*NEW-FCI*

# FINE CERAMIC INSERT

## —TECHNICAL DATA—

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# INTRODUCTION

In recent years, there have been in mounting needs for durability of structural objects, and, it has also become more and more strongly required for materials of insert to be prepared for corrosion of concrete structures caused by chloride attacks.

Alumina ceramics, which is the constituent material of the Fine Ceramic Insert (FCI), has important material properties. It is a half of steel in weight, and the hardest material next to diamond and is strongly resistant to acids and alkalis. **"FCI is the insert that does not corrode nor generate causes of salt damages".**

The FCI is very compatible with concrete and due to FCI's constituent materials it does not corrode nor cause corrosion to occur. All of the problems inherent to date inherent with the use of conventional metallic inserts resolved.

In November, 1998, the Japan Institute of Construction Engineering (JICE) awarded a Technical Evaluation Certificate to FCI with regard to "Construction method for hanging scaffoldings for prestressed concrete bridges with uses of fine ceramic Insert".

Since the beginning of its sales, FCI has been continually developed and improved to meet the changing requirements of the construction industry. All FCI products do not allow cement fluids to flow into the threaded area of inserts during concrete placement.

In 2002, the Japan Prestressed Concrete Contractors Association (JPCCA) issued the publication "Guideline for design and application of inserts for outrigger scaffoldings for wheel guards and bridge railings:" The FCI range of products that comply with the requirements of this document were updated at that time..

In April, 2005, JPCCA published "Guideline for Design and Application of Inserts" and the aforesaid 2002 Guideline was discontinued. Upon the occasion of the issue of this new guideline, the technical data for FCI was once again updated.

In July, 2005, the technical data related to the fire resistance of FCI was supplemented.

In October 2008, a new integral type FCI range was introduced. FCI was redesigned with the sleeve and body molded into one part before being fired. All of the new FCI range was tested independently by the Japan Testing Centre for Construction Materials (JTCCM). Testing of types and lengths, M12 x 60 and M16 x 65, 75, 85 was conducted. Results of the pull out tests of the embedded inserts confirmed that new one piece integral FCI type had the same or equivalent strength compared to those of previous two part types. Also for larger sizes such as M20, M22 and M24, the integral type of FCI has been developed to meet variety of needs.

We would like to recommend the use of FCI to all of our customers.

# *CONTENTS*

## *Specifications of Materiuals*

### (1) FCI Body

Alumina sintered body with purity of 96%

Table 1: Mechanical property of Alumina sintered body

| Item | Unit | Value |
|---|---|---|
| Hardness | k N | 12.7 |
| Flexural Strength | N/mm$^2$ | 398 |
| Compressive Strength | N/mm$^2$ | 2160 |
| Young Modulus | N/mm$^2$ | $3.17 \times 10^7$ |
| Poisson Ratio | — | 0.227 |
| Unit weight/volume | g/cm$^3$ | 3.8 |

### (2) Size and shape of FCI (Integral type)

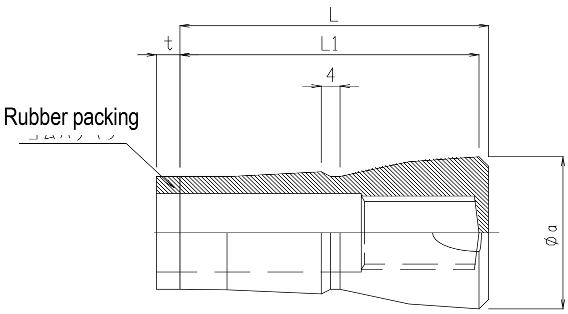
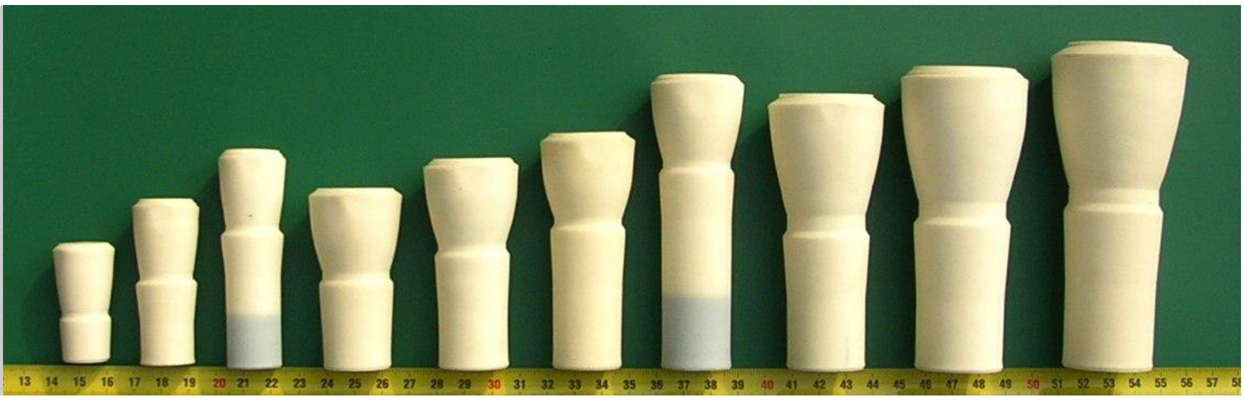



Fig. 1 Shape of integral typed FCI

Table2. Dimensional Table for FCI of integral type

| Naming | L | L1 | φa | t | Remarks |
|---|---|---|---|---|---|
| M10N×43 | 43.0 | 41.0 | 22 | 1.0 | |
| M12N×60 | 59.5 | 57.5 | 24 | 1.5 | |
| M12N×C84 | 79.0 | 77.0 | 24 | 5.0 | For PCCA |
| M16N×65 | 65.5 | 63.5 | 33 | 2.0 | |
| M16N×75 | 75.5 | 73.5 | 33 | 2.0 | |
| M16N×85 | 85.5 | 83.5 | 33 | 2.0 | |
| M16N×C111 | 106 | 104 | 33 | 5.0 | For PCCA |
| M20N×100 | 100 | 97 | 42 | 2.0 | |
| M20N×120 | 120 | 117 | 42 | 2.0 | |
| M22N×110 | 110 | 106 | 45 | 2.0 | |
| M22N×130 | 130 | 126 | 45 | 2.0 | |
| M24N×120 | 120 | 116 | 50 | 2.0 | |
| M24N×140 | 140 | 136 | 50 | 2.0 | |

Pic. 1: FCIs in integral type



M10 M12 M16 M20 M22 M24

## *Strength Property of FCI*

### (1) Strength of threads

The table 3 shows the result of shearing test on threads.

