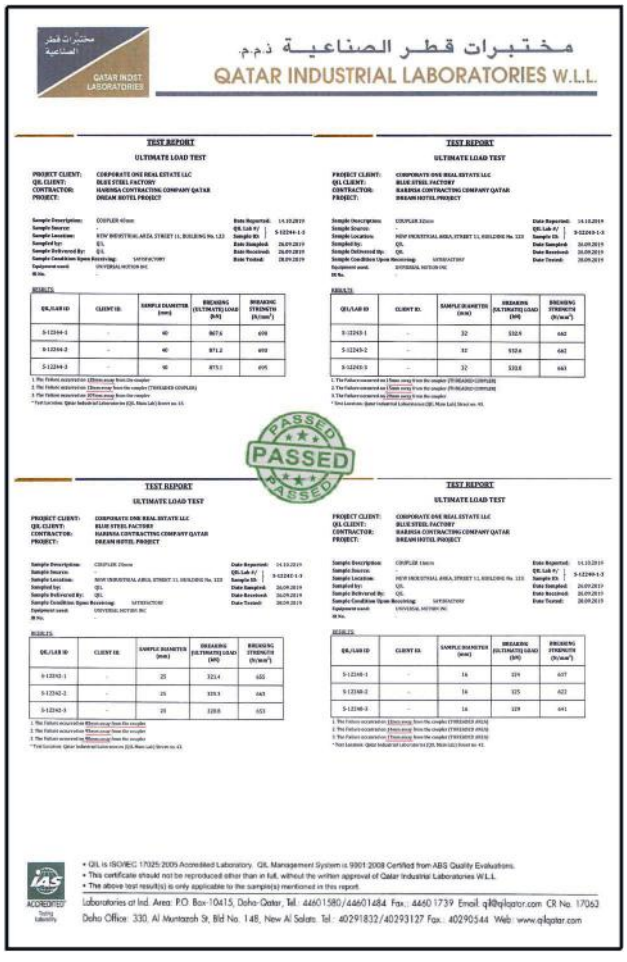
Legend: GL - Gauge Length; UTS - Ultimate Tensile Stress; MOF - Mode of Failure; BB - Bar Break clear of splice & Grips; POF - Position of Failure; OSL - Outside Splice Length

Table 5: Elongation Measurements of Specimens Subjected to Low Cycle Test

SPECIMEN NO. (Ø32mm Coupled Rebar)		Across Failure in Bar			Measured on Side A			Measured on Side B			Across Failure Close to Coupler			MOF
		Over Failure Side A [mm]	Measured Over [mm]	%	In Side A [mm]	Measured Over [mm]	%	In Side B [mm]	Measured Over [mm]	%	From Coupler Over Failure in Bar A	Measured Over	%	
Type C	1/6	-	160	-	113.3	100	13.3	114.0	100	14.0	-	-	-	BB
					-	160	-	182.0	160	13.8	-	-	-	
	1/7	195.3	160	22.1	110.8	100	10.8	111.4	100	11.4	-	-	-	BB
					-	160	-	177.2	160	10.8	-	-	-	
	1/8	-	160	-	112.3	100	12.3	112.0	100	12.0	-	-	-	BB
					-	160	-	178.4	160	11.5	-	-	-	
	1/9	-	160	-	112.2	100	12.2	114.3	100	14.3	-	-	-	BB
					-	160	-	181.7	160	13.6	-	-	-	
	1/10	-	160	-	112.3	100	12.3	111.5	100	11.5	-	-	-	BB
					-	160	-	177.5	160	10.9	-	-	-	
Type A	1/16	178.3	160	11.4	114.2	100	14.2	110.8	100	10.8	-	-	-	BB
					-	160	-	176.3	160	10.2	-	-	-	
	1/17	200.9	160	25.6	114.4	100	14.4	110.0	100	10.0	-	-	-	BB
					-	160	-	175.4	160	9.6	-	-	-	
	1/18	199.2	160	24.5	111.7	100	11.7	112.0	100	12.0	-	-	-	BB
					-	160	-	180.0	160	12.5	-	-	-	
	1/19	201.1	160	25.7	114.5	100	14.5	110.6	100	10.6	-	-	-	BB
					-	160	-	176.3	160	10.2	-	-	-	
	1/20	194.9	160	21.8	110.6	100	10.6	111.5	100	11.5	-	-	-	BB
					-	160	-	178.7	160	11.7	-	-	-	
AVERAGE		-	-	21.8	-	-	12.6	-	-	11.6	-	-	-	-

Legend: MOF - Mode of Failure; BB - Bar Break clear of splice & Grips

QATAR TESTS & CONSULTANT APPROVALS


مختبرات قطر الصناعية ذ.م.م
QATAR INDUSTRIAL LABORATORIES W.L.L.

TEST REPORT
ULTIMATE LOAD TEST

PASSED


Early Works Package (EWP) for Lusail Plaza Towers (BP12)- Plot 3 (BP12C)

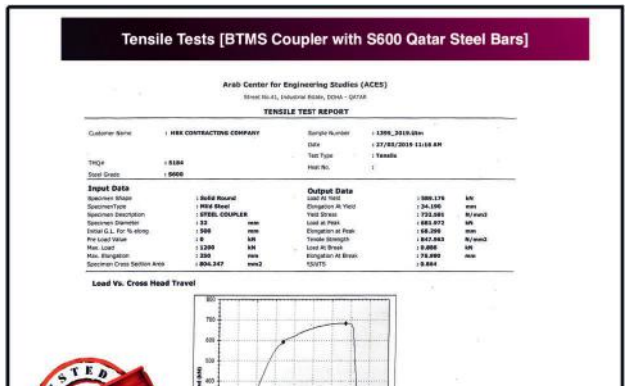
Material Approval Submission for Mechanical Splicing Couplers


Tensile Tests [BTMS Coupler with B500B Qatar Steel Bars]

Arab Center for Engineering Studies (ACES)

TENSILE TEST REPORT

TESTED OK BAR-BREAK


Tensile Tests [BTMS Coupler with S600 Qatar Steel Bars]

Arab Center for Engineering Studies (ACES)

TENSILE TEST REPORT

TESTED OK BAR-BREAK

3RD PARTY TESTS [TESTS WITH ASTM BARS]

Size: #6(D19), #7(D22), #8(D25), #9(D29), #10(D32), & #11(D36)mm
BMS COUPLERS with ASTM 615 Grade 60

STANDARD OF ACI 318 TEST REPORT

PASSED

This test is intend to comprehend whether the BMS(Bar-Coupler Mechanical Splice System) using ASTM A615 Grade 60 reinforcing bar was built meet the ACI 318 Mechanical splices test requirement. For satisfying this requirement, Boo Won BMS examines the series of test(static tensile tests)

ACI 318 [12.14.3.2] test requirement
A full mechanical splice shall develop in tension or compression, as required, at least 1.25fy of the bar.

[Table 1.1] The general tabulation of the test result

Distinguishment		Coupler's condition after finishing test	Min/Max of each $\frac{f_u}{f_y}$ (%)	
Specimen	sort of test			
#6 [D19]	Static tensile strength test	OK	165 (166)	OK
#7 [D22]	Static tensile strength test	OK	169 (169)	OK
#8 [D25]	Static tensile strength test	OK	165 (171)	OK
#9 [D29]	Static tensile strength test	OK	162 (163)	OK
#10 [D32]	Static tensile strength test	OK	161 (166)	OK
#11 [D36]	Static tensile strength test	OK	169 (170)	OK
Note		The coupler whether it is damaged or not	More than 125% is OK	

5. Test Results

Test Items	Unit	Sample	Test Results	Test method used
Tensile strength (Sample No:BH-BT11-S-1)	N/㎟	1	713	
Yield strength (Sample No:BH-BT11-S-1)	N/㎟	1	502	
Elongation (Sample No:BH-BT11-S-1)	%	1	10	
Tensile strength (Sample No:BH-BT11-S-2)	N/㎟	2	710	
Yield strength (Sample No:BH-BT11-S-2)	N/㎟	2	493	
Elongation (Sample No:BH-BT11-S-2)	%	2	8	
Tensile strength (Sample No:BH-BT11-S-3)	N/㎟	3	710	
Yield strength (Sample No:BH-BT11-S-3)	N/㎟	3	496	
Elongation (Sample No:BH-BT11-S-3)	%	3	8	

※This "Test Report" is related to the project(Contract No. 부정-C-12-001)
※BMS : Bar-Coupler mechanical splice system

- - - - continued on the next page - - - -

Affirmation	Tested by	Technical Manager

Our report apply only to the standard or procedures identifide and to the sample(s) tested unless otherwise specified. The test results are not indicative of representative of the qualities of the lot from which the sample was taken or of apparently identical or similar products.

Korea Conformity Laboratories President Jae Bin Song

BMS COUPLERS with ASTM 615 Grade 60

STANDARD OF ACI 349 TEST REPORT

PASSED

This test is intend to comprehend whether the BMS(Bar-Coupler Mechanical Splice System) using ASTM A615 Grade 60 reinforcing bar was built meet the ACI 349 Mechanical splices test requirement. For satisfying this requirement, Boo Won BMS examines the series of test(cyclic tensile test, stain test)

ACI 349 [12.14.3.4.1] test requirement
Mechanical connections shall be qualified for use in the construction on the basis of the following performance tests

(a) Static Tensile Strength Tests - A Minimum of six static tensile strength tests shall be conducted considering the range of variabilities in splicing material, in material of reinforcing bars and in the anticipated environmental conditions. All test samples shall meet the requirement of 12.14.3.4

12.14.3.4 A full mechanical connection shall develop in tension or compression, as required, at least 125% of specified yield strength fy of the bar.

(b) Cyclic Tests - Three specimens of the bar-to-bar connection for each reinforcing bar size and grade shall be subjected to 100 cycles of tensile stress variations from 5 to 90% of the specified minimum yield strength of the reinforcing bar. The specimens shall withstand the cyclic test without loss of static tensile strength capacity when compared with like specimen in (a) and tested statically to failure following cyclic tests.

[Table 1.1] The cyclic tensile test of the test result

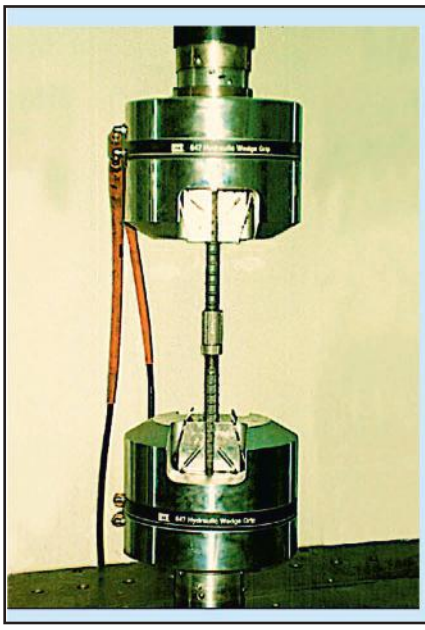
Distinguishment		Coupler's condition after finishing test	The cyclic tensile test	Min/Max of each $\frac{f_u}{f_y}$ (%)	
Specimen	sort of test				
#6[D19]	The cyclic tensile test	OK	No abnormal phenomenon after loading 100 times cyclic load	165 (166)	OK
#7[D22]	The cyclic tensile test	OK	No abnormal phenomenon after loading 100 times cyclic load	169 (170)	OK
#8[D25]	The cyclic tensile test	OK	No abnormal phenomenon after loading 100 times cyclic load	165 (172)	OK
#9[D29]	The cyclic tensile test	OK	No abnormal phenomenon after loading 100 times cyclic load	162 (162)	OK
#10[D32]	The cyclic tensile test	OK	No abnormal phenomenon after loading 100 times cyclic load	162 (166)	OK
#11[D36]	The cyclic tensile test	OK	No abnormal phenomenon after loading 100 times cyclic load	169 (170)	OK
Note		The coupler whether it is damaged or not	No abnormal phenomenon after loading 100 times cyclic load OK	More than 125% is OK	

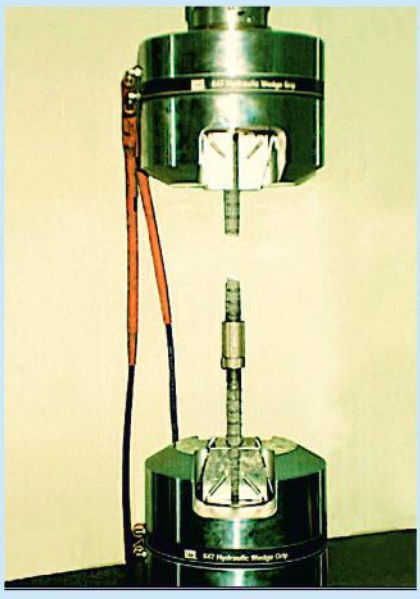
3. Use of Report : The certification test for BMS
4. Test Sample : BMS(#10)
5. Test Results

