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RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION OF REINFORCED CONCRETE STRACTURESUSING D57 AND D64 LARGE-DIAMETER THREADED REINFORCING BARS

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JSCE Subcommittee for Research on Design and Construction with
Extra-1argediameter Threaded Reinforcing Bars

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SYNOPSIS

The Committee on Concrete of the Japan Society of Civil Engineers published “Recommendations for Design of Reinforced Concrete Structures Using D51 Large-diameter Reinforcing Bars (Draft)” as Publication No.40, and in 1977, “Recommendations” of the same title as No.43 of the Society’s Concrete Library. With these providing momentum, D51 large-diameter reinforcing bars have come to be widely used for civil structures.

Subsequently, although research and development went ahead concerning splicing methods for large-diameter reinforcing bars, there was no trend seen to further increase bar diameters used.

In recent years, much progress has been made in manufacturing techniques of reinforcing bars, and it has become possible to make bars of even larger diameter which, moreover, have higher levels of performance. Construction of large-scale civil Structures has increased, and aiming for rationalization of design and construction through use of reinforcing bars of even larger diameters has cone under study. It was under such circumstances that in 1988 the Committee on Concrete of the Japan Society of Civil Engineers was requested by the three companies; of Nippon Steel Corporation, Sumitomo Metal Industries, Ltd., and Kobe Steel, Ltd. to carry out “Investigations and Research on Threaded Extra-large-diameter Reinforcing Bars.”

The Committee on Concrete, on accepting the request, established a Subcommittee for Research on Design and Construction with Extra-1arge-diameter Threaded Reinforcing Bars in March 1989 and commenced investigations and studies in relation to this subject.

As a result of the investigations and Studies, D57 and D64 were selected as extra-large-diameter threaded reinforcing bars to be considered, and moreover, it was decided that instead of referring to them especially as extra-1arge-diameter reinforcing bars, they would just be called D57 and D64 large-diameter threaded reinforcing bars.

The Subcommittee carried out various tests and studies to ascertain the practical natures of these large-diameter bars, and using the results, prepared “Recommendations for Design and Construction of Reinforced Concrete Structures Using D57 and D64 Large-diameter Threaded Reinforcing Bars (Draft),” and the Committee on Concrete, upon carrying out deliberations, approved the draft.

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(DRAFT)

CONTENTS

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CHAPTER 1 GENERAL

1.1 Scope of App1ication

(1) These Recommendations give general standards regarding matters necessary in particular in design and construction of reinforced concrete structures using D57 and D64 large-diameter threaded reinforcing bars. Matters not covered in these Recommendations shall be in accordance with “Design Volume” and “Construction Vo1unem” of the Standard Specifications for Concrete (1991 Edition) of the Japan Society of Civil Engineers (hereinafter referred to as Standard Specifications “Design Volume” and “Construction Volume”).
(2) The large-diameter threaded reinforcing bars D57 and D64 considered in these Recommendations shall satisfy the requirements of the Japan Society of Civil Engineers Standard, “Standards for D57 and D64 Large-diameter Threaded Reinforcing Bars for Reinforced Concrete (Draft)” (hereinafter referred to as “Large-diameter Threaded Reinforcing Bar Standard”).

[Commentary]

Regarding (1) These Design and Construction Recommendations consider general reinforced concrete civil structures using D57 and D64 large-diameter threaded reinforcing bars, and specify general standards on necessary natters thought to be peculiar to these reinforcing bars. Therefore, matters not indicated here are to be in accordance with the “Design Volume” and “Construction Volume” of Standard Specifications for Concrete (1991 Edition) of the Japan Society of Civil Engineers (hereinafter referred to as Standard Specifications “Design Vo1ume” and “Construction Volume”). As the design technique, using the limit state design method is fundamental, but design by the allowable stress intensity method will also be indicated in Chapter 6 respecting its track record up to this time.

Regarding (2) In prescribing these Recommendations, the Japan Society of Civil Engineers Standard, “Standards for D57 and D64 Large-diameter Threaded Reinforcing Bars for Reinforced Concrete (Draft)” (hereinafter referred to as “Large-diameter Threaded Reinforcing Bar Standard”) was prepared. This is because provisions concerning reinforcing bars exceeding D51 in size are not contained in JIS G 3112, “Steel Bars for Concrete Reinforcement.” Further, the dimensions of nominal diameters in JIS G 3112, and the respective corresponding sizes in inches are 2-1/4 inch (57.2 mm) and 2-1/2 inch (63.5 mm).

The “Large-diameter Threaded Reinforcing Bar Standard” is based on items prescribed in JIS G 3112 and contains details peculiar to D57 and D64. That is, of the contents of JIS G 3112, changes were made in the upper limit values and lower limit values of chemical components and yield points, along with which provisions were newly added regarding the strain value at the yield plateau and large bending of reinforcing bars. Further, that tension tests of D57 and D64 large-diameter threaded reinforcing bars can be performed using test pieces cut out in addition to the method of testing bars of product form was newly added. These provisions had the objectives of satisfying the performance requirements of reinforced concrete structures due to increasing reinforcing bar diameter and of securing quality in manufacturing.

Furthermore, research and development is going on for practicalization of D70 large-diameter threaded reinforcing bars, but because of the insufficient track record and test data for adoption in these Recommendations, it was excluded from the scope of application of these Recommendations, being set aside as an object for future study.

1.2 Definitions of Terms

The following terms are defined in these Recommendations.

Threaded reinforcing bar - Deformed bar with deformations on surface made in threaded form by hot rolling.

Threaded reinforcing bar splice - Splice consisting of threaded reinforcing bars joined by couplers with threads provided inside. Kinds of splices include grout fixing type, torque fixing type, and crimped fixing type.

Threaded reinforcing bar anchoring - Method of anchoring threaded reinforcing bar to concrete using anchorage plate and anchorage nut

Crack-control reinforcement - Main reinforcing bar of size D51 or under in axial direction arranged at concrete surface side of large-diameter threaded reinforcing bar to reduce crack width

[Commentary]

Regarding crack-control reinforcement Crack-Control reinforcement is arranged at the concrete surface side of the large-diameter threaded. reinforcing bar to reduce crack width, along with which it has the role of main reinforcement in the axial direction of the member against design load, and by arranging in combination with D57 and D64 large-diameter threaded reinforcing bars, it provides crack control in a rational manner.