Table 3. Result of thread shearing test (6 laps or 9 laps for M20 and bigger)

| Size | Concrete strength N/mm² | Ave. Breaking Load kN | Standard Value kN |
|---|---|---|---|
| M10 | 48.1 | 45.4 | 34.2 |
| M12 | | 70.7 | 51.4 |
| M16 | | 120 | 95.8 |
| M20 | | 210 | 154.4 |
| M22 | | 289.0 | 190.9 |
| M24 | | 342.6 | 222.4 |

(Note) 1. Standard: Rank 5/strength classification of steel nut (JIS B 1052)

For using FCI, it is recommended to keep the loads and torques in range within the guaranteed values as per the Table 4

Table 4. Mechanical Property for FCI in main body

| Size | Bolt As(mm2) | Guaranteed thread shearing load (kN) | Guaranteed clamping torque (kN・mm) | Remarks |
|---|---|---|---|---|
| M10 | 58 | 13.9 | 27.8 | Yield load = 240N/mm for the bolt of Rank 4.6 under the classification of strength |
| M12 | 84.3 | 20.2 | 48.5 | |
| M16 | 157 | 37.7 | 120.6 | |
| M20 | 245 | 58.8 | 235.2 | |
| M22 | 303 | 72.7 | 319.8 | |
| M24 | 353 | 84.7 | 406.5 | |

Notes:

1. Guaranteed thread shearing load = Yield load x As
2. Guaranteed clamping torque = k・D・kN, calculated basing on torque coefficient k = 0.2
3. Rupture probability will be less than $10^{-3}$% against the above guaranteed thread shearing load

### (2) Pull-out Tension

Pull-out tension for FCI to be determined by conical breaking of concrete shall be calculated in accordance with the design formula for various anchor bolts provided in “Indication and its exposition for designing various comprehensive structures” by Architectural Institute of Japan.

$$Pt = \sqrt{\sigma c \times 10.2} \times \pi \times L \times (L + D) \times 0.098$$

Pt: Pull-out tension

δc: Standard strength of concrete for design (N/mm2)

L: Inserting depth of FCI

D: Outer diameter of FCI (mm)

Fig. 2 on the next page shows the values calculated by the above formula and results of a pull-out test, which represent the correlation between concrete strength and pull-out tension.

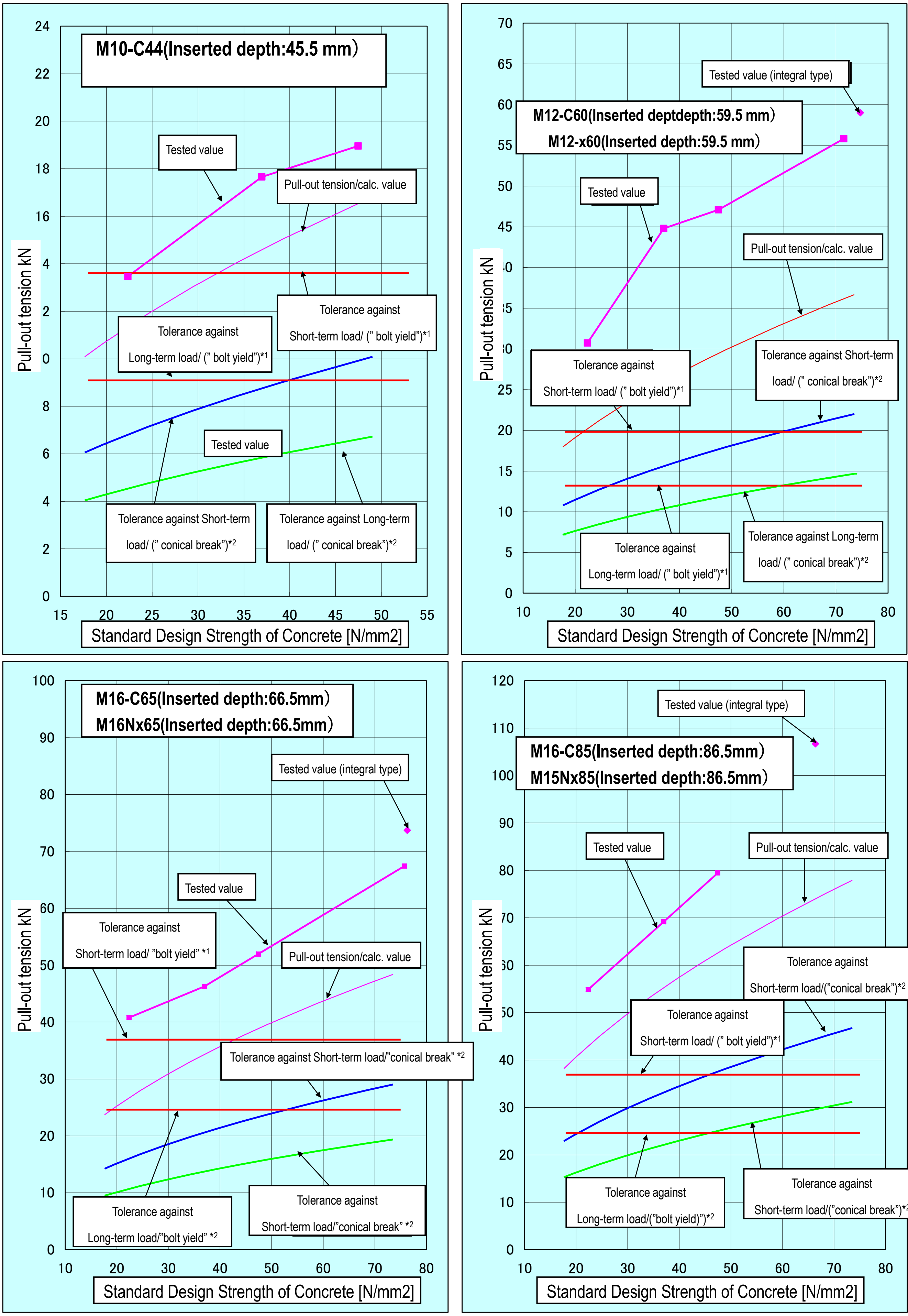



Fig.2: Correlation between strength of concrete and pull out tension of FCI

Notes 1*, 2*: Strength measured by yield point of bolts for 1*, and conical break of concrete for 2*

（3） **Shearing Strength**

Results of a test conducted by using FCI of M12 are shown hereafter.