Test Items	Unit	Sample	Test Results	Test method used
Tensile strength (Sample No:BH-BT10-C-1)	N/㎟	1	680	
Yield strength (Sample No:BH-BT10-C-1)	N/㎟	1	460	
Elongation (Sample No:BH-BT10-C-1)	%	1	9	
Tensile strength (Sample No:BH-BT10-C-2)	N/㎟	2	695	
Yield strength (Sample No:BH-BT10-C-2)	N/㎟	2	465	
Elongation (Sample No:BH-BT10-C-2)	%	2	9	
Tensile strength (Sample No:BH-BT10-C-3)	N/㎟	3	696	
Yield strength (Sample No:BH-BT10-C-3)	N/㎟	3	468	
Elongation (Sample No:BH-BT10-C-3)	%	3	11	

※This "Test Report" is related to the project(Contract No. 부정-C-12-001)
※BMS : Bar-Coupler mechanical splice system

- - - - End of Report - - - -





BMS Couplers have been tested to ACI 318, (ICC-ES), ACI 349 & 359 Nuclear codes with ASTM bars, passing the requirements of Type-2 (which is less demanding than the one of ISO 15835-1 S2)

ASTM A 615 & ASTM A706 Grade 60, 75 & 80 Grade Bars (ASTM #3, #4, #5, #6, #8, #9, #10, #16, #18 inches)		
Building Codes	ACI 318 Type I & Type II	
Criterion	Strength	Type 1=125% * specified yield strength; Type 2= T1+specified tensile strength . CODE 18.2.7.1 Mechanical splices shall be classified as (a) or (b): (a) Type 1 – Mechanical splice conforming to 25.5.7 (b) Type 2 – Mechanical splice conforming to 25.5.7 and capable of developing the specified tensile strength of the spliced bars
	Slip	N/A
Certification per Third Party Tests	Tests & Field Applications	

BMS WELDABLE COUPLER TESTS

KCL

시험성적서

BMS Weldable Coupler Tests

1. 성 적 서 번 호 : CT20-105681K

BMS WELDABLE COUPLER

D16 (SD400 GRADE BAR): [KS D 0249-2019]

(Weldable) 시험항목	단위	시험방법	시험결과	비 고	시험장소
인장강도 (Tensile Strength)	N/㎟	(1)	587	-	A
항복강도 (Yield Strength)	N/㎟	(1)	458		

D29 (SD400 GRADE BAR):

(Weldable) 시험항목	단위	시험방법	시험결과	비 고	시험장소
인장강도 (Tensile Strength)	N/㎟	(1)	598	-	A
항복강도 (Yield Strength)	N/㎟	(1)	456		

D32 (SD400 GRADE BAR):

(Weldable) 시험항목	단위	시험방법	시험결과	비 고	시험장소
인장강도 (Tensile Strength)	N/㎟	(1)	584	-	A
항복강도 (Yield Strength)	N/㎟	(1)	453		

D19 (SD500 GRADE BAR):

시험항목	단위	시험방법	시험결과	비 고	시험장소
인장강도 (Tensile Strength)	N/㎟	(1)	680	-	A
항복강도 (Yield Strength)	N/㎟	(1)	561		

D22 (SD500 GRADE BAR):

(Weldable) 시험항목	단위	시험방법	시험결과	비 고	시험장소
인장강도 (Tensile Strength)	N/㎟	(1)	719	-	A
항복강도 (Yield Strength)	N/㎟	(1)	543		

D22 (SD600 GRADE BAR):

(-Weldable) 시험항목	단위	시험방법	시험결과	비 고	시험장소
인장강도 (Tensile Strength)	N/㎟	(1)	759	-	A
항복강도 (Yield Strength)	N/㎟	(1)	650		

D25 (SD600 GRADE BAR):

(Weldable) 시험항목	단위	시험방법	시험결과	비 고	시험장소
인장강도 (Tensile Strength)	N/㎟	(1)	768	-	A
항복강도 (Yield Strength)	N/㎟	(1)	668		

D29 (SD600 GRADE BAR):

(Weldable) 시험항목	단위	시험방법	시험결과	비 고	시험장소
인장강도 (Tensile Strength)	N/㎟	(1)	761	-	A
항복강도 (Yield Strength)	N/㎟	(1)	640		

2020년 09월 18일

한국건설생활환경시험연구원장

SETSCO SERVICES PTE LTD

SETSCO 18 Teban Gardens Crescent Singapore 608925 Tel : (65) 6566 7777 Fax: (65) 6566 7718 Website: www.setsco.com Business Reg. No. 196900269D

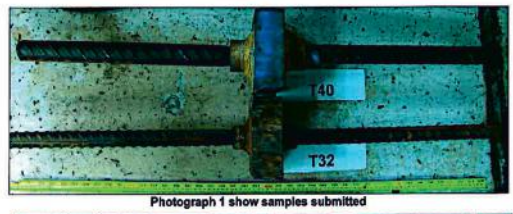
TEST REPORT [BMS Weldable Coupler]

Results:

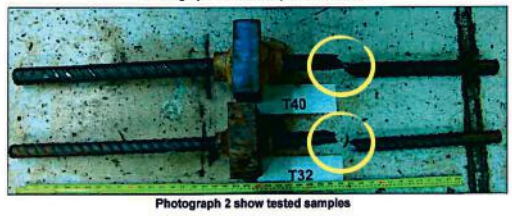
Table : Tension Load Test

Sample Reference	Mechanical Spliced Reinforcement Steel Bars (Ironman BMS Weldable Coupler)	
	T32	T40
Nominal Size (mm) #	32.0	40.0
Nominal Cross-sectional Area, So (mm^2)	804.25	1256.64
Maximum Load, P (kN)	528.3	782.8
$\frac{(P \times 1000)}{So} (N / mm^2)$	656.9	622.9
Position of Fracture	Fractured at the reinforcement steel bar	

'#' - Based on client's sample reference.



Photograph 1 show samples submitted



Photograph 2 show tested samples

시험성적서

TEST REPORT

BMS Weldable Coupler Tests

Reference No. 접수번호 : R081007-BU034 Date 접수일자 : 2008 년 10 월 07 일

Client 신청인 : (주)부원비엠에스 조 필 영 BOOWON B.M.S

Address 주 소 : 충북 충주시 용탄동 590 제2산업단지

Test Specimen 시 료 명 : 철근 이음 용접용 커플러 (SD500) BMS Weldable Coupler (SD500)

시 험 결 과

Test Item 시험항목	시험결과 Test Result				Test Method 시험방법
	D25	D29	D32	D35	
Tensile Strength 인장강도 (N/㎟)	687	663	696	633	KS B 0802 - 2003
Yield Strength 항복점 (N/㎟)	565	525	519	529	

Reference No. 접수번호 : R081007-BU033 Date 접수일자 : 2008 년 10 월 07 일

Client 신청인 : (주)부원비엠에스 조 필 영 BOOWON B.M.S

Address 주 소 : 충북 충주시 용탄동 590 제2산업단지

Test Specimen 시 료 명 : 철근 이음 용접용 커플러 (SD400) BMS Weldable Coupler (SD400)

시 험 결 과

Test Item 시험항목	시험결과 Test Result				Test Method 시험방법
	D16	D19	D22	D25	
Tensile Strength 인장강도 (N/㎟)	608	591	569	589	KS B 0802 - 2003
Yield Strength 항복점 (N/㎟)	509	477	427	494	

비 고 : 1. 이 성적서는 의뢰자가 제시한 시료 및 시료명으로 시험한 결과이며, 용도 이외의 사용을 금합니다.
2. 이 성적서는 한국건자재시험연구원의 사전 서면동의없이 홍보·선전, 광고 및 소송용으로 사용될 수 없습니다.

담 당 자 : 이 옥 원 (055)371-2140

2008년 10 월 14 일

Korea Conformity Laboratories

한 국 건 자 재 시 험 연 구 원 장

(부산 · 울산 · 경남지원, 주소 : 626-810 경남 양산시 물금읍 증산리 934-6, 전화번호 : 055-371-2140, www.kicm.re.kr)

Professional Testing Services Pte Ltd

32 Kian Teck Road, Singapore 628779.
Tel: 6778 1271 (5 Lines) Fax: 6779 3621 Email: sales@ptspl.com
Website: http://www.ptspl.com Co. Reg No.: 00774/1985-K

BMS Weldable Coupler Tests

TEST REPORT

Laboratory Test No : PTS / 47368 / 12 Date Tested : 21 February 2012

Customer : Preshcon Couplers Pte Ltd
57 Ubi Avenue 1
#03-10 Ubi Centre
Singapore 408936

P O / Order No : -- Total Page : 1 Page

Test Method : BS EN 10002-1 : 2001 Your Ref : Project: SS-01 (Hyundai Kingpost)

Reference Code : Customer's Specification

Date of Receipt of Test Items : 20 February 2012 / JN 37294

Subject (as received) :

Two (2) pieces of steel weldable threaded coupler (size: D25, 38mm OD x 23.4mm screw ID x 2 nos), Material: KS D 3592 / JIS G3539 / JIS G3507) welded on steel plate surface (thickness: 50mm) both side threaded with T25 reinforcement steel bar test samples, marked: Sample 1 & Sample 2, for Tensile Test.

Tensile Test Results: Test Temperature: +23°C to +30°C

Sample Marking	Nominal Cross Sectional Area (mm^2)	Ultimate Tensile Load (kN)	Ultimate Tensile Stress (N/mm^2)	Location of Fracture
Sample 1	491	318.51	649	Broke at the T25 reinforcement steel bar non threaded portion
Sample 2	491	318.78	649	Broke at the T25 reinforcement steel bar non threaded portion

Photo 1: Fracture Specimen after tensile

Test Conducted By :

Test Witnessed By : Mr
Mr
Mr
Mr
Mr

Remarks : --

Approved Signatory

Laboratory Manager

Form No : GENERAL0812201
This results reported herein have been performed in accordance with the laboratory's terms of accreditation under Singapore Laboratory Accreditation Scheme.
This report shall not be reproduced except in full, without the written approval of the laboratory.

ACI STRUCTURAL JOURNAL TECHNICAL PAPER
MS No. S-2016-027

Side-Face Blowout Failure of Large-Diameter High-Strength Headed Bars [with Boo Won B.M.S. Terminators*] in Beam-Column Joints

by Sung-Chul Chun, Chang-Sik Choi, and Hyung-Suk Jung

The provisions of ACI 318 on headed bars have several limitations on the bar yield strength, cover, and effects of transverse reinforcement. Anchorage strengths significantly depend on failure modes and geometric conditions where headed bars are anchored. Twenty-seven simulated beam-column joints were tested using 550 MPa (80 ksi) headed bars of 43 and 57 mm (No. 14 and 18) diameter. Intentional side-face blowout failure occurred by preventing the other failure modes. As the embedment length and side cover increase, the anchorage strength also increases. Hairpin-type transverse reinforcement enhanced the strength. The 550 MPa (80 ksi) yield strength of large-diameter headed bars could be developed even with a $1d_b$ side cover by providing hairpin-type transverse reinforcement, increasing the embedment length, or increasing the compressive strength of concrete. From regression analyses of 59 sets of data, a model is proposed for predicting the anchorage strength of headed bars terminated within exterior beam-column joints.

Keywords: exterior beam-column joint; headed bar; reinforcement; side-face blowout.

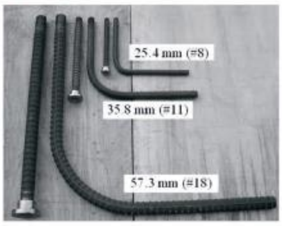


Fig. 1—No. 8, 11, and 18 reinforcing bars.

INTRODUCTION

According to ACI 318-14,[1] the development length of headed bars is equal to 80 percent of that used for hooks, provided that headed bars meet the requirements of Class HA heads in ASTM A970-15.[2] In addition, the following conditions must be satisfied: the net bearing area o... is at least four times the cross-sectional area of th...