CHAPTER 2 DESIGN VALUES OF MATERIALS

2.1 Specified Concrete Strength

The specified strength, f_{ck} , of concrete shall be not less than 210 kgf/cm^2.

[Commentary]

Since it is thought low-strength concrete will generally not be employed in reinforced concrete structures using D57 and D64 large-diameter threaded reinforcing bars, the specified concrete strength was prescribed to be not less than 210 kgf/cm^2. The provisions that follow are predicated on the specified strength of being not less than 210kgf/cm^2.

2 .2 Design Bond Strength of Concrete

The design bond strength, f_{bod} , of concrete may be obtained by the following equation.

$$f_{bod} = 0.6\, f_{ck}^{\prime 2/3} / \gamma_c \qquad (2.2.1)$$

provided that $f_{bod} \leq 33$ kgf/cm2
where, γ_c : material coefficient of concrete

[Commentary]

According to results of pull-out tests on D57 and D64 large-diameter threaded reinforcing bars, equal values as for D51 have been obtained regarding bond strength, and therefore, it was made permissible for design bond strength, f_{bod} , to be calculated dividing the characteristic value of bond strength obtained using the same equation as the calculation equation given in 3.2.1 of the Standard Specification "Design Volume."

2 .3 Design Strength of Reinforcing Bar

(1) Design strengths of reinforcing bars for tension, compression, and shear shall be the respective characteristic values of strength divided by material coefficient, γ_s .

(2) The characteristic value, f_{yk} , of tensile yield strength and characteristic value, f_{uk} of tensile strength of a reinforcing bar shall be determined based on the respective strengths. The tension test shall be according to the Large-diameter Threaded Reinforcing Bar Standard.

(3) The characteristic value, f_{yk} , of tensile yield strength and characteristic value, f_{uk} of tensile strength of a reinforcing bar may be the lower value of respective standard values in the Large-diameter Threaded Reinforcing Bar Standard. The cross-sectional area of reinforcing bar used in design may in general be the nominal cross-sectional area.

(4) The characteristic value, f'_{yk} , of compressive yield strength of a reinforcing bar may be made equal

to the characteristic value, f_{yk} , of tensile yield strength.

(5) The characteristic value, f_{vyk} , of shearing yield strength of a reinforcing bar generally be determined by the following equation

$$f_{vyk} = f_{yk} \big/ \sqrt{3} \qquad (2.3.1)$$

[Commentary]

Regarding (2) In the large-diameter Threaded Reinforcing Bar Standard, it is stipulated that the method of using reinforcing bars directly in the form of product or the method of using test pieces cut out may be employed in tensile tests. In the event of determining tensile yield strength and characteristic value of tensile strength employing the latter method, compared with the case of using the reinforcing bar directly in product form, it is known from the results of comparison tests that values about 5 to 10% higher are obtained, and it is to be permissible to set the respective characteristic values using 90% of the test values obtained using cut-out test pieces.

2.4 Design Fatigue Strength of Reinforcing Bar

The design fatigue strength, f_{srd}, of a reinforcing bar may generally be obtained by Eq. (2.4.1) as a function of stress intensity, σ_{sp}, of the reinforcing bar due to fatigue life, N, and permanent load.

$$f_{srd} = 1900 \frac{10^{\alpha}}{N^{k}} \left(1 - \frac{\sigma_{sp}}{f_{ud}} \right) / \gamma_s \qquad (2.4.1)$$

provided that $N \leq 2 \times 10^6$

where, f_{ud} : design tensile strength of reinforcing bar

γ_c : material coefficient of reinforcing bar, generally may be taken as 1.05

(i) In principle, α and k shall be determined by tests.

(ii) In case of $N \leq 2 \times 10^6$, α and k may be generally be taken as the value of Eq. (2.4.2).

$$\alpha = k_o (0.82 - 0.003\phi) \qquad (2.4.2)$$
$$k = 0.12$$

where, ϕ : reinforcing bar diameter (mm)

k_o : coefficient concerning shape of lug of reinforcing bar, and generally may be taken as 1.0

[Commentary]

According to the results of fatigue tests on the parent material of D57 and D64 large-diameter threaded reinforcing bars, fatigue strengths equal to D51 have been obtained, and therefore, it was made permissible to use the same equation as the calculation equation given in 3.3.2 of Standard Specification "Design volume."

CHAPTER 3 CONSIDERATIONS CONCERNING CRACKS

3.1 Allowable Crack Width

(1) In principle, allowable crack width, w_a, shall be determined giving consideration to the purpose of use, environmental conditions, conditions of members, etc. of the structure.
(2) The allowable crack width of D57 and D64 large-diameter threaded reinforcing bars may generally be set as given in Table 3.1.1 in accordance with environmental conditions and cover.

Table 3.1.1-Allowable crack width, w_a (cm).

Type of reinforcing bar	Environmental conditions for reinforcing bar corrosion		
	General environment	Corrosive environment	Especially severe Corrosive environmental.
Large-diameter threaded reinforcing bar	0.005c	0.004c	0.0035c

Note: c indicates cover (cm)

[Commentary]

This article was prescribed following 7.3.3 of the Standard Specifications “Design Volume.”

When D57 and D64 large-diameter threaded reinforcing bars are used, cover, c, generally becomes larger than for conventional reinforcing bars of designation D51 and under, and cases of 10 cm being exceeded are conceivable. In this case also, the conditions of flexural cracks and widths have been confirmed in past tests to be similar to cases of conventional reinforcing bars. Therefore, the expression, “cover, c, shall be not more than 10 cm as a standard” in Standard Specification “Design Volume” was deleted.

According to this article, if cover becomes large allowable crack width will proportionately become large, and if crack width becomes too large, even if there is no problem from the standpoint of durability, it is thought a problem will arise in case good appearance or watertightness is especially demanded. When it is necessary for appearance and watertightness to be especially considered, what may be done is to set the allowable crack width as necessary and make a study adapting this article.