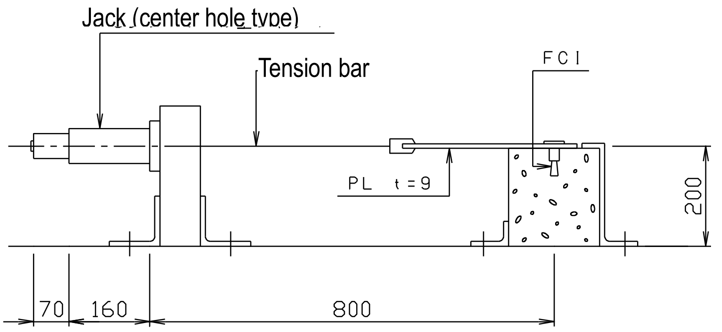



Fig.3: Method of shear test

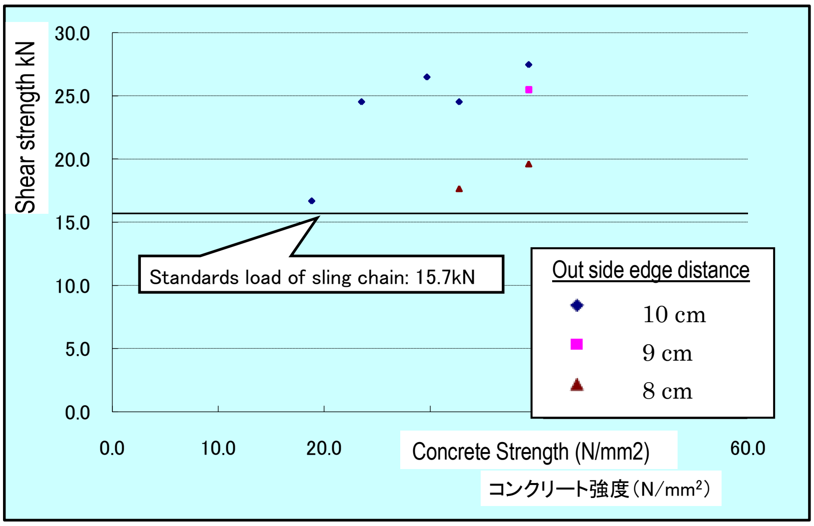



Fig.4: Results of shear test

（4） **Fatigue Strength**

Results of a fatigue test conducted by using FCI of M12 are shown hereunder.

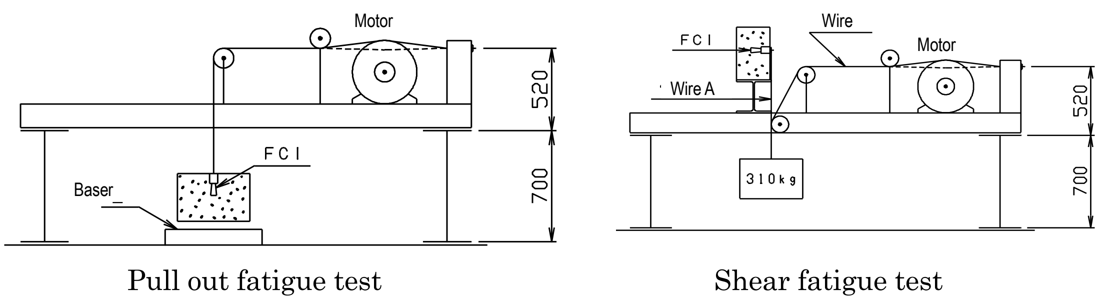



Fig.5: Method of shear test

Table 5: Results of fatigue tests

| | Load (N) | Concrete strength (N/mm²) | Tested cycles | Observation of FCI |
|---|---|---|---|---|
| Pull out | 3040 | 36.6 | 50820 | normal |
| | | | 50630 | normal |
| | | | 50325 | normal |
| Shear | 3040 | 36.6 | 52174 | normal |
| | | | 50380 | normal |

## *Salt and Alkali Resistances of FCI*

FCI has been tested to assess the resistance of the product to salts and alkalis. In accordance with the technical evaluation certificate, "Construction methods for hanging scaffoldings of prestressed concrete with application of fine ceramic insert" issued by Japan Institute of Construction Engineering (JICE) in November, 1988), it is confirmed that these elements pose no problems for FCI.

（1） **Salt Resistance**

Result for the resistance of FCI after being dipped in brine with 5% of salt contents for 500 and 1,000 hours respectively.

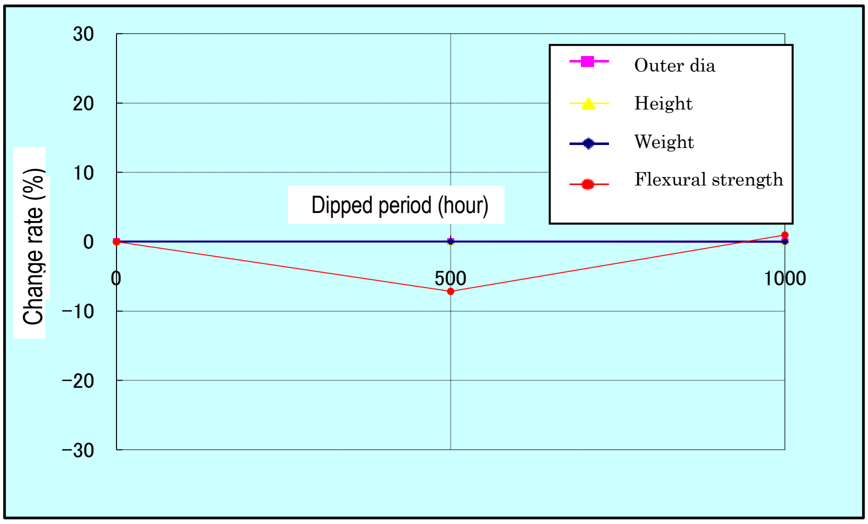



Fig.6: Test results confirming salt resistance performance

（2） **Alkali Resistance**

Result for the resistance of FCI after being dipped in an alkali solution (PH=13) for 500 and 1,000 hours respectively.

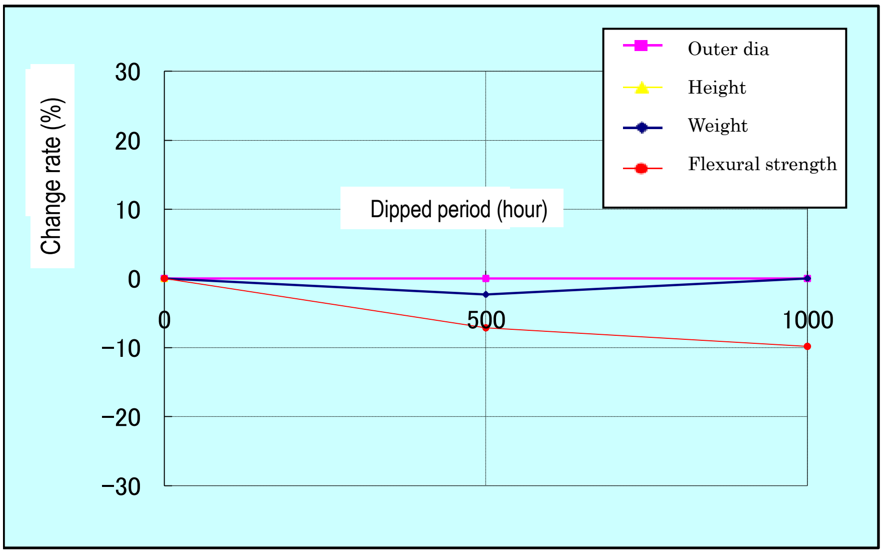



Fig.7: Test results confirming alkali resistance performance

## *Fire Resistance of FCI*

Due to its high purity alumina system ceramics material, FCI has a very high fire resistance performance. For the M16 Type of FCI, the following are the results of a thread shear test which was conducted after the FCI was kept in a furnace for 60 minutes at a temperature of 1,200℃, by which, it can be confirmed that FCI after heating is similar in shearing strength to the one before heating .