42 MPa (6000 psi) have also increased. For large-diameter headed bars of 43 and 57 mm (No. 14 and 18), the minimum side cover of $2d_b$ is larger than the minimum cover of 40 mm (1-1/2 in.). Moreover, transverse reinforcement is believed to be effective for the anchorage of headed bars because the confinement by transverse reinforcement limits the progres-

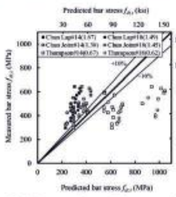


Fig. 7—Comparison of measured bar stresses with predictions. (Note: Values in parentheses are averages of tests to predictions.)

TEST RESULTS

Overall behavior and failure modes

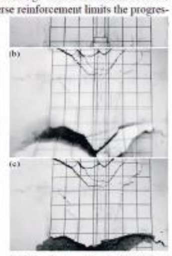


Fig. 3—Typical specimen failure

authors wish to thank Boo Won B.M.S. Co. Ltd., Korea, for providing the headed bars used in the tests.

REFERENCES

1. ACI Committee 318, "Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary (ACI 318R-14)," American Concrete Institute, Farmington Hills, MI, 2014, 519 pp.
2. ASTM A970/A970M-15, "Standard Specification for Headed Steel Bars for Concrete Reinforcement," ASTM International, West Conshohocken, PA, 2015, 9 pp.
3. Thompson, M. K.; Ziehl, M. J.; Jirsa, J. O.; and Breen, J. E., "CCT Nodes Anchored by Headed Bars-Part 1: Behavior of Nodes," *ACI Structural Journal*...

APPENDIX A

Table A—Comparison of tests with predictions

Specimen ID	$f_{h,p}$, MPa (ksi)	$f_{h}/f_{h,p}$ Bar 1	Bar 2
This study			
D43-L7-C1-S42	353 (54.3)	0.84	0.93
D43-L7-C1-S42-HP0.5	424 (65.2)	1.06	0.91

İSTANBUL TEKNİK ÜNİVERSİTESİ – İNŞAAT FAKÜLTESİ
YAPI MALZEMESİ LABORATUVARI
34469 MASLAK / İSTANBUL TEL: (0212) 285 3757-58 FAX: (0212) 285 6587

Manşonlu Birleşim Çekme Deneyi
Rapor no/Tarih: 401/16.05.2014
Başvuru No/Tarih: 2143/16.05.2014

TAV-SERA YAPI

İlgili dilekçeniz ile birlikte laboratuvarımıza teslim ettiğiniz ve dilekçenizde "*Emaar Square Projesi*"nde" kullanılmasının planlandığını belirttiğiniz *BMS* marka, "*Bar Anchor Terminatör tip*" manşon plaka ile birleştirilmiş muhtelif çaplı nervürlü çelik çubuklar üzerinde çekme-sıyrılma deneyi yapılmıştır

Tablo 1. Manşonlu birleşimler üzerinde yapılan çekme deneyi sonuçları.

Numune Tanıtım		Anma Çapı (mm)	Manşon Birleşimi	Akma Dayanımı (kN)	Akma Dayanımı MPa	Çekme Dayanımı (kN)	Çekme Dayanımı MPa	Gözlem
1	BMS, Bar Anchor Terminatör tip	Φ22	Φ22 mm manşon	177,6	467	213,9	563	Manşonlu birleşimin kopması çelik çubukta meydana gelmiştir.
2				176,6	465	214,8	565	
3				186,4	490	221,7	583	
4		Φ26	Φ26 mm manşon	250,2	471	302,1	569	
5				248,2	467	294,3	554	
6				254,1	479	311,0	586	
7		Φ32	Φ32 mm manşon	364,9	454	482,7	600	
8				365,9	455	482,7	600	
9				362,0	450	477,7	594	

Not: Numune tanıtımı firma tarafından beyan edilmiştir.

[redacted]
İnşaat Mühendisi

Doç. Dr. [redacted]
Yapı Malzemesi Laboratuvarı Sorumlusu

T.C.
İSTANBUL TEKNİK ÜNİVERSİTESİ REKTÖRLÜĞÜ
İNŞAAT FAKÜLTESİ DEKANLIĞI
MASLAK, İSTANBUL

Kayıt No/Tarih: *379568 /29.03.2018*

Test with BMS Terminators [D28, D32, D36]

BTMS Mekanik Yapı Elemanları San. Ve Tic. A.Ş.

Terminatör Tip Sonlandırma Manşonunun Çekme-Sıyrılma Deneyleri Hakkında Hazırlanan

TEKNİK RAPOR

İ.T.Ü.
İNŞAAT FAKÜLTESİ
Tarih: 30 Mart 2018
No.: 379568

Bu Rapor İTÜ Döner Sermaye İşletmesi Yönetmeliğine Göre Hazırlanmıştır.

BTMS MECHANICAL CONSTRUCTION EQUIPMENT

According to your application letter dated 28.03.2018, tensile / pull-out tests were performed on the mechanical anchor couplers which are connected to rebar samples. It was stated in your application letter that the couplers are planned to be used in **"Consulate Building Project in Ankara"** which is constructed by [redacted] Tests were performed according to ASTM C900. The results are shown in below.

Sample Identification

BMS28T- 0002 BMS32T- 0016 BMS36T-0007

Table 1. Dimensions

Sample Code	Nominal Rebar Diameter (mm)	d_h (mm)	t_h (mm)	h (mm)	d_c (mm)
BMS28T-0002	28	64,8	10,41	32,7	43,1
BMS32T-0016	32	72,0	10,26	35,1	48,0
BMS36T-0007	36	79,0	12,29	37,6	51,0

Table 2. Test Results

Sample Code	Nominal Rebar Diameter (mm)	Max Load (kN)	Tensile Strength (MPa)	Result/Observations
BMS28T-0002	Φ28	397,1	645	BAR BREAK (Samples did not fail from the couples)
BMS32T-0016	Φ32	564,6	702	
BMS36T-0007	Φ36	692,5	680	

Samples after testing

[redacted]
Civil Engineer, Msc.

Associate Prof.Dr. [redacted]
ITU Faculty of Civil Engineering
Construction Materials Division

Page 2/2

the way to trust KCL

TEST REPORT

1. No : CT15-027747_M1
2. Client :
   - ○ Name : BOOWON B.M.S
   - ○ Address : 165, Chungjusandan 2-ro, Chungju-City, Chungbuk, Korea
   - ○ Date of Receipt : 2015.03.02
   - ○ TESTING PERIOD : 2015.03.02 ~ 2015.03.18
3. Use of Report : Quality Assuarence
4. Test Sample : BMS Terminator-SD500
5. Method :
   (1) KS B 0802:2003

Reissuance (R1)
Date : 2015.06.03

Modification (M1)
Date : 2015.03.24

TESTED OK BAR-BREAK

6. Test Results

1) D22

Test Item(s)	Unit	Test method	Test Results	Testing Environment
Tensile strength	N/㎟	(1)	641	(22 ± 1) ℃, (18 ± 2) % R.H
Yield Strength	N/㎟	(1)	528	(22 ± 1) ℃, (18 ± 2) % R.H

2) D25

Test Item(s)	Unit	Test method	Test Results	Testing Environment
Tensile strength	N/㎟	(1)	688	(22 ± 1) ℃, (18 ± 2) % R.H
Yield Strength	N/㎟	(1)	572	(22 ± 1) ℃, (18 ± 2) % R.H

3) D29

Test Item(s)	Unit	Test method	Test Results	Testing Environment
Tensile strength	N/㎟	(1)	695	(22 ± 1) ℃, (18 ± 2) % R.H
Yield Strength	N/㎟	(1)	618	(22 ± 1) ℃, (18 ± 2) % R.H

4) D32

Test Item(s)	Unit	Test method	Test Results	Testing Environment
Tensile strength	N/㎟	(1)	684	(22 ± 1) ℃, (18 ± 2) % R.H
Yield Strength	N/㎟	(1)	544	(22 ± 1) ℃, (18 ± 2) % R.H

※Used in the calculation of the strength of the joint cross-sectional area specified in the KS D 3504 uses a nominal cross-sectional area

---- End of Report ----

Affirmation	Tested By	Technical Manager
	Name : [redacted]	Name : [redacted]

Our report apply only to the standards or procedures identified and to the sample(s) tested unless otherwise specified. The test results are not indicative of representative of the qualities of the qualities of the lot from which the sample was taken or of apparently identical or similar products.

2015.03.18

Korea Conformity Laboratories President

PASSED PASSED PASSED Song

---

the way to trust KCL

TEST REPORT

No : CT19-068684

7. TEST RESULTS

1) BMS32 Terminators & Standard Couplers with ASTM A706 Grade 80 rebars

Test Item(s)	Unit	Test Method	Test Results	Remark
Tensile strength	N/㎟	(1)	771	-

2) BMS25-BT-01

Test Item(s)	Unit	Test Method	Test Results	Remark
Tensile strength	N/㎟	(1)	774	-

3) BMS25-BT-02

Test Item(s)	Unit	Test Method	Test Results	Remark
Tensile strength	N/㎟	(1)	750	-

4) BMS25-BT-03

Test Item(s)	Unit	Test Method	Test Results	Remark
Tensile strength	N/㎟	(1)	774	-

5) BMS25-BT-04

Test Item(s)	Unit	Test Method	Test Results	Remark
Tensile strength	N/㎟	(1)	774	-

6) BMS25-BH-01

Test Item(s)	Unit	Test Method	Test Results	Remark
Tensile strength	N/㎟	(1)	750	-
Elongation	%	(1)	19	-

7) BMS25-BH-02

Test Item(s)	Unit	Test Method	Test Results	Remark
Tensile strength	N/㎟	(1)	777	-
Elongation	%	(1)	13	-

※Manufacturer : BOOWON B.M.S
※Project Name : Chacao Bridge Construction Project / Chile

6) BMS25-BH-01

Test Item(s)	Unit	Test Method	Test Results	Remark
Tensile strength	N/㎟	(1)	750	-
Elongation	%	(1)	19	-

7) BMS25-BH-02

Test Item(s)	Unit	Test Method	Test Results	Remark
Tensile strength	N/㎟	(1)	777	-
Elongation	%	(1)	13	-

※Manufacturer : BOOWON B.M.S
※Project Name : Chacao Bridge Construction Project / Chile
※Contractor : HYUNDAI ENGINEERING & CONSTRUCTION
※Steel bars : Steel bars in accordance with ASTM A706/706M Grade 80(25 mm) / Cross-sectional area - 510 ㎟
※Joint Type : 2),3),4),5)- TYPE B / 6),7)-TYPE A
※Test Evaluation : 2),3),4),5) ACI 318 Type 2 / 6),7)- ASTM A 970 Class
※ Dimension : Coupler 2),3),4),5) / Ext. Dianeter(D) - 38mm, Length(L) - 58mm
Terminator 6),7) / Ext. Dianeter(D) - 63mm, Ext. Diameter(D1) - 38mm
Length(L) - 29mm

TESTED OK TESTED

---- End of Report ----

İTÜ

Doc.No:HDSK-MA-QAS-121-E Rev.00

ISTANBUL TECHNICAL UNIVERSITY
RECTORSHIP

EARTHQUAKE ENGINEERING AND
DISASTER MANAGEMENT INSTITUTE

TECHNICAL REPORT

about

Anchorage Capacity of Terminator Couplers of
3rd Bosphorous Bridge Project

Requested by:
[redacted] AND CONSTRUCTION JOINT VENTURE

This Report was Prepared According to ITU Circulating Capital Enterprise Rules

Prepared by:

Res. Assist. [redacted] Assoc. Prof. [redacted]
ITU Civil Engineering Faculty
Material Science Division

TESTED OK BAR-BREAK

İ.T.Ü
DEPREM MÜHENDİSLİĞİ VE
AFET YÖNETİMİ ENSTİTÜSÜ
Tarih : 06.11.2015
Kayıt No: 455

ITU CIVIL ENGINEERING FACULTY
NOVEMBER 2014
Tel: (0212) 285 37 61 – email : orcunkaya@itu.edu.tr - hasanyildirim@itu.edu.tr

---

Table 2. Compressive Strength Values

Test Age (day)	Compressive Strength (MPa)
3	31.7
7	46.8
10	52.1
13	57.4
16	59.3
21	61.2

The concrete test specimens were casted upside down as indicated in ISO 15698-2.