3 .2 Considerations Concerning Flexural Cracking

(1) Considerations concerning flexural cracking shall in general consist of ascertaining that crack width, w, obtained by Eq. (3.2.1) is not more than the allowable crack width, w_a, given in Table 3.1.1.

$$w = k\{4c + 0.7(c_s - \phi)\}(\sigma_{se}/E_s + \varepsilon'_s) \tag{3.2.1}$$

where, k : constant expressing effect of bond properties of steel, which generally may be taken as 1.0 in case of large-diameter threaded reinforcing bar

c : cover (cm)

c_s : center-to-center spacing of reinforcing bars (cm)

ϕ : reinforcing bar diameter (cm)

ε'_{cs} : numerical value for considering increase in crack width due to drying shrinkage and creep of concrete

σ_{se} : increase in reinforcing bar stress intensity (kgf/cm^2)

E_S : Young's modulus of reinforcing bar which may be made 2.1 x 10^6 kgf/cm^2

(2) The D57 or D64 large-diameter threaded reinforcing bar to be the object in considerations concerning flexural cracking shall in principle be tension reinforcement at a location closest to the surface of concrete and stress intensity shall be determined in accordance with 7.2 of the Standard Specifications "Design Volume."

[Commentary]

This article was prescribed following 7.3.4 of the Standard Specifications "Design Volume."

Regarding (1) According to static loading tests of large beam specimens using D64 large-diameter threaded reinforcing bars, it was ascertained that Eq. (7.3.1) in Standard Specification "Design Volume" can be applied for calculating flexural crack widths of beams, and it was deemed that the same equation as Eq. (7.3.1) in Standard Specification "Design volume" can be used for Eq. (3.2.1).

In case tensile stress intensity of concrete due to bending moment and axial force is lower than 60% of the design tensile strength of the concrete, examination of flexural cracking need not be done.

Regarding (2) In case D57 or D64 large-diameter threaded reinforcing bars are arranged in multiple layers, the stress intensity of tensile reinforcement at a location closest to the surface of concrete should be used as the reinforcing bar stress intensity as a rule, but in general, the value at the centroid of the tensile reinforcement group may be used.

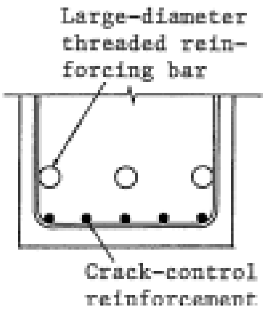
3.3 Crack-control Reinforcement

In the event it is considered control of cracking is especially necessary, crack-control reinforcement may be provided.

[Commentary]

This article was added as a specific provision for D57 and D64 large-diameter threaded reinforcing bars. In case of using D57 and D64 large-diameter threaded reinforcing bars for a structure in a corrosive environment, or in case watertightness or good appearance is especially demanded, the method of arranging crack-control reinforcement as in Commentary Fig. 3.3.1 at the cover for the large-diameter threaded reinforcing bars may be used. The examination of flexural crack width in this case must consider the crack-control reinforcement.

Consideration must be given that concrete reaches thoroughly into every part in arrangement of crack-control reinforcement.



Commentary Fig. 3.3.1-Method of arranging crack-control reinforcement

CHLAPTER 4 GENERAL STRUCTURAL DETAILS

4 .1 Cover

Cover of reinforcement shall be in accordance with 10.2 in Standard Specification "Design Volume."

[Commentary]

Since it has been ascertained from past test results that ad-equate bond strength for stress transmission between reinforcement and concrete can be demonstrated if cover not less than bar diameter is secured even when D57 and D64 1argedianeter threaded reinforcing bars are used, it was decided to specify the same kind of cover as for ordinary reinforcement.

In actual construction, since influence of bending of reinforcing bars and construction errors such as errors in placing of reinforcement and formwork errors will be unavoidable, it is desirable for values somewhat on the larger side than prescribed in this article to be set out.

Furthermore, in actual structures, there are cases in which crack-control reinforcement is used as axial reinforcement in addition to shear reinforcement, additional reinforcement, and erection reinforcement other than large-diameter threaded reinforcing bars. Consideration must be given that cover in such case will be according to 10.2 in Standard Specification "Design Volume." For the sake of reference, the basic covers prescribed in the Standard Specifications are reprinted in Commentary Table 4.1.1.

Commentary Table 4.1.1-Basic covers prescribed in 10.2 in Standard Specifications "Design Volume" (cm).

Environmental condition	Member		
	Slab	Beam	Column
General environment	2.5	3.0	3.5
Corrosive environment	4.0	5.0	6.0
Especially severe corrosive environment	5.0	6.0	7.0

4 .2 Clearance between Reinforcing Bars and Center-to-center spacing

(1) The horizontal clearances between D57 and D64 axial reinforcing bars in beams shall be more than bar diameter and, in addition, not less than 4/3 times the maximum size of coarse aggregate. Further, the horizontal clearances shall be suitably secured to allow insertion of internal vibrators to be used for consolidation of concrete.

In the event of arranging axial reinforcement in two or more layers, the vertical clearance shall in general be not less than the bar diameter (see Fig. 4.2.1).

(2) The clearances between D57 and D64 axial reinforcing bars in columns shall be not less than 1.5

times the bar diameter and, in addition, not less than 4/3 tines the maximum size of coarse aggregate.

(3) The clearances between crack-control reinforcing bars shall be in accordance with 10.3 in Standard Specifications. “Design Volume.” However, clearances between crack-control reinforcing bars and D57 or D64 large-diameter threaded reinforcing bars shall be not less than the average diameter of the two.

(4) In the event of using D57 and D64 large-diameter threaded reinforcing bars as axial reinforcement and lateral reinforcement orthogonal to the axial reinforcement, the center-to-center spacing shall in principle be not more than 45cm.

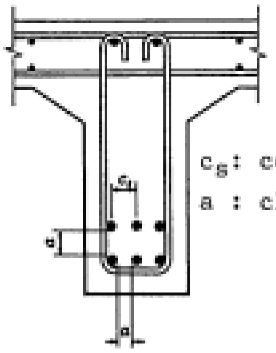


Fig. 4.2.1-Clearances between reinforcing and center-to-center spacing.

[Commentary]

The contents of this article consist of the contents of 10.3 in Standard Specifications “Design Volume.” modified or deleted considering D57 and D64 1arge-diameter threaded reinforcing bars. Clearances of reinforcing bars are set as stipulated in this article, but it is desirable for the design to have some amount of allowance in consideration of cross-sectional dimensions of members, degree of ease or difficulty- in execution of work, and other factors. In the case of large-diameter threaded reinforcing bars, clearances at splices will be problematic at times, and this is provided for in 4.5.