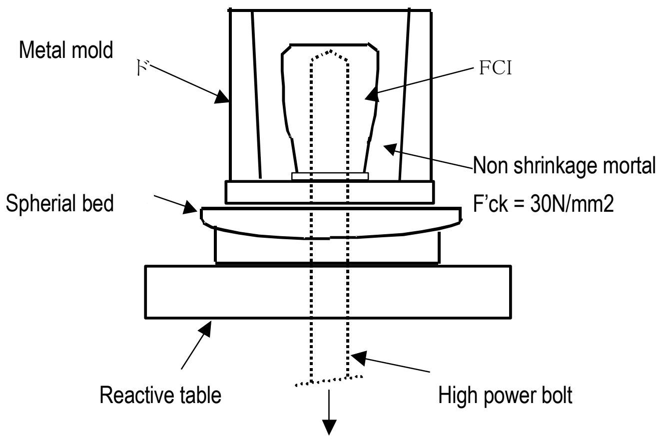



Fig.8: Method for Thread shear strength

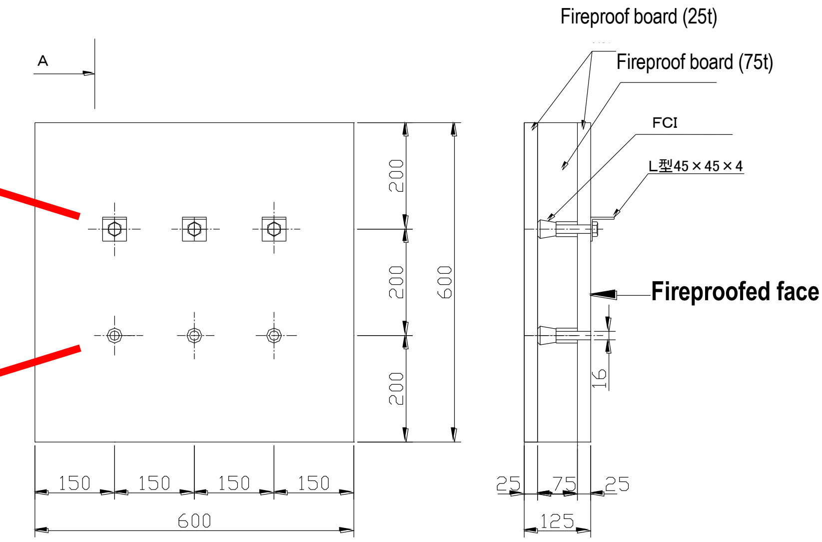
Table 6. Fire resistive performance of FCI/M16

| | Thread shear strength (kN) |
|---|---|
| Before heating | 136 |
| After heating (1200℃, 60min) | 130 |
| Standard value | 95.4 |

Also, shown below are the results of a test to heat up FCI of M16 (for 60 min. at 1200℃) fixed on a fire proof board of 600mm(W) x 600mm(L) x 125mm(t). There were no changes seen in FCI after heating up.

Pic.2: With metal

Pic.3: Without metal




**Lay-out of FCI set on fire proof board**

View from the side of A

Pic.4: After heated (with metal)

Pic.5: After heated (without metal)

## *Designing Method for FCI*

The design for FCI inserts to be inserted in concrete can be made in accordance with section 4.1 of "Design of Anchor Bolt having heads" under paragraph 4.; "Design of Anchor Bolt in Various Types" in "Guideline and its Exposition for Design of Various Comprehensive Structures" issued by the Architectural Institute of Japan.

### (1) The Cases of Pull-out Tension Loaded

$$Pa1 = \phi1 \cdot \sqrt{f'ck \times 10.2} \cdot \pi \cdot L \cdot (L + D) \times 0.098$$
$$Pa2 = \phi2 \cdot fsy \cdot As$$

Pa1: Pull-out tension (N) per a piece of FCI for the case of the value determined basing on conular breakage of concrete.
Pa2: Pull-out tension (N) per a piece of FCI for the case of the value determined basing on yield load of bolt.
$\phi$1, $\phi$2: Reduction coefficients using the values of the Table 1
L: Inserting depth of FCI (mm)
D: Outer diameter of ECI (mm)
Fsy: Yield point of fixing bolts
*As*: The smaller value (mm) between the section area for the threaded parts and other parts of fixing bolt

Table 7: Reduction Coefficients

| | $\phi$1 | $\phi$2 |
|---|---|---|
| For Long term load | 0.4 | 2/3 |
| For Short term load | 0.6 | 1.0 |
| For JPCCA [1)] | 1/3 | 2/3 |

1) For JPCCA, design shall be based on Pa2 which is determined basing on the yield load of fixing bolt

For the case of the standard FCI applied, pull-out tensions composing to each concrete of design standard strength, f'ck=24, 27, 30, 40, 50, 60 N/mm² are shown in the Table 8.

Table 8: Pull-out Tension of FCI (Integral type)

$$Pa1 = \varphi 1 \cdot \sqrt{(Fck \cdot 10.2)} \cdot 3.14 \cdot L \cdot (L+D) \cdot 0.098$$

For Architectural Long Term Loads — Long term φ 1 = 0.4

| FCI Size | Inserting Depth L(mm) | Outer Dia D(mm) | Pull-out tension agaist concrete strength Pa1 (KN) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 24 | 27 | 30 | 40 | 50 | 60 |
| M10N×43 | 41 | 22 | 5.0 | 5.3 | 5.6 | 6.4 | 7.2 | 7.9 |
| M12N×60 | 57 | 24 | 8.9 | 9.4 | 9.9 | 11.5 | 12.8 | 14.1 |
| M12N×C84 | 80 | 24 | 16.0 | 17.0 | 17.9 | 20.7 | 23.1 | 25.3 |
| M16N×65 | 63 | 33 | 11.6 | 12.4 | 13.0 | 15.0 | 16.8 | 18.4 |
| M16N×75 | 73 | 33 | 14.9 | 15.8 | 16.7 | 19.2 | 21.5 | 23.6 |
| M16N×85 | 83 | 33 | 18.5 | 19.7 | 20.7 | 23.9 | 26.8 | 29.3 |
| M16N×C111 | 107 | 33 | 28.8 | 30.6 | 32.3 | 37.2 | 41.6 | 45.6 |
| M20N×100 | 97 | 42 | 26.0 | 27.5 | 29.0 | 33.5 | 37.5 | 41.1 |
| M20N×120 | 117 | 42 | 35.8 | 38.0 | 40.1 | 46.3 | 51.7 | 56.6 |
| M22N×110 | 106 | 45 | 30.8 | 32.7 | 34.5 | 39.8 | 44.5 | 48.7 |
| M22N×130 | 126 | 45 | 41.5 | 44.0 | 46.4 | 53.6 | 59.9 | 65.6 |
| M24N×120 | 116 | 50 | 37.1 | 39.3 | 41.5 | 47.9 | 53.5 | 58.6 |