Figure 1. Casted Concrete Blocks

Table 6. Test Results of Ø40mm rebar and longitudinal terminator system

Sample No	Yield Strength ($R_{eH,test}$) Load (kN)	Yield Strength ($R_{eH,test}$) Stress (MPa)	Tensile Strength ($R_{m,test}$) Load (kN)	Tensile Strength ($R_{m,test}$) Stress (MPa)	$R_{m,test}/R_{eH,test}$	Observation
1	774,2	616	>900	>716	>1,16	No failure was observed until 900 kN, maximum loading capacity of test machine.
2	726,5	578	>900	>716	>1,24	
3	786,2	626	>900	>716	>1,14	

3. Determination of Anchorage Capacity under low-cycle elastic-plastic loading (Category S)

This test has 4 stages;

- 20 load cycles between 0,05 $R_{eH,spec}$ and 0,33 $R_{eH,spec}$
- 4 load cycles between 0,05 $R_{eH,spec}$ and $S_{N,test}$
- 4 load cycles between 0,05 $R_{eH,spec}$ and $S_{N,test}$
- Loading to failure

$\varepsilon_{t,max}$ values were measured in 1st cycle of 2nd stage and upper limits of 2nd and 3rd stages were determined with these measurements. At the end of 3rd stage, specimens were loaded up to the failure or maximum capacity of test machine. Test results are given in Table 7-10.

Table 7. Test Results of Ø32mm rebar and shear terminator system

Sample No	Yield Strength ($R_{eH,test}$) Load (kN)	Yield Strength ($R_{eH,test}$) Stress (MPa)	Tensile Strength ($R_{m,test}$) Load (kN)	Tensile Strength ($R_{m,test}$) Stress (MPa)	$R_{m,test}/R_{eH,test}$	Observation
1	297,1	605	356,7	727	1,20	Bar break occured at 4th stage. No pull-off was observed during the test.
2	291,1	593	356,7	727	1,23	
3	297,1	605	362,7	739	1,22	

3. Determination of Anchorage Capacity Under Static Loading (Category B1 and B2)

The purpose of the static loading test is determination of the static anchorage capacity of the terminators. The principle of the test in concrete is to load the anchorage part of the terminator that is incorporated in the concrete prism by the tensile force. The force is measured up to the failure or maximum capacity of test machine and actual yield and tensile strengths were determined. Test results are given in Table 3-6.

Table 3. Test Results of Ø25mm rebar and shear terminator system

Sample No	Yield Strength ($R_{eH,test}$) Load (kN)	Yield Strength ($R_{eH,test}$) Stress (MPa)	Tensile Strength ($R_{m,test}$) Load (kN)	Tensile Strength ($R_{m,test}$) Stress (MPa)	$R_{m,test}/R_{eH,test}$	Observation
1	303,1	617	362,7	739	1,20	Bar break occured. No pull-off was observed during the test.
2	303,1	617	368,7	751	1,22	
3	297,1	605	362,7	739	1,22	

Table 4. Test Results of Ø25mm rebar and longitudinal terminator system

Sample No	Yield Strength ($R_{eH,test}$) Load (kN)	Yield Strength ($R_{eH,test}$) Stress (MPa)	Tensile Strength ($R_{m,test}$) Load (kN)	Tensile Strength ($R_{m,test}$) Stress (MPa)	$R_{m,test}/R_{eH,test}$	Observation
1	273,2	557	368,7	751	1,35	Bar break occured. No pull-off was observed during the test.
2	297,1	605	368,7	751	1,24	
3	297,1	605	344,8	702	1,16	

Table 5. Test Results of Ø32mm rebar and longitudinal terminator system

Sample No	Yield Strength ($R_{eH,test}$) Load (kN)	Yield Strength ($R_{eH,test}$) Stress (MPa)	Tensile Strength ($R_{m,test}$) Load (kN)	Tensile Strength ($R_{m,test}$) Stress (MPa)	$R_{m,test}/R_{eH,test}$	Observation
1	452,2	562	577,4	718	1,28	Bar break occured. No pull-off was observed during the test.
2	452,2	562	577,4	718	1,28	
3	458,1	570	571,5	711	1,25	

Table 8. Test Results of Ø25mm rebar and longitudinal terminator system

Sample No	Yield Strength ($R_{eH,test}$) Load (kN)	Yield Strength ($R_{eH,test}$) Stress (MPa)	Tensile Strength ($R_{m,test}$) Load (kN)	Tensile Strength ($R_{m,test}$) Stress (MPa)	$R_{m,test}/R_{eH,test}$	Observation
1	303,1	617	362,7	739	1,20	Bar break occured at 4th stage. No pull-off was observed during the test.
2	291,1	593	350,8	715	1,20	
3	297,1	605	356,7	727	1,20	

Table 9. Test Results of Ø32mm rebar and longitudinal terminator system

Sample No	Yield Strength ($R_{eH,test}$) Load (kN)	Yield Strength ($R_{eH,test}$) Stress (MPa)	Tensile Strength ($R_{m,test}$) Load (kN)	Tensile Strength ($R_{m,test}$) Stress (MPa)	$R_{m,test}/R_{eH,test}$	Observation
1	452,2	562	571,5	711	1,26	Bar break occured at 4th stage. No pull-off was observed during the test.
2	464,1	577	583,4	725	1,26	
3	470,1	584	577,4	718	1,23	

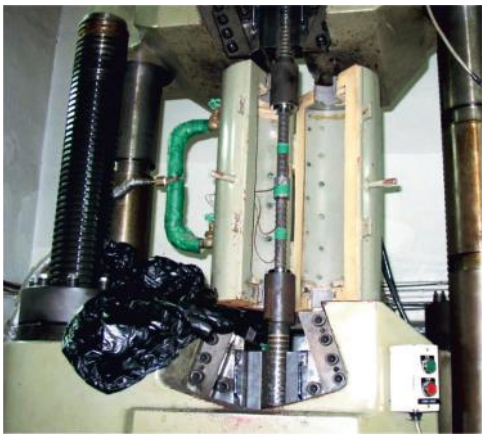
Table 10. Test Results of Ø40mm rebar and longitudinal terminator system

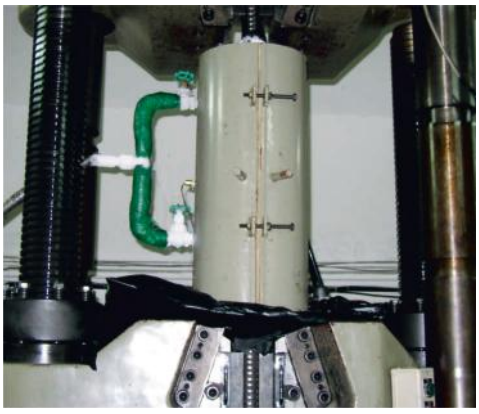
Sample No	Yield Strength ($R_{eH,test}$) Load (kN)	Yield Strength ($R_{eH,test}$) Stress (MPa)	Tensile Strength ($R_{m,test}$) Load (kN)	Tensile Strength ($R_{m,test}$) Stress (MPa)	$R_{m,test}/R_{eH,test}$	Observation
1	708,1	633	>900	>716	>1,16	No failure was observed until 900 kN, maximum loading capacity of test machine, at 4th stage.
2	804,1	640	>900	>716	>1,24	
3	774,2	616	>900	>716	>1,14	

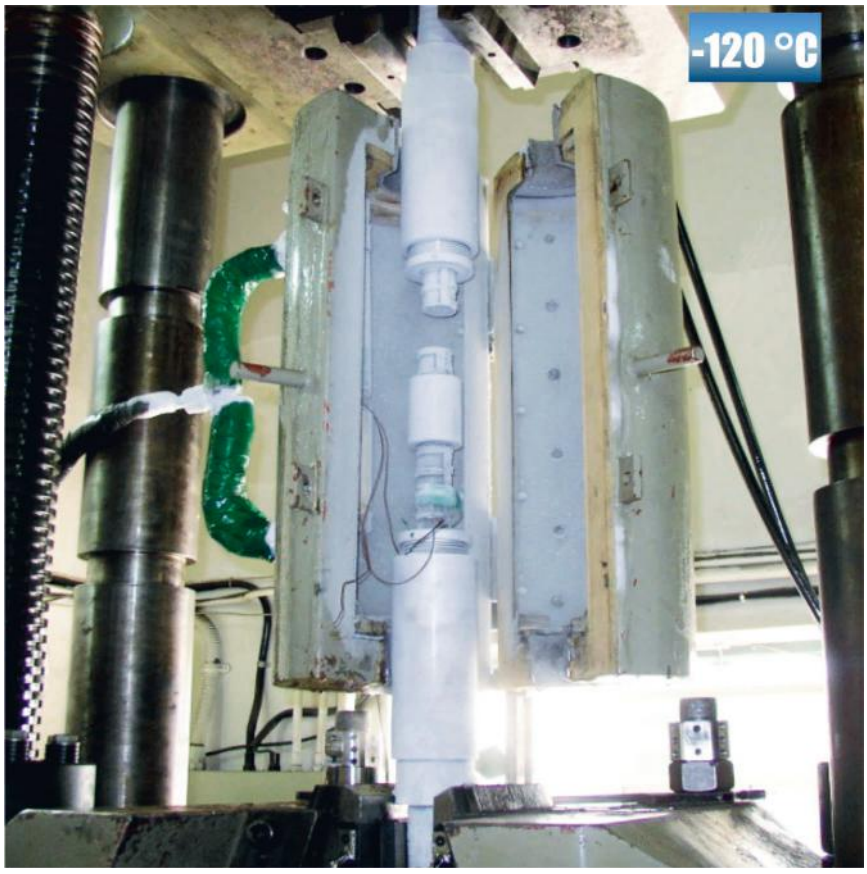
4. General Results

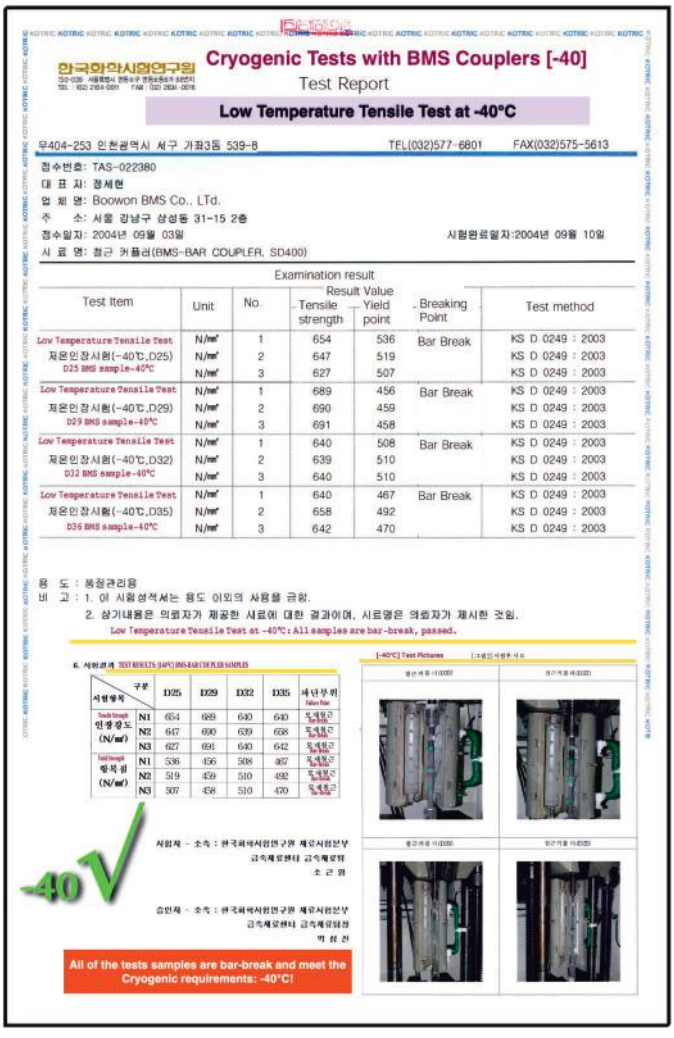
- According to ISO 15698-1, the terminator shall be capable of anchoring $R_{eH,spec}$ (R_m/R_{eH})$_{spec}$ for Category B1 and B2. This limit is equal to 540 MPa for B500B steel grade and TS708 limits. All specimens satisfy these requirements.
- Project Designer assumed that, the terminator shall be capable of anchoring 1,1$R_{eH,spec}$ for Category B1 and B2.
- According to ISO 15698-1, terminator coupler system sustains stages 1 through 3 of the loading programme, given at Section 3 of this report, without failure for Category S. All specimens satisfy these requirements.
- According to ISO 15698-2, the test is terminated upon fracture of the terminator coupler system, crushing of the concrete in the terminator bearing zone or upon reaching the specified number of cycles without fracture for Category S. All specimens satisfy these requirements without fracture.
- All rebar specimens are B500B class. According to TS 708, $R_{e,spec}$ is 500 MPa and minimum $R_{m,test}/R_{eH,test}$ is 1,08. Test results show that all specimens satisfy these requirements.