Regarding (1), (2) The provisions of not less than 2 cm for clearances of axial reinforcement in beams and not less than 4 cm for axial reinforcement in columns of 10.3 in Standard Specifications “Design Volume.” would be included in the provisions for not less than bar diameter in these recommendations which consider D57 and D64 large-diameter threaded reinforcing bars and were therefore deleted. Furthermore, it may be considered that the provisions according to maximum size of coarse aggregate actually do not have any effect, but since large coarse aggregates may be used depending on the structure, the provisions were left in.

Regarding (3) Since D57 and D64 large-diameter threaded reinforcing bars are used mainly in large-scale structures, the upper limit value of center-to-center spacing of reinforcing bars was made 45 cm aiming for rationalization of construction. Furthermore, in case of using crack-control reinforcement, the center-to-center spacing is to be made not more than 30 cm as a rule, the same as in 7.3.7 of Standard Specifications “Design Volume.”

4 .3 Bending Configuration of Axial Reinforcement

(1) The inside bending radii of hooks of D57 and D64 large-diameter threaded reinforcing bars shall be not less than the values in Table 4.3.1.
(2) In case of using crack-control reinforcement, the inside bending radii of hooks shall be according to 10.4.2 in Standard Specifications “Design Volume.”

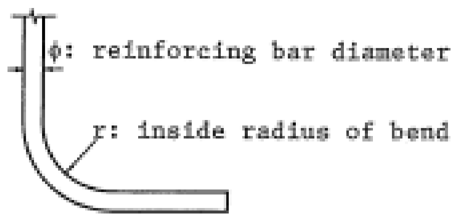
Table 4.3.1-hside bending radius of hook.

Type of reinforcement	Inside bending radius(γ)
	Hook
Large-diameter threaded reinforcing bar	
SD295-N	2.5 ϕ
SD345-N	3.0 ϕ
SD390-N	3.0 ϕ
SD490-N	3.5 ϕ

[Commentary]

This article was prescribed following 10.4.2 in Standard Specifications “Design Volume.” Provisions concerning ordinary round bars were deleted, and the types of reinforcing bars in Table 4.3.i were changed to the designations for the types in “Large-diameter Threaded Reinforcing Bar Standards.” since it is unthinkable that large-diameter threaded reinforcing bars will be used for stirrups and hoops, provisions concerning this were deleted.

The inside bending radii of hooks of axial reinforcement were made 0.5 ϕ larger than the inside bending radii prescribed for flexural tests in Large-diameter Threaded Reinforcing Bar Standards.



Commentary Fig. 4.3.1-Inside bending radius.

4 .4 Anchoring of Reinforcing Bar

(1) Anchoring of reinforcing bars shall follow 10.5 in Standard Specifications “Design Volume.”

(2) In anchoring of reinforcing bars, anchoring with threaded reinforcing bars may be used in lieu of standard hooks. In the event of using threaded reinforcing bar anchoring, the anchorage length may be

reduced by 10 ϕ from the basic anchorage length. In this case, ϕ is bar diameter.

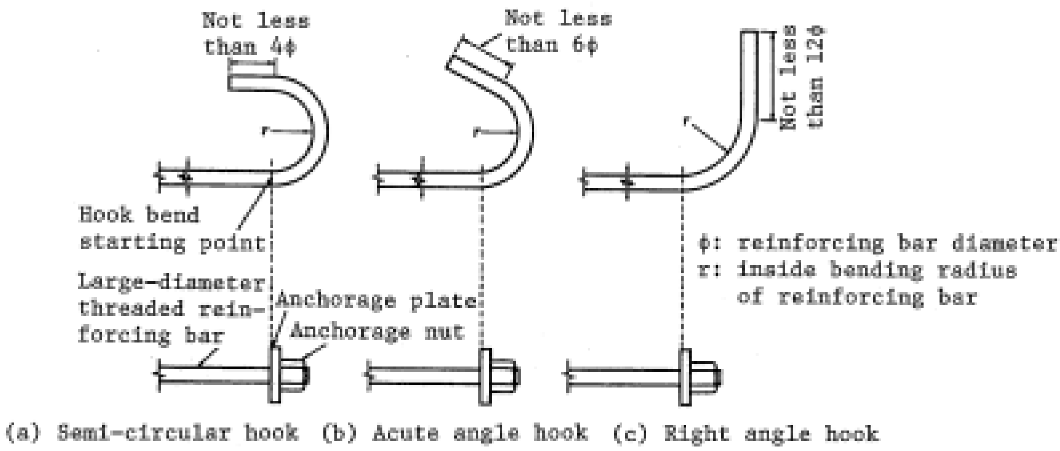
(3) In the event of anchoring tension reinforcement at tension zones of concrete, 10.5.3(3) in Standard Specifications "Design Volume" shall be followed.

[Commentary]

Regarding (1) This article prescribes that 10.5 in Standard Specifications "Design Volume." is to be followed. Regarding the anchorage properties of D57 and D64 large-diameter threaded reinforcing bars, it was prescribed that 10.5 in Standard Specifications "Design Volume." is to be followed since it was the same as for the conventional reinforcing bars up to D51. The configurations of standard hooks are shown in Commentary Fig. 4.4.1.
Regarding (2) For anchorage of a threaded reinforcing bar, by installing an anchorage plate which provides bearing power at the end of the threaded reinforcing bar taking advantage of the configurations of the bar, and combining the bearing power of the anchorage plate with the effect of bond to concrete at the embedded length of the bar, axial force acting on the reinforcing bar can be transmitted to the concrete, and it was prescribed that this can be used instead of a standard hook at the end of a reinforcing bar. It has been revealed by tests and actual use up till now that with anchorage of threaded reinforcing bars it is possible to markedly improve constructability compared with cases of using standard hooks in anchorage of reinforcing bars where reinforcement is heavily congested, and that anchoring performance of threaded bar anchorage is extremely high compared with that of a standard hook. However, because examples of use in the civil engineering field are still small in number, the provision in this case was limited to making it permissible for standard hooks to be replaced by threaded bar anchorage.