| For Architectural Short Term Loads | | | | | | Short term φ 1＝ | 0.4 | |
|---|---|---|---|---|---|---|---|---|
| FCI Size | Inserting Depth L(mm) | Outer Dia D(mm) | Pull-out tension against concrete strength Pa1 (KN) | | | | | |
| | | | 24 | 27 | 30 | 40 | 50 | 60 |
| M10×45 | 41 | 22 | 4.97 | 5.28 | 5.56 | 6.42 | 7.18 | 7.87 |
| M12×60 | 57 | 24 | 8.89 | 9.43 | 9.94 | 11.48 | 12.83 | 14.06 |
| M12×79 | 80 | 24 | 16.02 | 16.99 | 17.91 | 20.69 | 23.13 | 25.33 |
| M16×65 | 63 | 33 | 11.65 | 12.35 | 13.02 | 15.04 | 16.81 | 18.42 |
| M16×75 | 73 | 33 | 14.90 | 15.81 | 16.66 | 19.24 | 21.51 | 23.56 |
| M16×85 | 83 | 33 | 18.54 | 19.67 | 20.73 | 23.94 | 26.76 | 29.32 |
| M16×106 | 107 | 33 | 28.85 | 30.60 | 32.25 | 37.24 | 41.64 | 45.61 |
| M20×100 | 97 | 42 | 25.97 | 27.54 | 29.03 | 33.52 | 37.48 | 41.06 |
| M20×120 | 117 | 42 | 35.83 | 38.00 | 40.06 | 46.25 | 51.71 | 56.65 |
| M22×110 | 106 | 45 | 30.83 | 32.69 | 34.46 | 39.80 | 44.49 | 48.74 |
| M22×130 | 126 | 45 | 41.49 | 44.01 | 46.39 | 53.57 | 59.89 | 65.61 |
| M24×120 | 116 | 50 | 37.08 | 39.33 | 41.46 | 47.88 | 53.53 | 58.64 |

| For Civil Engineerins (PCCA specifications) | | | | | | | φ 1＝ | 1/3 |
|---|---|---|---|---|---|---|---|---|
| FCI Size | Inserting Depth L(mm) | Outer Dia D(mm) | Pull-out tension against concrete strength Pa1 (KN) | | | | | |
| | | | 24 | 27 | 30 | 40 | 50 | 60 |
| M10N×43 | 41 | 22 | 4.1 | 4.4 | 4.6 | 5.3 | 6.0 | 6.5 |
| M12N×60 | 57 | 24 | 7.4 | 7.9 | 8.3 | 9.6 | 10.7 | 11.7 |
| M12N×C84 | 80 | 24 | 13.3 | **14.1** | **14.9** | **17.2** | **19.3** | **21.1** |
| M16N×65 | 63 | 33 | 9.7 | 10.3 | 10.8 | 12.5 | 14.0 | 15.3 |
| M16N×75 | 73 | 33 | 12.4 | 13.2 | 13.9 | 16.0 | 17.9 | 19.6 |
| M16N×85 | 83 | 33 | 15.4 | 16.4 | 17.3 | 19.9 | 22.3 | 24.4 |
| M16N×C111 | 107 | 33 | 24.0 | **25.5** | **26.9** | **31.0** | **34.7** | **38.0** |
| M20N×100 | 97 | 42 | 21.6 | 22.9 | 24.2 | 27.9 | 31.2 | 34.2 |
| M20N×120 | 117 | 42 | 29.8 | 31.6 | 33.3 | 38.5 | **43.0** | **47.2** |
| M22N×110 | 106 | 45 | 25.7 | 27.2 | 28.7 | 33.1 | 37.0 | 40.6 |

Bearing Strength of Fixing Bolt

| Pa2=φ 2・fys・As | | | | | | Steel Nut |
|---|---|---|---|---|---|---|
| Bolt Size | Efffective section area As($mm^2$) | Yield strength fys N/$mm^2$ | Tensile yeild load KN | L/T*φ 2 2/3 KN | S/T**φ 2 1 KN | Guaranteed load on thread KN |
| M10 | 58.0 | 240 | 13.9 | 9.3 | 13.9 | 34.2 |
| M12 | 84.3 | | 20.2 | 13.5 | 20.2 | 51.4 |
| M16 | 157.0 | | 37.7 | 25.1 | 37.7 | 95.8 |
| M20 | 245.0 | | 58.8 | 39.2 | 58.8 | 154.4 |
| M22 | 303.0 | | 72.7 | 48.5 | 72.7 | 190.9 |
| M24 | 353.0 | | 84.7 | 56.5 | 84.7 | 222.4 |

Note: * L/T = Long term, S/T = Short term

Strength classification for JIS B 1052, Steel Nut >5

## (2) The Cases of Shearing Strength Loaded

$$Qa = \phi \cdot (0.5 \cdot As \cdot \sqrt{f'ck \cdot Ec})$$

Qa: Shearing strength per a piece of FCI (N)

$\phi$ : Reduction coefficient assumed to be 0.4 and 0.6 for long/short term load respectively

f'ck: Design standard strength of concrete (N/mm2)

*As* : The smaller value (mm) between the section area for the threaded parts and other parts of fixing bolt

Fc: Young modulus for concrete

Table 9: Shearing Strength of FCI (Integral type)

| For Long Term Loads | | | | | Long termφ ＝ | 0.4 | |
|---|---|---|---|---|---|---|---|
| Size | Threads section area As(mm²) | Shearing strength aginst concrete strength Qa(KN) | | | | | |
| | | 24 | 27 | 30 | 40 | 50 | 60 |
| Young modulus Ec(KN/ | | 25 | 26.5 | 28 | 31 | 33 | 35 |
| M10 | 58.0 | 9.0 | 9.8 | 10.6 | 12.9 | 14.9 | 16.8 |
| M12 | 84.3 | 13.1 | 14.3 | 15.5 | 18.8 | 21.7 | 24.4 |
| M16 | 157 | 24.3 | 26.6 | 28.8 | 35.0 | 40.3 | 45.5 |
| M20 | 245 | 38.0 | 41.4 | 44.9 | 54.6 | 62.9 | 71.0 |
| M22 | 303 | 46.9 | 51.3 | 55.5 | 67.5 | 77.8 | 87.8 |
| M24 | 353 | 54.7 | 59.7 | 64.7 | 78.6 | 90.7 | 102.3 |