A PRODUCT OF EXCEPTIONAL PERFORMANCE









한국화학시험연구원

Cryogenic Tests with BMS Couplers [-40]

Test Report

Low Temperature Tensile Test at -40°C

우404-253 인천광역시 서구 가좌3동 539-8 TEL(032)577-6801 FAX(032)575-5613

접수번호: TAS-022380
대 표 자: 정세현
업 체 명: Boowon BMS Co., LTd.
주 소: 서울 강남구 삼성동 31-15 2층
접수일자: 2004년 09월 03일 시험완료일자:2004년 09월 10일
시 료 명: 철근 커플러(BMS-BAR COUPLER, SD400)

Examination result

Test Item	Unit	No.	Result Value Tensile strength	Yield point	Breaking Point	Test method
Low Temperature Tensile Test 저온인장시험(-40℃,D25) D25 BMS sample-40°C	N/㎟	1	654	536	Bar Break	KS D 0249 : 2003
	N/㎟	2	647	519		KS D 0249 : 2003
	N/㎟	3	627	507		KS D 0249 : 2003
Low Temperature Tensile Test 저온인장시험(-40℃,D29) D29 BMS sample-40°C	N/㎟	1	689	456	Bar Break	KS D 0249 : 2003
	N/㎟	2	690	459		KS D 0249 : 2003
	N/㎟	3	691	458		KS D 0249 : 2003
Low Temperature Tensile Test 저온인장시험(-40℃,D32) D32 BMS sample-40°C	N/㎟	1	640	508	Bar Break	KS D 0249 : 2003
	N/㎟	2	639	510		KS D 0249 : 2003
	N/㎟	3	640	510		KS D 0249 : 2003
Low Temperature Tensile Test 저온인장시험(-40℃,D35) D35 BMS sample-40°C	N/㎟	1	640	467	Bar Break	KS D 0249 : 2003
	N/㎟	2	658	492		KS D 0249 : 2003
	N/㎟	3	642	470		KS D 0249 : 2003

용 도 : 품질관리용
비 고 : 1. 이 시험성적서는 용도 이외의 사용을 금함.
2. 상기내용은 의뢰자가 제공한 시료에 대한 결과이며, 시료명은 의뢰자가 제시한 것임.
Low Temperature Tensile Test at -40°C : All samples are bar-break, passed.

구분 / 시험항목		D25	D29	D32	D35	파단부위 Failure Point
Tensile Strength 인장강도 (N/㎟)	N1	654	689	640	640	모재철근 Bar-Break
	N2	647	690	639	658	모재철근 Bar-Break
	N3	627	691	640	642	모재철근 Bar-Break
Yield Strength 항복점 (N/㎟)	N1	536	456	508	467	모재철근 Bar-Break
	N2	519	459	510	492	모재철근 Bar-Break
	N3	507	458	510	470	모재철근 Bar-Break

-40 √

All of the tests samples are bar-break and meet the Cryogenic requirements: -40°C!

한국화학시험연구원

Cryogenic Tests with BMS Couplers [-120]

시 험 성 적 서

TEST REPORT

우404-253 인천광역시 서구 가좌3동 539-8 TEL(032)570-9700 FAX(032)575-5613

Test Report

Low Temperature Tensile Test at -120°C

접수번호: TAS-0022381
대 표 자:
업 체 명: Boowon BMS Co., LTd.
주 소: 충북 충주시 용탄동 590
접수일자: 2004년 09월 03일 시험완료일자:2004년 11월 04일
시 료 명: 상온 스웨이징 나사이음 철근 커플러(BMS-BAR COUPLER)

Examination result

Test Item	Unit	D22	D38	D51	Breaking Point	Test method
Low Temperature Tensile Test 저온인장시험 (-120℃) 인장강도 Tests at: -120°C	N/㎟	564	563	584	모재철근 Bar-break	KS D 0249 : 2003
		583	568	588	모재철근 Bar-break	
		564	568	581	모재철근 Bar-break	

용 도 : 품질관리용
비 고 : 1. 이 시험성적서는 용도 이외의 사용을 금함.
2. 상기내용은 의뢰자가 제공한 시료에 대한 결과이며, 시료명은 의뢰자가 제시한 것임.
Tensile tests at -120°C Temperature: All samples are bar-break-Passed.

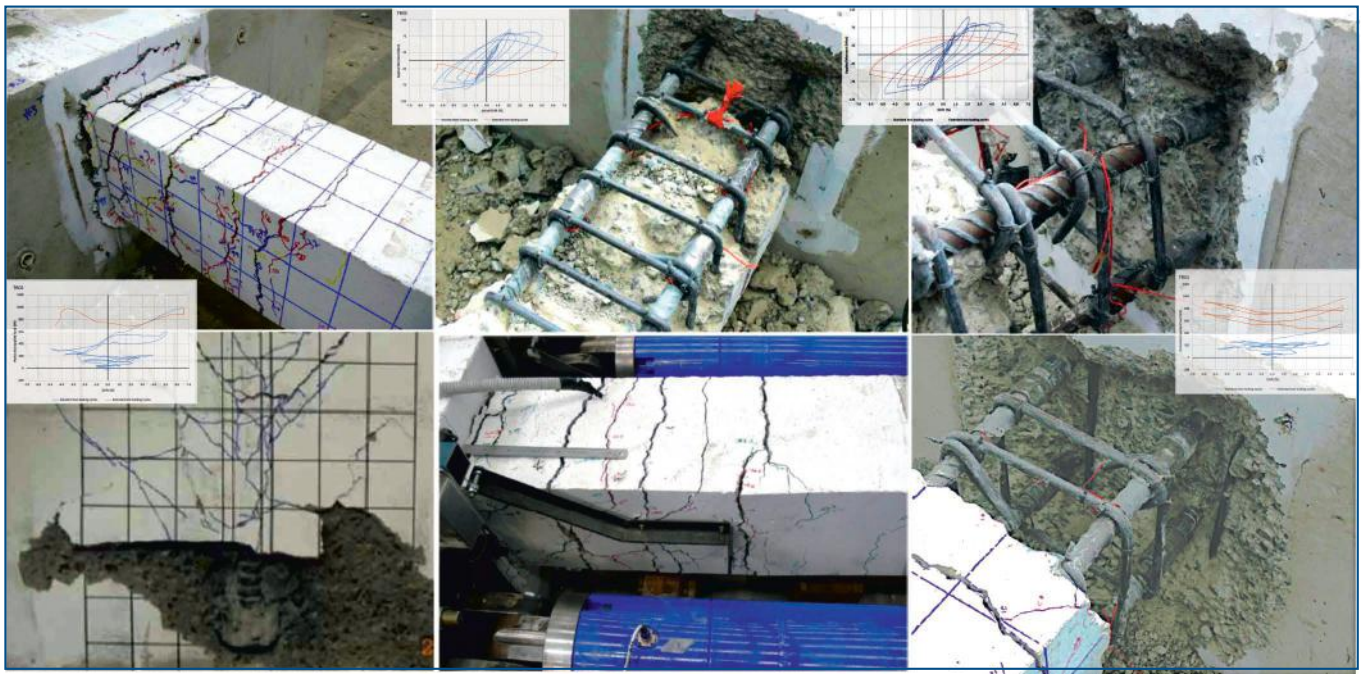
구분 / 시험항목		D22	D38	D51	파단부위 Failure Point
Tensile Strength 인장강도 (N/㎟)	N1	564	563	584	모재 철근 Bar-Break
	N2	583	568	588	모재 철근 Bar-Break
	N3	564	568	581	모재 철근 Bar-Break

Pictures of Cryogenic Test Results [-120°C]

All of the tests samples are bar-break and meet the Cryogenic requirements: -120°C!

-120 √

COUPLER STRONGER THAN REBAR



Analyzing the test results clearly shows the system to be a 'product of **exceptional performance**'

BAR-BREAK BMS COUPLER

Typical Test Results (ISO 15835 1&2, BS 4449, ACI 318, ACI 349, ASTM A970M, GOST 34278-2017, QSC 2014, TS500)

Bar Grade	Nominal Bar Size [Ø mm]	Yield Stress- fy [N/mm²]	Ultimate Stress- fu [N/mm²]	Permanent Elongation-Slip [0.6 x fy-mm]	Fatigue Performance [μ4 ≤0.3 & μ8≤0.6]	Failure Mode
B500B	Ø16	564	647	0,013		Bar Break
B500B	Ø20	565	680	0,047		Bar Break
B500B	Ø32	561	688	0,020	0.185 & 0.264	Bar Break
B460B	Ø40	475	620	0,032	0.2 & 0.3	Bar Break
B500C	Ø25	545	674	0,020	0.162 & 0.240	Bar Break
B500C	Ø32	564	693	0,040	0.228 & 0.287	Bar Break
B500C	Ø40	554	715	0,013	0.180 & 0.210	Bar Break
B420C	Ø25	465	620	0,020		Bar Break
ASTM A615 GR60	Ø32 [#10]		677	25% Elongation		Bar Break
ASTM A706 GR80	Ø32		777	22% Elongation		Bar Break

World-wide References

Qatar's Lusail Towers

Kuwait's Jaber Causeway

Azerbaijan's MOT Tower

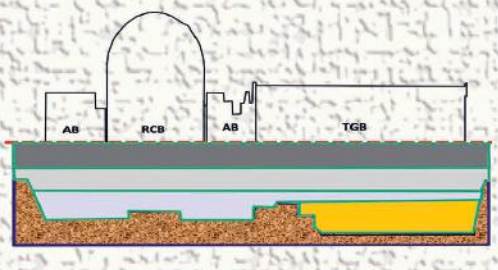
The Tallest !

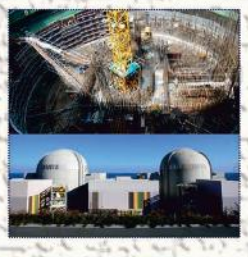
Korea's Longest Bridge

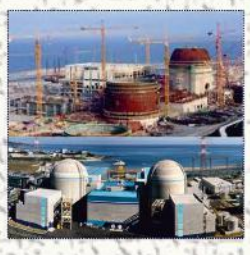
Istanbul's 3rd Bosphorus Bridge

The Longest !

The 5th Tallest !



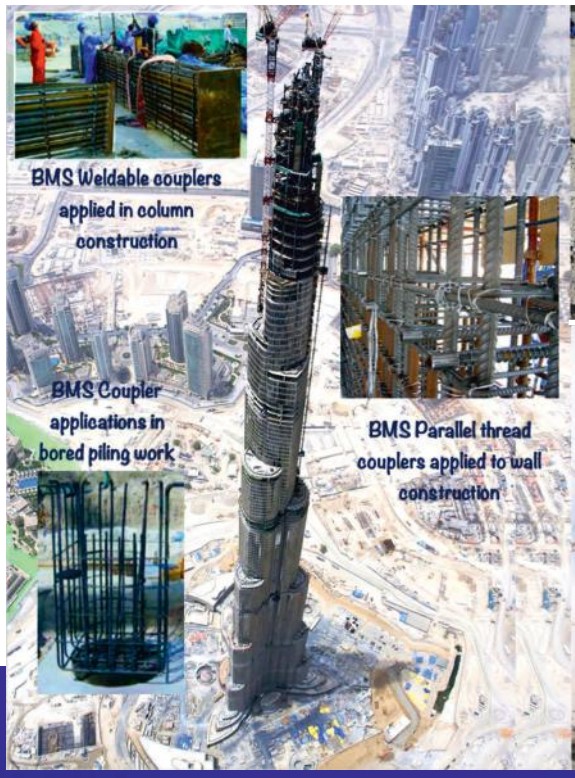




Nuclear Power Plants

THE WORLD'S TALLEST BUILDING !

Burj Khalifa Tower: The World's Tallest!



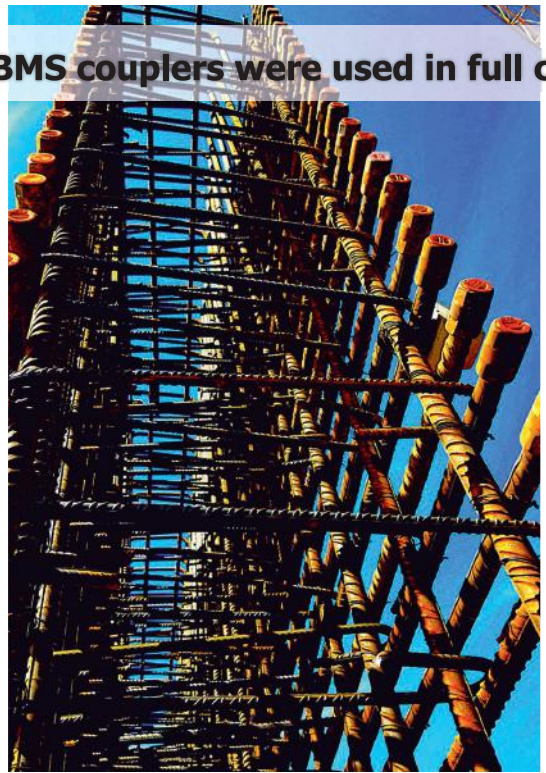
More than 2,5 million BMS mechanical couplers were used in the world's giant project!