The shapes of standard hooks for D57 and D64 large-diameter threaded reinforcing bars, and the method of replacing with threaded reinforcing bar anchorage are shown in Commentary Fig. 4.4.1, and in case of using threaded reinforcing bar anchorage, the part of the bar from the starting point of the hook to the end of the anchored part is to be replaced with threaded bar anchorage. A case of threaded reinforcing bar anchorage in use is shown in Commentary Fig. 4.4.2, and examples of parts or locations where it is conceivable for threaded bar anchorage to be used are shown in Commentary Figs. 4.4.3 to 4.4.5.

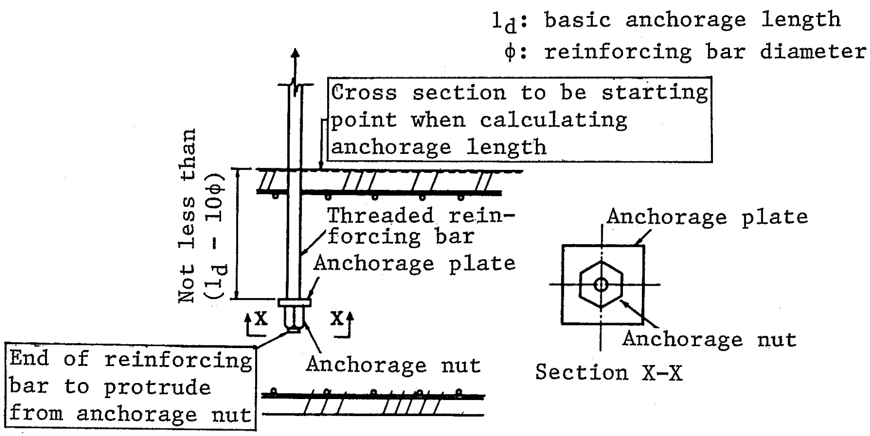
In threaded reinforcing bar anchorage, a square shape is to be standard for the anchorage plate, and the standard dimensions are shown in Commentary Fig. 4.4.1. Further, when using a circular anchorage plated it is to have a projected area equivalent to the case of a square plate,. The materials for anchorage plates are to be steels corresponding to SS 400 and SS 490 specified in JIS G 3101, "Rolled Steel for General Structures," and SM 400 A, B, C, and SM490 A, B, C in JIS G 3106, "Rolled Steels for Welded Structure." As for the anchorage nut, a product which has been confirmed by pull-out tests to be safe against loads acting on the reinforcing bar is to be used. Furthermore, the anchorage plate, anchorage nut, and threaded reinforcing bar must be assembled by an appropriate method so that there will not be any play, and the mechanism such that loosening of anchorage plate and anchorage nut can be prevented during erection of reinforcement and placement of concrete. Still further, attention must be given to clearances between anchorage plates and cover of anchorage plates when using threaded reinforcing bar anchorages.



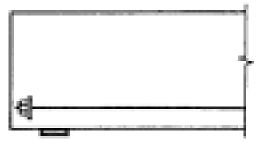
Commentary Fig. 4.4.1-Configurations of standard hooks for reinforcing bar ends and replacement by threaded reinforcing bar anchorage.

Commentary Table 4.4.1-Standard dimensions of anchorage plates (unit: mm).

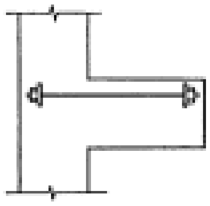
Bar designation	$210 \leq f'_{ck} < 300\ kgf/cm^2$		$f'_{ck} \geq 300\ kgf/cm^2$		Hole dia.
	Plate width	Plate thickness	Plate width	Plate thickness	
D57	150	19	135	16	66
D64	165	22	150	16	73



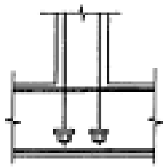
Commentary Fig. 4.4.2-Conceptual diagram of use of threaded reinforcing bar anchorage.



Commentary Fig. 4.4.3-Threaded reinforcing bar anchorage at beam or slab.



Commentary Fig. 4.4.4-Threaded reinforcing bar anchorage at bar ends of cantilevered bean and cantilevered slab.



Commentary Fig. 4.4.5-Threaded reinforcing bar anchorage at end of main reinforcement of column and wall.

Regarding (3) It is the rule for the end portion of a tension reinforcing bar to be anchored in concrete not subject to tensile stress. However, even when large-diameter threaded reinforcing bars are used, there are cases when it is unavoidable for tension reinforcement to be anchored in tensile zones of concrete for reasons of bending fabrication or erection work of reinforcing bars. In such case, since it is necessary to keep anchored reinforcing bars from having adverse effects on shear strengths, cracking properties, etc. of members, the anchorage method of (3) of this article was prescribed.

This method is based upon 10.5.3(3) in standard Specifications "Design Volume" with an extension made from the cross section becoming unnecessary according to calculations by just the length equal to the sum of the basic anchoring length of ($l_d + l_s$) and the effective height of the member cross section, while further, either of the conditions of① is not less than 1.5 times the design shear force at the section from the reinforcing bar cut-off point to the cross section which becomes unnecessary according to calculations, or② , that the design flexural strength due to continuous reinforcing bars at the reinforcing bar cut-off point is not less than twice the design bending moment, and moreover, that the design shear strength is not less than 4/3 times the design shear force at the section from the cut-off point to the section which becomes unnecessary according to calculations, should be satisfied. By Satisfying these conditions, it is possible, to prevent flexural cracks occurring at the locations where reinforcing bars were cut from developing into diagonal cracks to have adverse effects on members. Therefore, it is advisable not to use threaded reinforcing bar anchorage for anchoring tension reinforcing bars in the tension zones of concrete.

4 .5 Splices of Reinforcement

(1) Splices of reinforcing bars shall be appropriately selected in accordance with type, diameter, stress condition of reinforcing bar, splice location, etc.

(2) The locations of splices of reinforcing bars shall avoid cross sections of large stresses as much as possible.

(3) The locations of splices of reinforcement shall in principle be staggered and not gathered in the sane cross section. The distance axially that splice locations are to be staggered shall as a standard be not less than 25 times the bar diameter added to splice length. Further, the location of a reinforcing bar splice shall be selected in a manner that splicing work using equipment for splice construction can be performed.