| For Shot Term Loads | | | | | Shot termφ ＝ | 0.6 | |
|---|---|---|---|---|---|---|---|
| Size | Threads section area As(mm²) | Shearing Strength against concrete strength Qa (KN) | | | | | |
| | | 24 | 27 | 30 | 40 | 50 | 60 |
| ﾔﾝｸﾞ係数Ec(KN/mm²) | | 25 | 26.5 | 28 | 31 | 33 | 35 |
| M10 | 58.0 | 13.5 | 14.7 | 15.9 | 19.4 | 22.4 | 25.2 |
| M12 | 84.3 | 19.6 | 21.4 | 23.2 | 28.2 | 32.5 | 36.6 |
| M16 | 157 | 36.5 | 39.8 | 43.2 | 52.4 | 60.5 | 68.3 |
| M20 | 245 | 56.9 | 62.2 | 67.4 | 81.8 | 94.4 | 106.5 |
| M22 | 303 | 70.4 | 76.9 | 83.3 | 101.2 | 116.8 | 131.7 |
| M24 | 353 | 82.0 | 89.6 | 97.1 | 117.9 | 136.0 | 153.5 |

### (3) The Cases of the Combined Pull-out Tension and Shearing Strength Loaded

In the case that the pull-out tension occurs at an angle to the FCI, it is necessary in the design process to provide sufficient insertion depth. Consideration must be given to all factors affected by the shearing load and the fixing bolt in addition to pull-out tension. According to "Guidance and its exposition for designing various comprehensive structures" (by Japan Institute of Architecture), it is described under Paragraph 4, "Design works for anchor bolts in various type" that there is a formula hereunder available for calculation of ultimate bearing forces for the case that both pull-out tension and shearing strength are loaded on anchor bolts.

$$\left(\frac{p}{pu}\right)^a + \left(\frac{q}{qu}\right)^a = 1 \qquad (1)$$

a: Take values such as 5/3, 2 etc. from coefficient
p: Pull-out bearing force
q: Shear bearing force
pu: Pull-out bearing force without shearing load
qu: Shear bearing force without pull-out tension

Assume as P for the breaking load to the direction added angle $\theta$ , then obtain:

$$p = P \cdot \cos\theta$$
$$q = P \cdot \sin\theta$$

Also assume as, a=2, then make it as:

$$qu = \frac{pu}{\sqrt{3}}$$

Then, obtain the formula converted from formula (1) as follows:

$$P = \frac{1}{\sqrt{1 + 2\sin^2\theta}} pu = A$$

A = reduction coefficient

According to a test conducted, it has been confirmed that the influence by the angle may be negligible in case it is less than 20 degrees against FCI.

## *Method for Calculating Length of Fixing Bolts*

**For the case of using integral type**

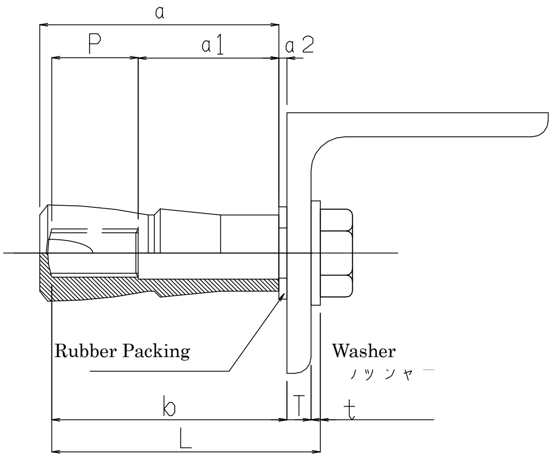



Fig. 10: Drawing for calculating length of fixing bolt

Table 10: Calculation data for shank length of fixing bolt

| Naming | Depth of thread b(mm) | Overall Length of FCI a (mm) | Depth of thread a 1(mm) | Rubber packing a 2(mm) | Thickness of washer t (mm) | Length of thread P(mm) | Nos of effective thread |
|---|---|---|---|---|---|---|---|
| M10N×43 | 40 | 43.0 | 21.5 | 1.0 | 2.0 | 18.5 | 11 |
| M12N×60 | 57 | 59.5 | 35.0 | 1.5 | 2.5 | 21.5 | 11 |
| M12N×C84 | 80 | 79.0 | 54.5 | 5.0 | | | |
| M16N×65 | 64 | 65.5 | 38.5 | 2.0 | 3.0 | 24.0 | 11 |
| M16N×75 | 74 | 75.5 | 48.5 | | | | |
| M16N×85 | 84 | 85.5 | 58.5 | | | | |
| M16N×C111 | 107 | 106 | 79.0 | 5.0 | | | |
| M20N×100 | 98 | 100 | 63.0 | 2.0 | | 33.0 | 11 |
| M20N×120 | 118 | 120 | 83.0 | | | | |
| M22N×110 | 108 | 110 | 69.0 | | | 37.0 | 13 |
| M22N×130 | 128 | 130 | 89.0 | | | | |
| M24N×120 | 117 | 120 | 75.0 | | 4.0 | 40.0 | 11 |
| M24N×140 | 137 | 140 | 95.0 | | | | |

Table 11: Calculation formula for shank length of fixing bolt

| 呼称 | pピッチ | L＝(9山×p)+a1+a2+ t+T |
|---|---|---|
| M10×43 | 1.5 | L≒38+T |
| M12N×60 | 1.75 | L≒55+T |
| M12N×C84 | | L≒78+T |
| M16N×65 | 2.0 | L≒61+T |
| M16N×75 | | L≒71+T |
| M16N×85 | | L≒81+T |
| M16N×C111 | | L≒105+T |

Table 12: Calculation formula for shank length of fixing bolt

| Naming | p (pitch) | L =(10 th*× p )+a1+a2+ t+ T |
|---|---|---|
| M20N×100 | 2.5 | L≒93+T |
| M20N×120 | | L≒113+T |
| M22N×110 | | L≒99+T |
| M22N×130 | | L≒119+T |
| M24N×120 | 3.0 | L≒111+T |
| M24N×140 | | L≒131+T |