BMS weldable couplers were used in column construction.

All re-bar coupled test specimens were bar-break & clear off coupler and grip!

1915 Canakkale Bridge, Türkiye: The World's Longest Suspension Bridge!

The Bridge spans over 2,000 meters between Lapseki and Gallipoli—over the Dardanelles Strait, in North-western Türkiye.

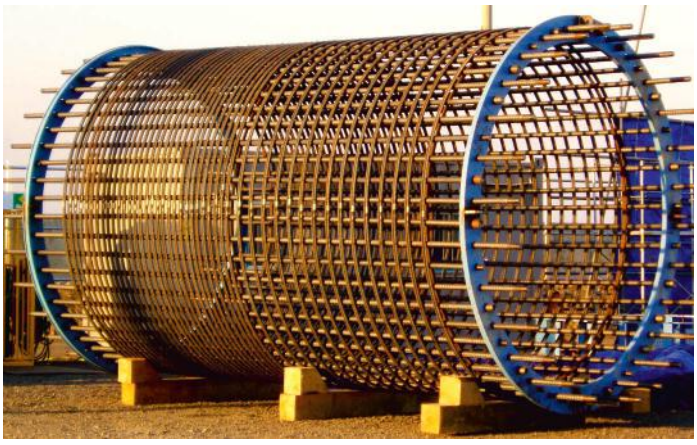


Thousands of BMS couplers were used in full confidence!

MARINA BAY SANDS TOWERS OF SINGAPORE

BMS Couplers were provided to the Singapore's Famous Towers!

LOTTE TOWER, SEOUL-KOREA: The World's 5th Tallest!



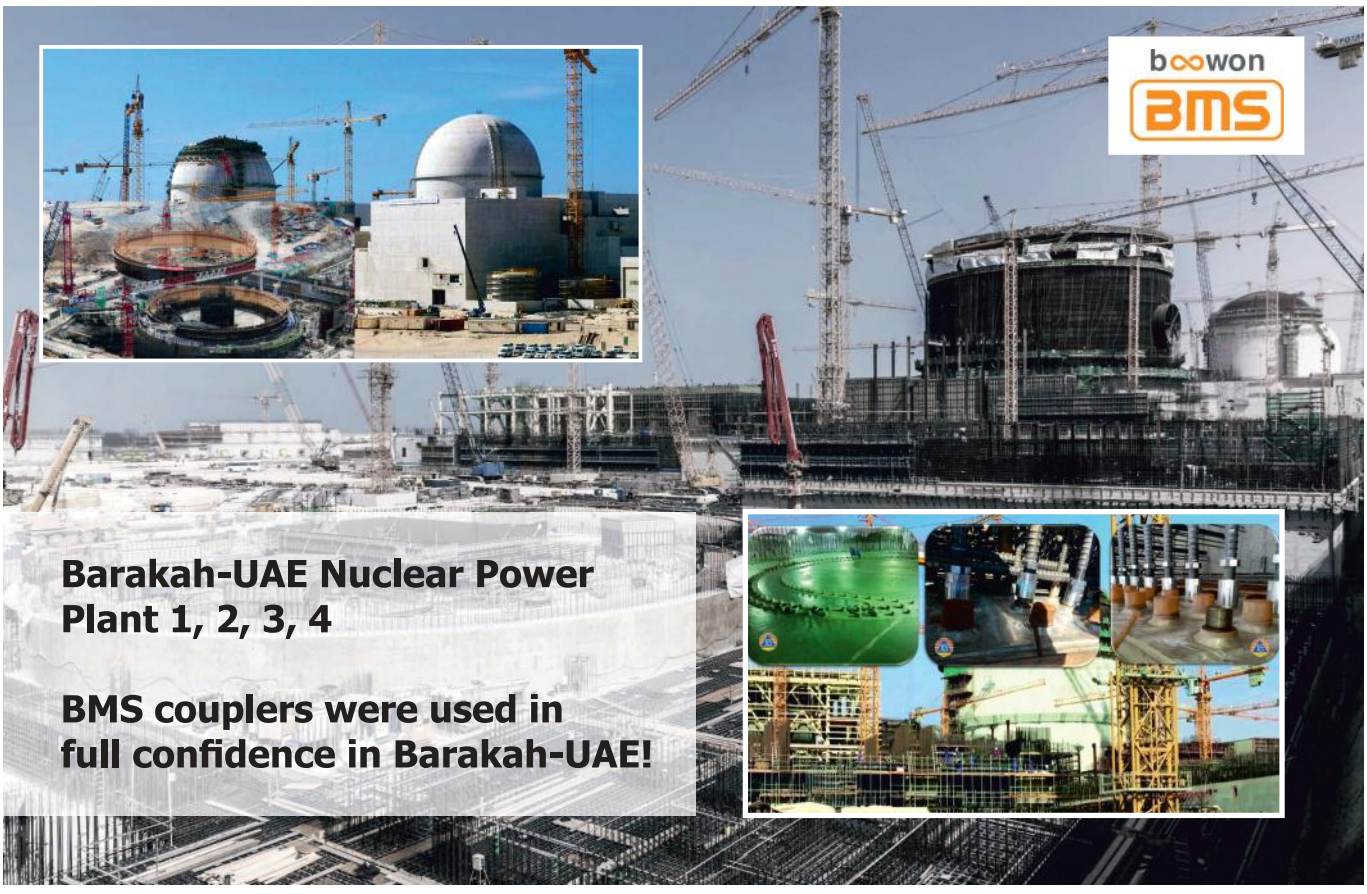
Incheon Bridge, Seoul-Korea: Korea's longest bridge!

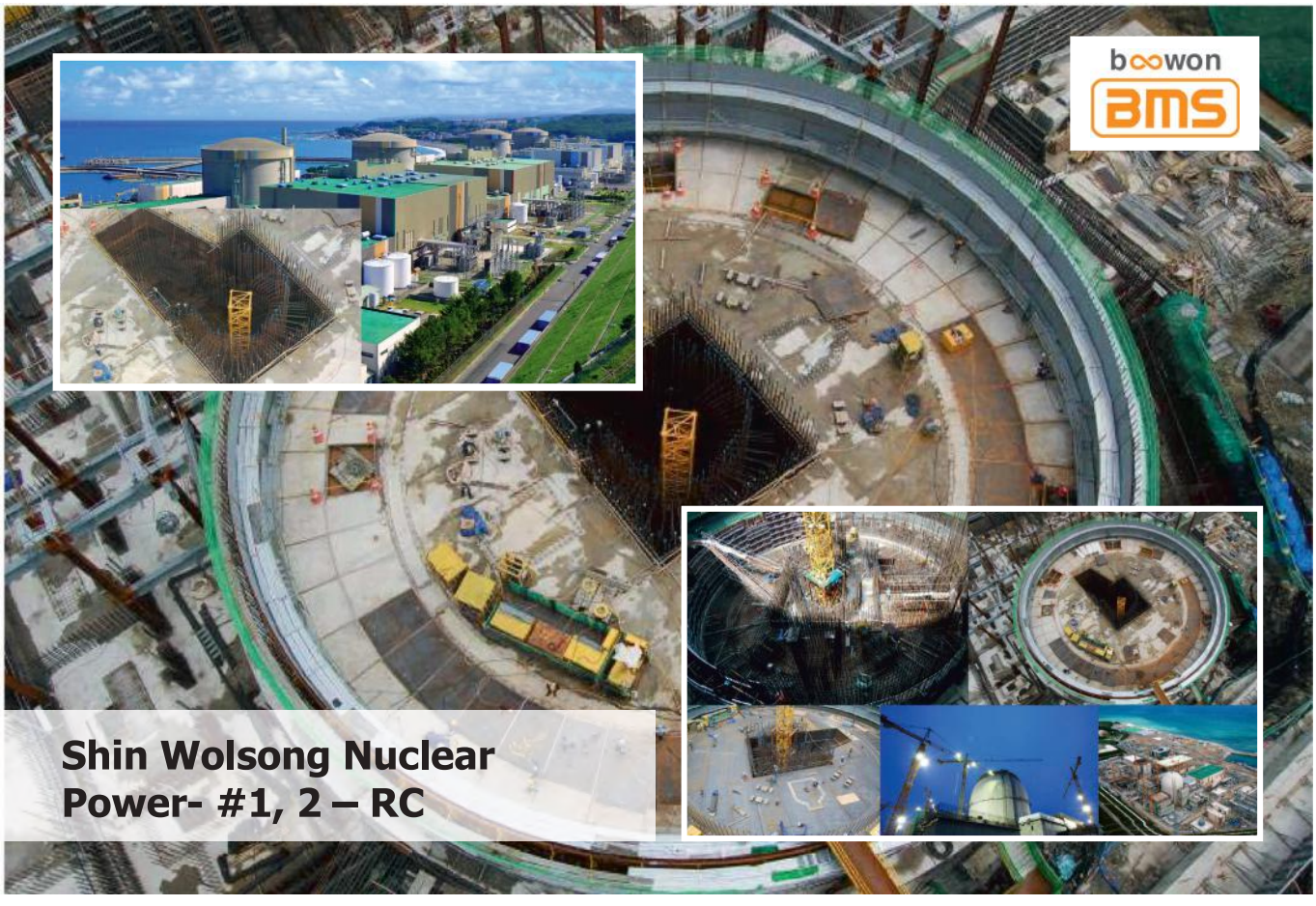
Jaber Causeway, Monumental Structure in Kuwait with BMS couplers!

Sangarm-dong, Seoul, Korea: 2002 World Cup Main Stadium!

Machang Bridge, Korea

NUCLEAR POWER PLANT PROJECTS WITH BMS COUPLERS





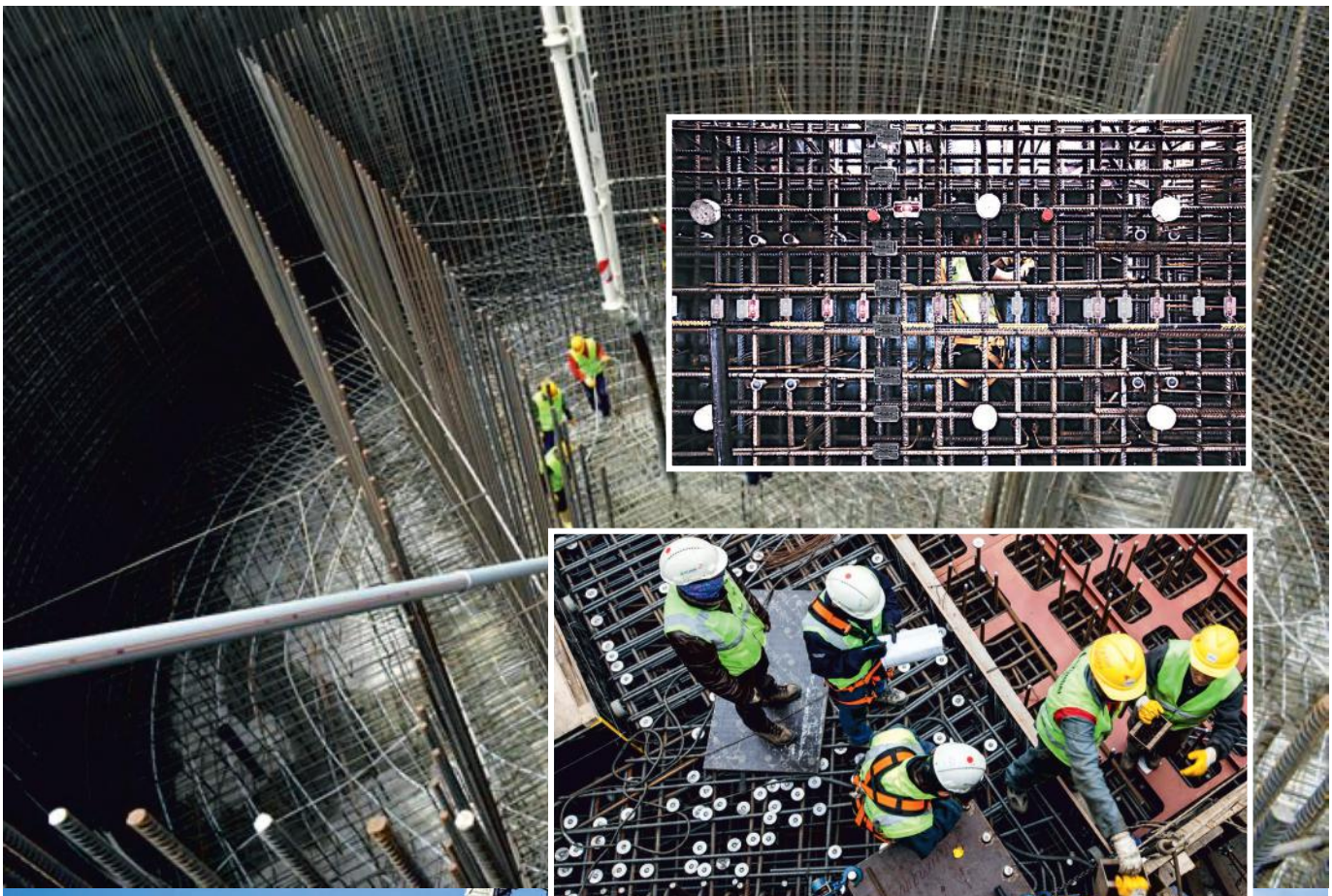

boowon
BMS
Shin Gori Nuclear
Power Plant 3 & 4 - RCB


boowon
BMS
Shin Hanul Nuclear
Power Plant 1 & 2- AB

ISTANBUL'S 3RD BOSPHORUS BRIDGE

The longest reinforced concrete bridge of Türkiye was constructed with BMS mechanical couplers!