(4) The clearance between a splice and an adjacent reinforcing bar, or clearances between splices shall be not less than the maximum size of coarse aggregates. In the event of making a splice after arrangement of reinforcing bars, clearances allowing insertion of equipment for construction of splices shall be secured.

(5) The cover for a splice shall satisfy the requirements of 4.1.

(6) Splices of reinforcing bars of difference diameters shall be according to the following:

(i) In case the degree of concentration of splices is 1/2 or under, the ratio of cross-sectional areas of reinforcing bars having different diameters shall as a rule be not less than i/2.

(ii) In case the degree of concentration of splices exceeds i/2, the ratio of cross-sectional areas of reinforcing bars having different diameters shall as a rule be not less than 3/4.

(iii) Examinations of locations of splices and shearing shall be made adapting the provisions of 10.5 in the Standard Specifications “Design volume.”

(7) In the event of splicing reinforcing bars of different quality, it shall be confirmed that the difference in quality will not adversely affect the performance of the splice.

(8) For members subject to influence of fatigue due to repetitive loading, it is advisable not to use splices of different varieties in the same cross sections.

(9) In the event of using lap splices for axial reinforcement, the provisions of 10.6.2 in the Standard Specifications “Design Volume” shall be adapted.

(10) In the event of using threaded bar splices, other mechanical connection type splices, or welded splices for axial reinforcement, splices satisfying the performance requirements specified in “Recommendations for Evaluating Reinforcing Bar Splices (Draft)” in ”Recommendations for Reinforcing Bar Splices” of the Japan Society of Civil Engineers shall be used.

[Commentary]

This article was prescribed based on 10.6 in the Standard Specifications “Design Volume” and the Japan Society of Civil Engineers “Recommendations for Reinforcing Bar Splices."

Regarding (1) As a splice for large-diameter threaded reinforcing bars there is basically the threaded bar splice taking advantage of the threaded deformation configuration at the surface of the reinforcing bar. This stipulation was provided since it is conceivable for lap splices or welded splices to be utilized depending on the case. Furthermore, there are the grout fixing system, torque fixing system, and crimped fixing system as threaded reinforcing bar splices.

Regarding (2), (3) The contents of this article will be fundamental in selecting locations for reinforcement splices, but when it is unavoidable for splices to be concentrated in the same cross section, the Japan Society of Civil Engineers "Recommendations for Reinforcing Bar Splices" is to be followed. Further, in case of using D57 and D64 large-diameter threaded reinforcing bars, since mechanical connections or welded splices will mainly be adopted, it is important for considerations to be given not only to study of location according to stress intensity, but also accessibility by splice construction equipment when contemplating splice locations.

Regarding (4) It may be considered that in almost all cases clearances between reinforcing bars are decided by whether or not splice construction equipment can be inserted. Therefore, it is important for the construction method and construction sequence of splices to be examined at the design stage, and it is desirable for clearances to be specified slightly on the large side in consideration of construction errors.

Regarding (5) With regard to cover for a splice, since splice materials must be adequately enveloped by concrete just the same as reinforcement, the conventional thinking in the Recommendations for Reinforcing Bar Splices was followed. Furthermore, when there are hoops or stirrups at the splice section, it is necessary for covers of these bars to satisfy the requirements of 10.2 in Standard Specifications "Design Volume." Still further, it is desirable for a somewhat larger cover thickness to be set in consideration of construction errors.

Regarding (6) Provisions for cases in which reinforcing bars of different diameters are spliced were set based on the Japan Society of Civil Engineers "Recommendations for Reinforcing Bar Splices." The degree of concentration of splices is to be determined by the ratio of the sum of cross-sectional areas of reinforcing bars to be spliced and the total sum of cross-sectional areas of all reinforcing bars at the cross section under consideration. The stipulation about examinations of locations of splices and shearing was provided since when there is a sudden change in reinforcement quantity at the splice section, flexural cracking is likely to occur, and this can develop into diagonal cracking to reduce shear strength of the member.

Regarding (7), (8) With regard to splices of reinforcing bars of different standards and different splice construction methods, and for methods of splicing in members subject to influence of fatigue, the provisions were set based on the Japan Society of Civil Engineers "Recommendations for Reinforcing Bar Splices."

Regarding (9) Since it may be expected that the use of lap splices will become necessary in actual construction, provisions concerning lap splices were left in. From the results of flexural tests of beam specimens having lap splices using D57 and D64 large-diameter threaded reinforcing bars, it was found that it is possible to apply the equation for calculating basic anchoring length to large-diameter threaded reinforcing bars and, therefore, it was decided that the contents of the Standard Specifications should be followed.

Regarding (10) Regarding splices of Class A in "Recommendations for Evaluating_Reinforcing Bar

Splices (Draft)" of Recommendations for Reinforcing Bar Splices, static strength capacity is roughly equal to that of parent material reinforcing bars, and it is desirable for this to be used for structural members from the viewpoints of convenience of design and construction and rationality. However, Class B splices may be used for members in which high stress intensities occur.

CHAPTER 5 REINFORCEMENT WORK

5.1 Fabrication of Reinforcing Bars

(1) Cutting of D57 and D64 large-diameter threaded reinforcing bars shall be performed as a rule using automatic sawing cutters or high-speed cutters. In the event gas metal-arc cutting is unavoidable, care shall be exercised that splicing work will not be adversely affected.

(2) Bending fabrication of D57 and D64 large-diameter threaded reinforcing bars shall be performed as a rule using a bending machine regarding which bending performance has been ascertained, and the bending fabrication shall be performed as a rule at normal temperature.

(3) Configurations and dimensions of bending fabrication of D57 and D64 1arge-diameter reinforcing bars shall be in accordance with the provisions of 4.3.

[Commentary]

Regarding (1) Since splices of D57 and D64 large-diameter threaded reinforcing bars are mostly mechanical connection splices using special splicing devices, it was made a rule for cutting of reinforcing bars to be performed using automatic sawing cutters or high-speed cutters with which cutting burrs and end deformations are less likely to occur. Although effects on splice performance of mechanical connector splices will be small even when gas metal-arc cutting is done, slag produced when cutting and irregularities of cut surfaces will be hindrances when fitting splicing devices, and correction of end surfaces by grinder or other means will become necessary.