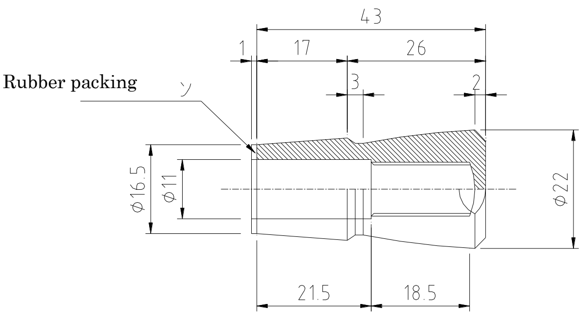
Note *th = threads

Table 13: Examples for shank length of fixing bolt applied

| Naming | Metal thick T(mm) | Calculated value (mm) | Length of bolt leg (mm) |
|---|---|---|---|
| M10N×43 (L=38+T) | 3.2 | 41.2 | 40 |
| | 4.5 | 42.5 | 45 |
| | 6.0 | 44.0 | |
| M12N×60 (L=55+T) | 3.2 | 58.2 | 60 |
| | 4.5 | 59.5 | |
| | 6.0 | 61.0 | |
| M12N×C84 (L=78+T) | 3.2 | 81.2 | 80 |
| | 4.5 | 82.5 | |
| | 6.0 | 84.0 | 85 |
| M16N×65 (L=61+T) | 4.5 | 65.5 | 65 |
| | 6.0 | 67.0 | |
| | 9.0 | 70.0 | 70 |
| M16N×75 (L=71+T) | 4.5 | 75.5 | 75 |
| | 6.0 | 77.0 | |
| | 9.0 | 80.0 | 80 |
| M16N×85 (L=81+T) | 4.5 | 85.5 | 85 |
| | 6.0 | 87.0 | |
| | 9.0 | 90.0 | 90 |
| M16N×C111 (L=105+T) | 4.5 | 109.5 | 110 |
| | 6.0 | 111.0 | |
| | 9.0 | 114.0 | 115 |
| M20N×100 (L=93+T) | 6.0 | 99.0 | 100 |
| | 9.0 | 102.0 | 105 |
| | 12.0 | 105.0 | |
| M20N×120 (L=113+T) | 6.0 | 119.0 | 120 |
| | 9.0 | 122.0 | 125 |
| | 12.0 | 124.0 | |
| M22N×110 (L=99+T) | 6.0 | 105.0 | 105 |
| | 9.0 | 108.0 | 110 |
| | 12.0 | 111.0 | |
| M22N×130 (L=119+T) | 6.0 | 125.0 | 125 |
| | 9.0 | 128.0 | 130 |
| | 12.0 | 131.0 | |
| M24N×120 (L=111+T) | 6.0 | 117.0 | 120 |
| | 9.0 | 120.0 | |
| | 12.0 | 123.0 | 125 |
| M24N×140 (L=131+T) | 6.0 | 137.0 | 140 |
| | 9.0 | 140.0 | |
| | 12.0 | 143.0 | 145 |