More than 300,000 BMS couplers were used!




Nakilat Shipyard, Qatar
boowon
BMS

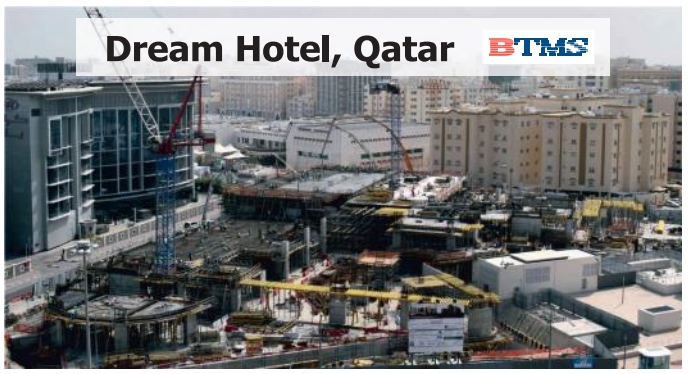

BTMS
Qatara Tower, Qatar

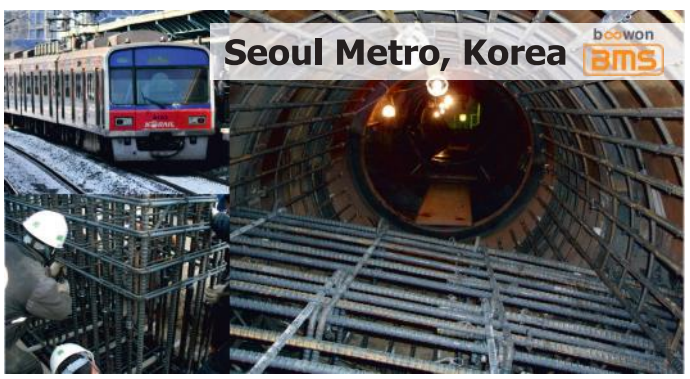

BTMS
Military Hospital, Qatar


Lusail Plaza Towers, Qatar
BTMS


Mushareb Road, Qatar
BTMS

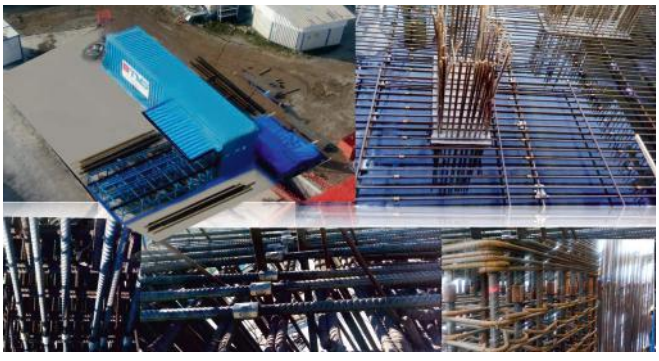

KL 118, Malaysia:
118 Storey-Tower!
boowon
BMS


Dream Hotel, Qatar
BTMS


Seoul Metro, Korea
boowon
BMS

BTMS PROJECTS

Vakıfbank GYO Tower, Istanbul- Türkiye:
High-rise of Vakıfbank in Istanbul's Finance Center uses high strength BMS Couplers supplied by BTMS in full confidence!



TEKFEN MOT Tower, Baku-Azerbaijan:
Ministry of Taxation Tower is built by using high strength BTMS Couplers!

Komurhan Bridge-Malatya/ Türkiye

North Marmara Highway Viaducts- Türkiye

Embassy Project in Ankara / Türkiye

Bomonti Tower Izmir-Türkiye

Baku-Central Bank of Azerbaijan uses BTMS/BMS couplers!