Regarding (2) Since D57 and D64 large-diameter threaded reinforcing bars have larger cross-sectional areas and greater bending rigidities compared with conventional reinforcing bars, the bending fabrication capacity demanded of the bending machine will be greater than for a conventional reinforcing bar. Therefore, it was stipulated that a bending machine be used upon ascertaining its fabricating performance. Furthermore, in the event it is unavoidable for hot bending fabrication to be performed, the same precautions as for reinforcing bars of D51 size and under will be necessary.

Regarding (3) Configurations in bending fabrication are to be in accordance with the relevant provisions in the Standard Specifications “Construction Volume” besides in accordance with the general structural details of 4.3 of these Recommendations.

5.2 Erection of Reinforcing Bars

Erection of D57 and D64 large-diameter threaded reinforcing bars shall be based on 10.3 in the Standard Specifications “Construction Volume,” provided that in the event of adopting a pre-assembly method taking advantage of the features of large-diameter threaded reinforcing bars or a method of the bars serving concurrently as erection steel and main reinforcement, specifications for erection of reinforcing bars in accordance with the construction shall be set up, and those specifications followed.

[Commentary]

It was stipulated that erection of D57 and I)64 large-diameter threaded reinforcing bars is to be just as with ordinary reinforcing bars. Construction methods positively taking advantage of the fact that larger-diameter threaded reinforcing bars have "screw-shaped" lug configurations throughout their lengths, and that the bars are of large diameter and bending rigidity is high are being contemplated. For example, there has been a pre-assembly method proposed in which large-diameter threaded reinforcing bars are at the four corners of a beam or column, with the spaces in between connected in lattice form by small-diameter reinforcing bars to improve self-standing properties and bending rigidities, and this should be referred to.

5.3 Splices of Reinforcing Bars

Performances, varieties, and arrangement methods of splices for large-diameter reinforcing bars shall be in accordance with 4.5, with the method of executing work to be in accordance with the procedures set up for the individual splicing methods.

[Commentary]

Designs of splices for D57 and D64 large-diameter threaded reinforcing bars in these Recommendations are suitably selected in accordance with the conditions of the place of work execution and are predicated on being clearly indicated in the design drawings. In this article, it is stipulated that in actual construction, in order for the specified splice performance to be demonstrated, work is to be done in reliable manner according to the execution procedures established for the individual methods. This article concerns not only specific problems of D57 and D64 1arge-diameter threaded reinforcing bars, but also natters in common for reinforcing bars of conventional diameters and their splicing methods, and attention is called for again that selection of splice locations be made according to the splicing method for reinforcing bars at the design stage based on "Recommendations for Design and Construction According to Type of Splice (Draft)" of the Japan Society of Civil Engineers "Recommendations for Reinforcing Bar Splices" and "Recommendations for Reinforcing Bar Splices (Part 2)."

CHAPTER 6 DESIGN BY ALLOWABLESTRESS INTENSITY METHOD

6.1 General

This chapter shall be applied to cases of designing reinforced concrete structures using D57 and D64 large-diameter threaded reinforcing bars by the allowable stress intensity method. The rule in such case shall be for reinforced concrete structures to be analyzed by linear theory with stress intensity computed by elastic theory. The strengths of members shall be ascertained through examinations that the stress intensities of reinforcing bars and concrete are below their respective allowable stress intensities.

[Commentary]

This article was prescribed based on 14.1 in the Standard Specifications “Design Volume.”

6.2 Allowable Bond Stress Intensity of Concrete

The allowable bond stress intensities of large-diameter threaded reinforcing bars meeting the requirements of the “Large-diameter Threaded Reinforcing Bar standards” and of concrete using crack-control reinforcement meeting the requirements of JIS G 3112 shall be not more than the values in Table 6.2.1.

Table 6.2.1-Allowable bond stress intensity (kgf/cm^2).

Type of reinforcing bar	Specified concrete strength(kgf/cm^2)			
	210	240	300	400 min.
D57, D64 large-diameter threaded reinforcing bar Crack-control reinforcement	15	16	18	20

[Commentary]

This article was prescribed based on 14.3.1 in the Standard Specifications “Design Volume.”

Bond strengths of D57 and D64 large-diameter threaded reinforcing bars and concrete, according to the results of pull-out tests, are equal to the values for D51 threaded reinforcing bars. Therefore, it was decided that, along with crack-control reinforcement, the values given in 14.3.1 in the Standard Specifications "Design Volume” may be used.

6.3 Allowable Stress Intensities of Reinforcement

(1) The allowable tensile stress intensities of large-diameter threaded reinforcing bars meeting the requirements of “Large-diameter Threaded Reinforcing Bar Standards” and crack-control reinforcement meeting the requirements of JIS G 3112 shall be not more than the allowable stress intensities in Table 6.3.1 applicable respectively to the cases of (i), (ii), and (iii) below.

(i) In case of a general structure for which the influence of cracking is considered, the allowable stress intensity of reinforcing bars shall be suitably determined while not more than the allowable tensile stress intensity for the general case of (a) in Table 6.3.1.

(ii) In case of a member subject to extreme influence of repetitive load, the allowable tensile stress intensity of reinforcement shall not generally exceed the value of (b) allowable tensile stress intensity determined by fatigue strength.

(iii) In the event the influence of cracking is not taken into consideration, the value of allowable tensile stress intensity of reinforcement used shall be that of (c) allowable tensile stress intensity determined by yield strength of Table 6.3.1.

Table 6.3.1-Allowab1e tensile stress intensity of reinforcement, σ_{sa} (kgf/cm^2).

Type of reinforcement	SD295-N	SD345-N	SD390-N
(a)Allowable tensile stress intensity in general case	1800	1800	1800
(b)Allowable tensile stress intensity determined by fatigue strength	1800	1600	1800
(c)Allowable tensile stress intensity determined by yield strength	2000	1800	2200

(2) The allowable compressive stress intensities of large-diameter threaded reinforcing bars meeting the requirements of "Large-diameter Threaded Reinforcing Bar Standards" and crack-control reinforcement meeting the requirements of JIS G 3112 may be made the value of (c) allowable tensile stress intensity determined by yield strength in Table 6.3.1.

[Commentary]

This article was prescribed based on 14.3.2 in the Standard Specifications. "Design Volume."