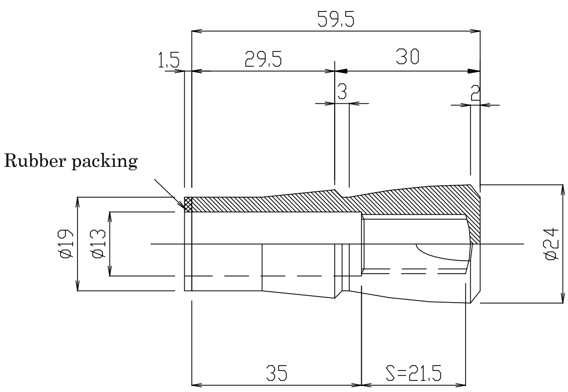
## *Drawings of FCI*

**(1) FCI-M10**

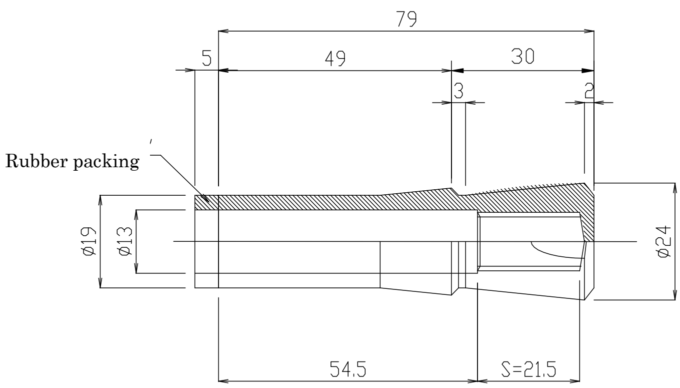



M10N×43（Number of effective thread =11）

**(2) FCI-M12**

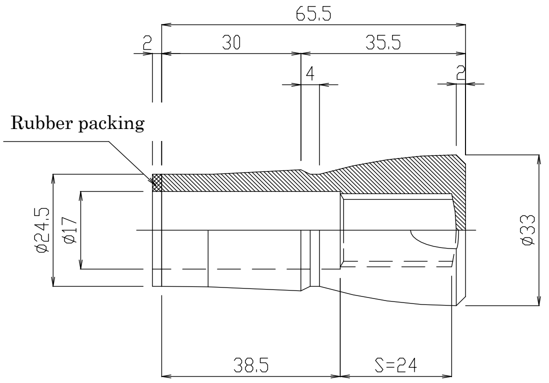



M12N×60（Number of effective threads=11）

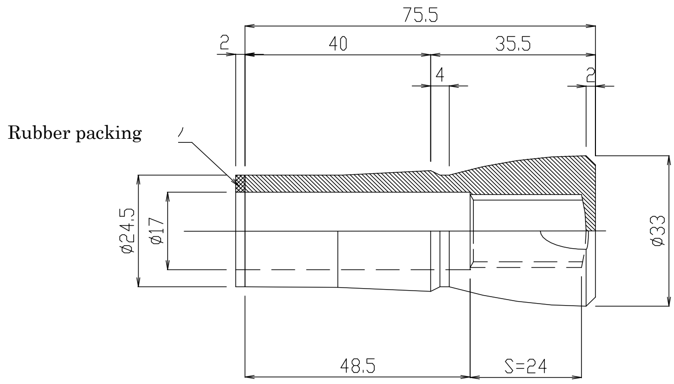



M12N×C84（Number of effective threads = 11）

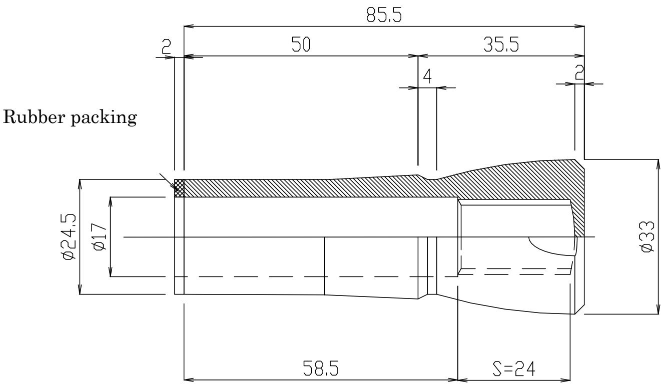
**(3) FCI-M16**



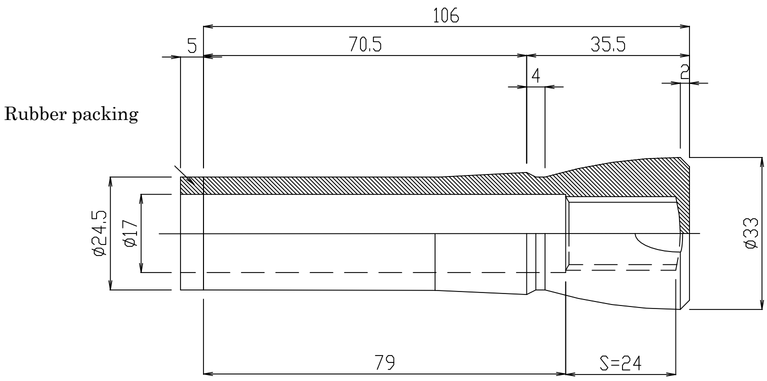

M16N×65（Number of effective threads=11）




M16N×75（Number of effective threads = 11）

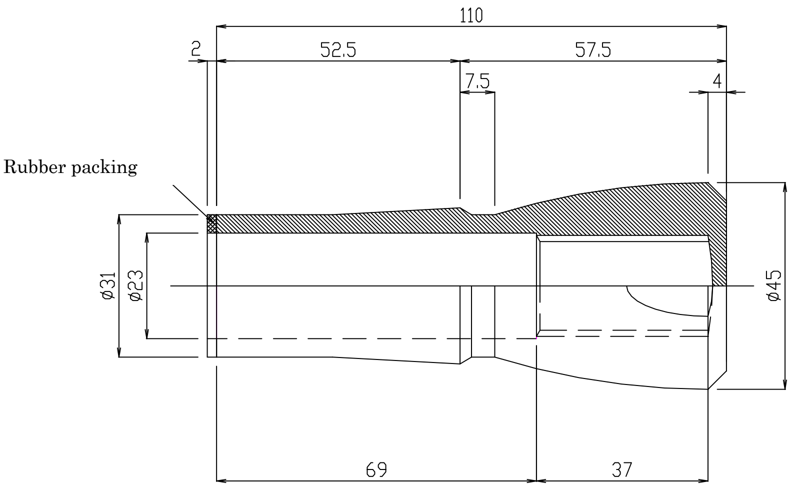



M16N×85 (Number of effective threads=11)

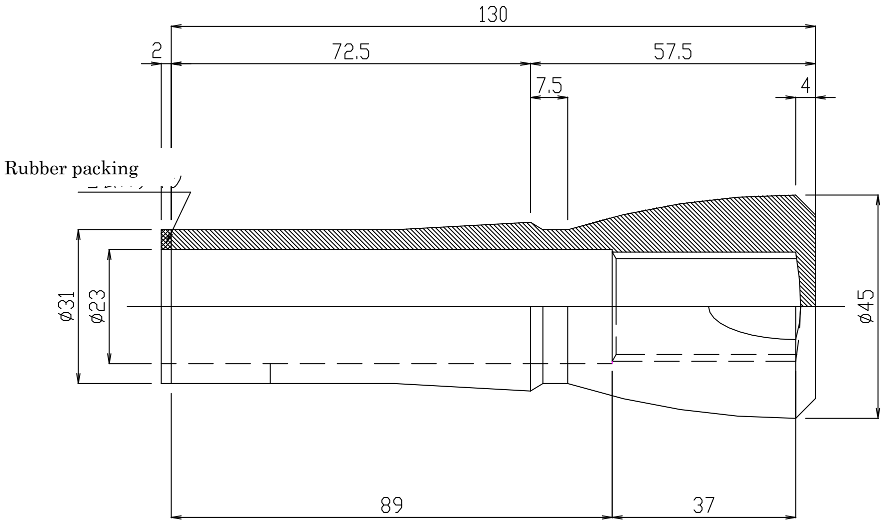



M16N×C111（Number of effective threads=11）

**(4) FCI-M22**

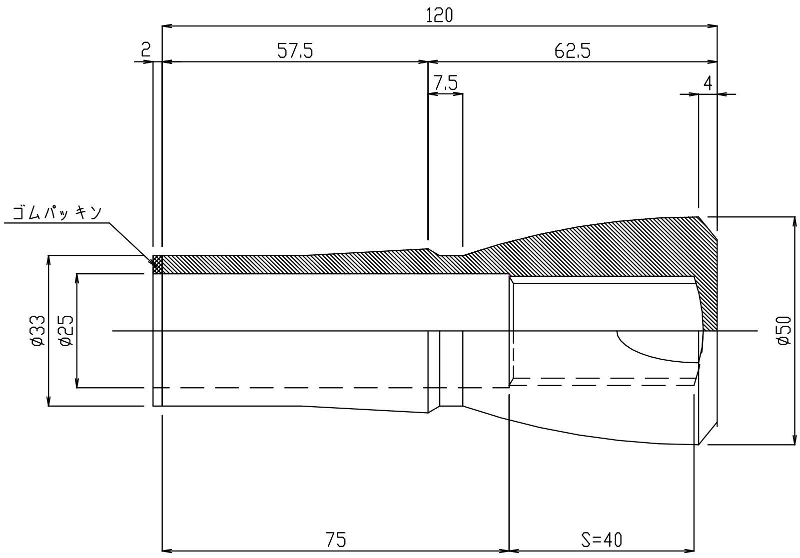



M22N×110（Number of effective threads=13）

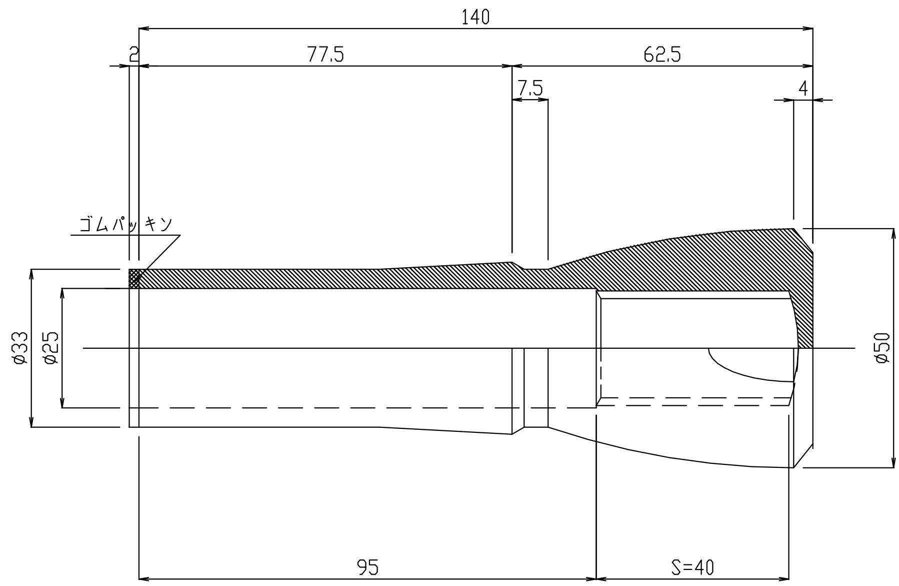



M22N×130（Nos of effective threads=13）

**M24** ＦＣＩ




M24N-120（Number of effective threads: 11）




M24N-140（Number of effective threads: 11）