Daewoo E&C_Khor Al Zubair Immersed Tunnel / Iraq

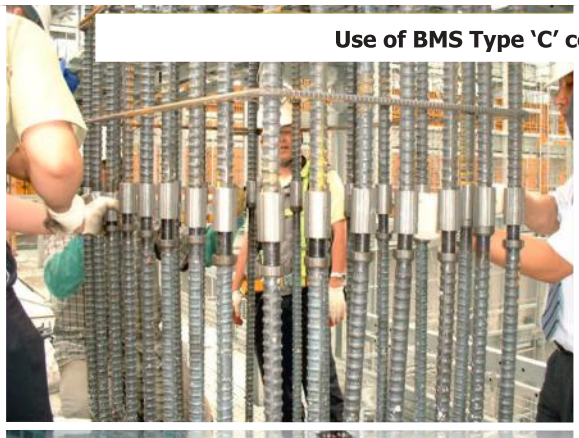
FIELD APPLICATIONS

Construction of prefabricated rebar cage by using BMS couplers

Use of jig for prefabrication of rebar cage

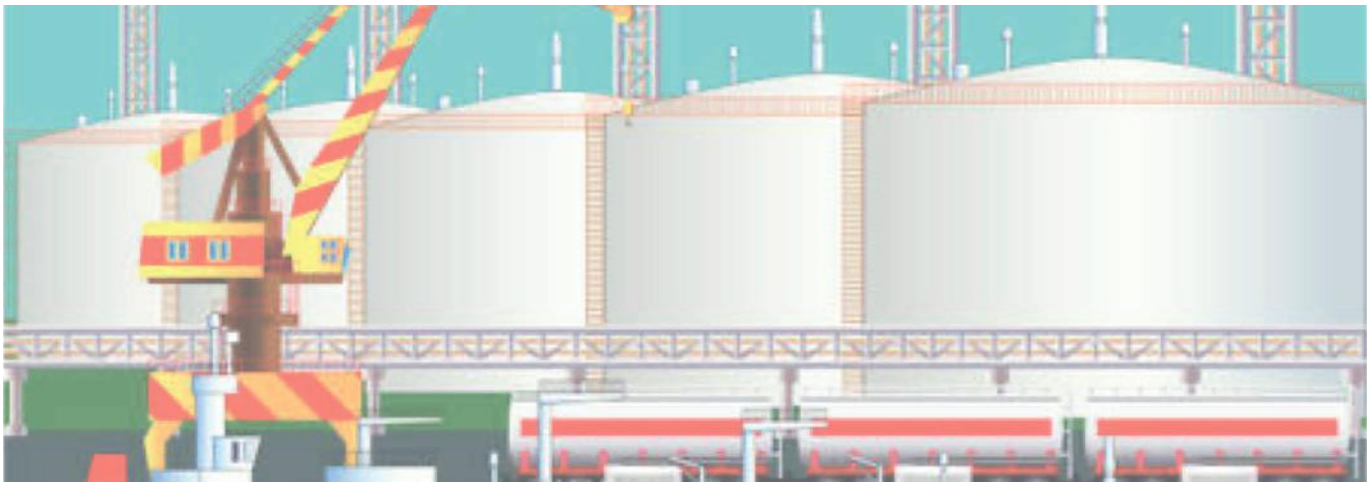
Transportation of reber column cage

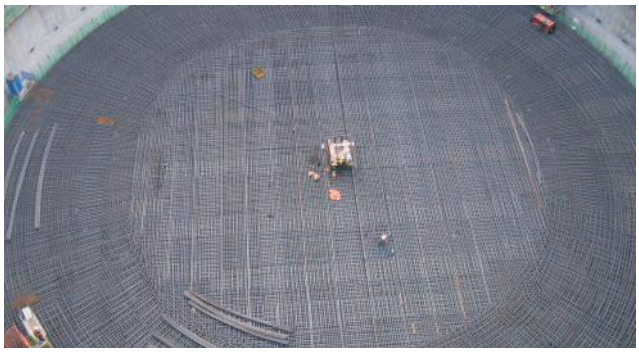
Use of BMS Type 'C' couplers



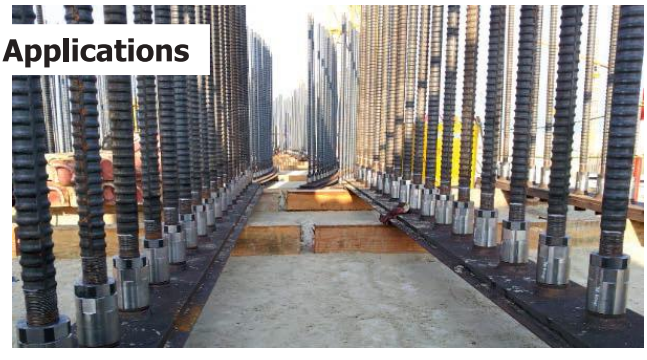
Completion of mounting cages

LNG Tanks BMS Coupler Applications

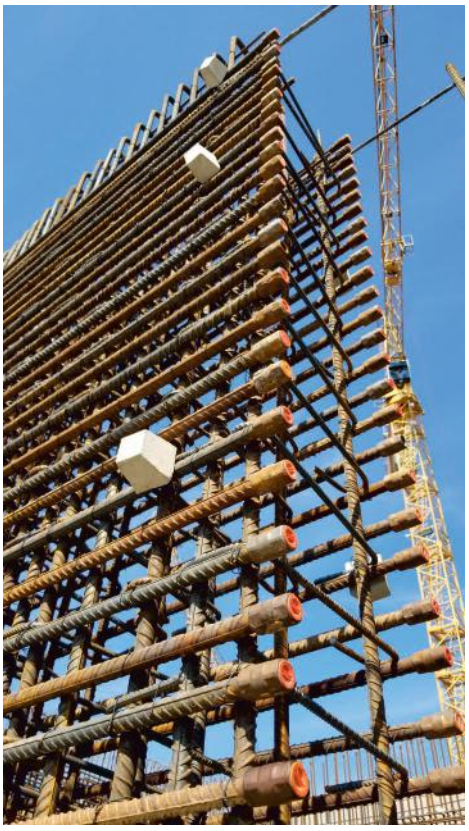


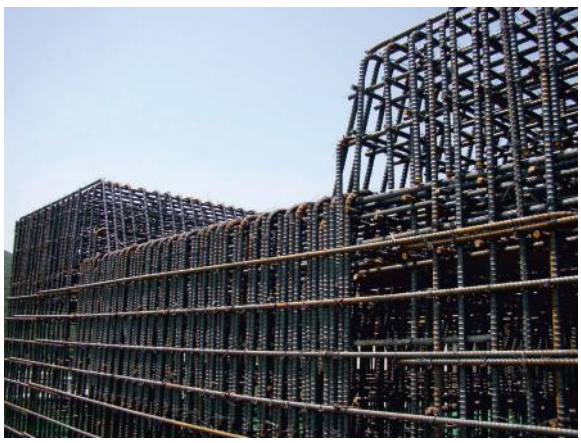


NPP BMS Coupler Applications

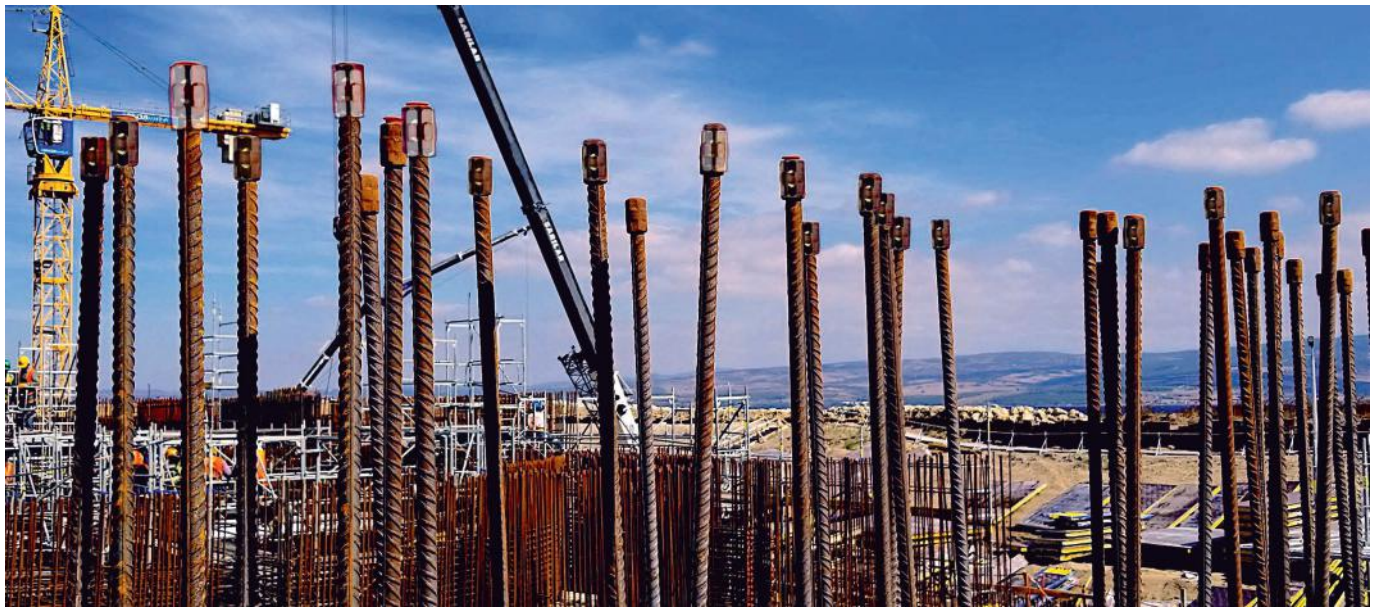


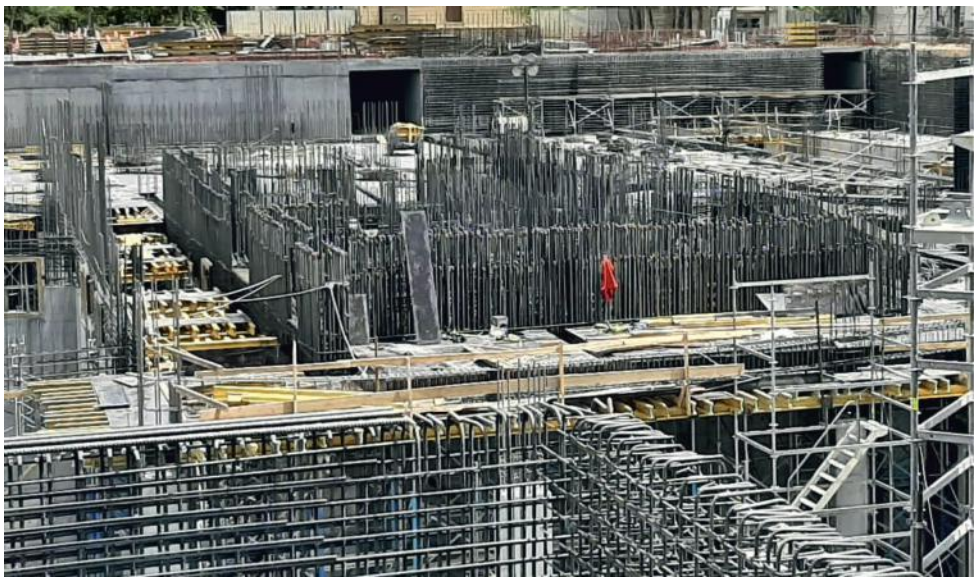
FIELD APPLICATIONS

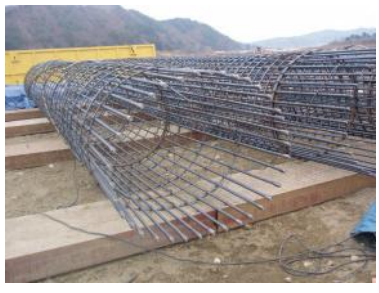




FIELD APPLICATIONS







NUCLEAR POWER PLANT PROJECTS WITH BOOWON BMS COUPLERS

Project	Contractor	Construction Supervision	Size	Capacity	Rebar	Processing
Shin Wolsong Nuclear Power Plant 1 & 2 〔Gyeongju-Korea〕	Daewoo, Samsung	Korea Institute of Nuclear Safety	#18(D57)	1,000,000 KW per each	ASTM A 615 Gr60	Field Processing
Shin Gori Nuclear Power Plant 3 & 4 〔Ulsan-Korea〕	Hyundai, Doosan	Korea Institute of Nuclear Safety	#18(D57)	1,400,000 KW per each	ASTM A 615 Gr60	
Shin Hanul Nuclear Power Plant 1 & 2 〔Uljin-Korea〕	Hyundai	Korea Institute of Nuclear Safety	#18(D57)	1,400,000 KW per each	ASTM A 615 Gr60	
Barakah Nuclear Power Plant 1, 2, 3 & 4 〔U.A.E〕	Hyundai, Samsung	ENEC	#18(D57)	1,400,000 KW per each	ASTM A 615 Gr60	
Nuclear high strength rebar study project	-		#18(D57)		ASTM A 615 Gr80	
Samcheok green power plant 〔Samcheok-Korea〕	GS	Korea Southern Power Co.,Ltd. (KOSPO)	D35 etc	1,000,000 KW per each	SD400	
Dangjin thermal power plant 9&10 〔Dangjin.Korea〕	Hanjin	Korea East-West Power Co.,Ltd. (EWP)	D35 etc	1,000,000 KW per each	SD500	

SKYSCRAPERS PROJECT WITH BOOWON BMS COUPLERS

Project	Contractor	Construction Supervision	Size	Capacity	Rebar	Processing
The Burj Khalifa (Dubai]	Samsung	TURNER Corperation	All	160 storey	-	Field Processing
Worli Mixed Use Project (India)	Samsung	Oberoi Group	All	83/52 storey	-	
Marina Bay Sands (Singapore)	Ssangyong	Hyder	All	57 storey	-	
KL118 (Malaysia)	Samsung	ARUP	All	118 storey	BS B500B	
Haeundae LCT 〔Busan,Korea〕	Posco	Jungang eng.	All	101/85 storey	SD600	Factory Processing
Jamsil Second Lotte World 〔Seoul,Korea〕	Lotte	Seoul city	All	123 storey	SD500, SD600	
IFC Building 〔Yeouido ,Korea〕	GS	Seoul city	All	55 storey	SD500	
Y22 Parkwon 〔Seoul, Korea〕	Samsung	Seoul city	All	72 storey	SD500	
Songdo ATT 〔Incheon,Korea〕	Daewoo	Incheon city	All	68 storey	SD500	
Vakıfbank Towers (Turkey)	RENCONS	Istanbul	All	90 storey	B420C	
MOT Tower (Azerbaijan)	TEKFEN	Baku	All	98 storey	ASTM A615 S420	Field Processing
Central Bank Tower (Azerbaijan)	TEKFEN	Baku	All	37 storey	ASTM A615 S420	
Bomonti Tower (Turkey)	TURKERLER	Izmir	D40	60 storey	B500C	
Qatara Tower (Qatar)		DOHA			QS500B	
Lusail Plaza Towers (Qatar)	HYUNDAI	DOHA	All		QS500B	
Vakıfbank Towers (Turkey)	RENCONS	Istanbul	All	90 storey	B500B	

CIVIL ENGINEERING PROJECTS WITH BOOWON BMS COUPLERS

Project	Contractor	Construction Supervision	Size	Capacity	Rebar	Processing
3rd Bosphorus Bridge Project (Turkey)	Hyundai & SK	Yooshin Eng.Corp.	D40 etc	Cable –stayed bridge & Suspension bridge / 2,164m	B500B	Field Processing
Dardannel-Canakkale Bridge Project (Turkey)	Dealim & SK. & Limak & Yapı Mrkz.	PARSON & TEKFEN	All	Cable –stayed bridge & Suspension bridge / 2,210m	B500C	
Jaber Causeway Project (Kuwait)	Hyundai	SSH	D40 etc	Cable –stayed bridge / 36,140m	ASTM A 706 Gr80	
Komurhan Bridge (Turkey)	GUL Insaat		D32,36,40		B500C	
US Embassy (Turkey)	BL HARBERT	PARSON	All	Emmbassy Building	ASTM A 706 Gr80	
Seohaedaegyo Bridge 〔Gyeonggi, Korea〕	Daelim	Daewoo Eng.	D32 etc	Cable –stayed bridge / 7,310m	SD400	Factory Processing
Yi Sun-sin Bridge 〔yeosu, Korea〕	Daelim	Hankook Eng, Donga Tech. Dvlp.	D32 etc	Suspension bridge / 2,260m	SD500	
Busan~Geoje Fixed Link Structure 〔Busan, Korea〕	Daewoo	Daewoo Enc	D32 etc	Suspension bridge / 8,200m	SD400	
North Marmara Viaducts (Turkey)	LIMAK	YUKSEL	D32		B500C	
ATAKOY Marina Residance	YAPIT		D12-32	Residential Tower	B500C	
Incheon Bridge 〔Incheon,Koreal〕	Samsung	ARUP	D51 etc	Cable –stayed bridge / 18,384m	SD400	
Machang Bridge 〔Changwon, Seoul〕	Hyundai/ Bouygues	Kunhwa Eng.	D51 etc	Cable –stayed bridge /1,700m	SD400	

BOO WON B.M.S CO., LTD.

Head Office : Zip code 06093, 29, Seolleung-ro 116-gil, Gangnam-gu, Seoul, Korea Tel : +822-549-0675 Fax : +822-549-0677
ChungJu factory : Zip code 27327, 165 Chungjusandan 2-ro, Chungju-City, Chungbuk, Korea Tel : +8243-856-6640 Fax : +8243-856-6643

Date : March 27, 2017

LETTER OF APPOINTMENT

We, as ***BOOWON B.M.S Co.,Ltd.***, a company incorporated in South Korea having its principal place of business at 29, Seolleung-ro 116-gil, Gangnam-gu, SEOUL, Seoul 06093, South Korea, hereby, is pleased to certify and confirm the appointment of:

BTMS

BTMSMEKANİKYAPIELEMANLARISANAYİVETİCARETA.Ş.
İbrikdereMah. D-100 Karayolu Cad.No:446, 41255 Kartepe-Kocaeli, Turkey

As our sole Authorized Dealer with all exclusivity rights for the ***Territory of Turkey and Qatar*** for the ***BMS-Rebar Couplers, BMS-Bar Products and Services of***:

(주)부원비엠에스
www.bbms.co.kr

We, hereby, also certify that BOOWONB.M.S Co.,Ltd. will not provide any technical support or issue a guarantee for any BMS product supplied to Turkey or Qatar by any company or institution or person other than BTMSMEKANİKYAPIELEMANLARISANAYİVETİCARETA.Ş..

Sincerely,

Name: Mr. Jeong, Se Hyun
Designation:President
For and Behalf of:BOOWONB.M.S Co., Ltd.

BTMS
COUPLER

BTMS MEKANIK YAPI ELEMANLARI SANAYI VE TICARET A.S.
Head Office : Ibrikdere Mah. D-100 Karayolu Cad. 446 41255 Kartepe - KOCAELI / TURKEY
Office: Serifali Mah. Kizkalesi Sk. 16 34775 Ümraniye - ISTANBUL / TURKEY
Tel. : +90216. 313 96 66 Fax:+90216. 313 71 51
E-mail: tms@tms.tc **Web:** www.btms.tc - www.tms.tc

A PRODUCT OF EXCEPTIONAL PERFORMANCE

Rebar Coupler We Trust

BTMS
COUPLER

TMS GROUP & BOOWON BMS

www.btms.tc +90 216 313 96 66