Regarding (i) of (1) According to the results of static flexura1 loading tests of large beam specimens using D64 large-diameter threaded reinforcing bars, it has been confirmed that if cover and spacing of reinforcing bars are the same, maximum crack widths at the bottom surfaces of the beams are not different from those for D51 threaded reinforcing bars. At the same tine, it was confirmed that Eq. (7.3.1) in the Standard Specifications "Design Volume" can be applied in calculation of maximum crack width at the bottom surface of the beam when stress intensity of the D64 large-diameter threaded reinforcing bar is at allowable stress intensity (1800 kgf/cm^2), and that it is not more than the allowable crack width (case of environment in general) in Table 7.3.2 in the same "Design Volume." Therefore, it was decided that the allowable stress intensities of SD295-N, SD345-N, and SD390-N of D57 and D64 large-diameter threaded reinforcing bars are to be set appropriately with 1800 kgf/cm^2 as the upper limit and based on the Japan Society of Civil Engineers "Recommendations for Design of Reinforced Concrete Structures Using D51 Large-diameter Reinforcing Bars." (established 1977).

Further, from the results of static flexura1 loading tests of large beams using D64 large-diameter threaded reinforcing bars assuming use in beans and slabs, in case of arranging crack-control reinforcement of about 20% of the necessary reinforcement quantity, it has been ascertained that the available tensile stress intensity in a general case may be made 1800 kgf/cm^2. Still further, when using a suitable amount of crack-control reinforcement, it will suffice to ascertain that the stress intensity occurring at the centroid of the tension reinforcement group including D57 or D64 large-diameter threaded reinforcing bars and crack-control reinforcement is not more than the allowable stress intensity set based on the value of (a) allowable tensile stress intensity in general case in Table 6.3.1.

In the event watertightness or good appearance is especially required according to the purpose of use of the structure, the allowable stress intensity must be even lower than the value in Table 6.3.1 by a method based on the examination of crack width in 7.3 of the Standard Specifications "Design Volume" setting allowable crack widths according to necessity.

Regarding (ii) of (1) This article was prescribed since it has been confirmed that the 2-million-cycle fatigue strength of D64 large-diameter threaded reinforcing bars is higher than 1800 kgf/cm^2 and not different from D51 threaded reinforcing bars.

JAPAN SOCIETY OF CIVIL ENGINEERS STANDARD
STANDARDSFOR D57 AND D64 LARGE-DIAMETER THREADED REINFORCING BARS FOR REINFORCED CONCRETE (DRAFT)

1 . SCOPE OF APPLICATION

These Standards shall provide specifications regarding D57 and D64 large-diameter threaded reinforcing bars made by hot rolling for use in reinforcement of concrete.

2 . TYPES AND DESIGNATIONS

Large-diameter threaded reinforcing bars shall be of four types with their designations as shown in Table 1.

Table 1-Types and designations.

Classification	Designation of type
Large-diameter threaded reinforcing bar	SD295-N SD345-N SD390-N SD490-N

3 . CHEMICAL COMPOSITION

Large-diameter threaded reinforcing bars shall be tested according to 7.1, the analyses of melts being as shown in Table 2. When necessary to secure strength, elements other than in Table 2 may be added.

Table 2-Chemical composition (Part 1)

Designa-tion of type	Chemical composition, % (not more than)					
	C	Si	Mn	P	S	Cu
SD295-N	0.25	0.50	1.50	0.030	0.030	0.05
SD345-N	0.25	0.50	1.55	0.030	0.030	0.05
SD390-N	0.28	0.55	1.60	0.030	0.030	0.05
SD490-N	0.30	0.55	1.60	0.030	0.030	0.05

Table 2-Chemical composition (Part 2)

Designation of type	Chemical composition, % (not more than)			
	Sn	Cr	N (ppm)	C + 1/6 Mn
SD295-N	0.010	0.07	70	0.48
SD345-N	0.010	0.07	70	0.48
SD390-N	0.010	0.07	70	0.52
SD490-N	0.010	0.07	70	0.57

4 . MECHANICAL PROPERTIES

(1) Large-diameter threaded reinforcing bars shall be tested according to 7.2, with the yield point or 0.2% permanent deformation, tensile strength, and elongation according to Table 3.

When performing flexural tests under the conditions of Table 3, cracks shall not be formed on the outside surface.

Table 3 - Mechanical properties.

Designation of type deformation	Tension test			Flexural test	
	Yield point or 0.2% permanent N/mm^2	Tensile Strength N/mm^2	Elongation %	Bending angle	Inside Radius
SD295-N	295-375	440min.	18 min.	180^o	2 times nominal dia.
SD345-N	345-425	490min.	20 min.	180^o	2.5 times nominal dia.
SD390-N	390-470	560min.	18 min.	180^o	2.5 times nominal dia.
SD490-N	490-570	620min.	14 min.	90^o	3 times nominal dia.

(2) The strain value(1) of the yield plateau shall be tested according to 7.2.4, and shall be made not less than 1.0%.

Note (1): By strain value at yield plateau is meant the strain value when stress intensity of reinforcement reaches the yield point or upper limit of the standard value of 0.2% permanent deformation in Fig. 1.

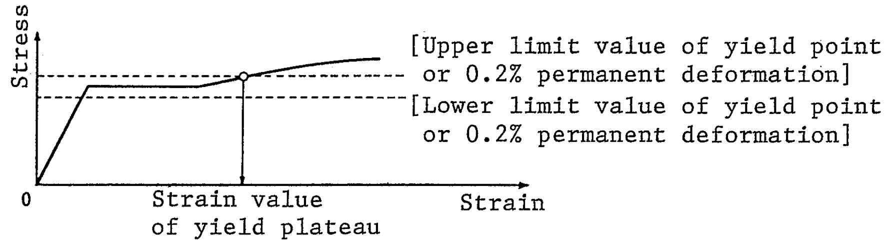


Fig. 1- Strain value of yield plateau.

(3) When performing tension tests using cut-out test pieces, evaluations of product yield point or 0.2% permanent deformation and tensile strength shall be made by Eqs. (4.1) and (4.2). The configuration and dimensions of test pieces in this case shall be according to 7.2.2.
However, for elongation and strain value at the yield plateau when performing tension tests using cut-out test pieces, the measurements obtained with the cutout test pieces shall be used without modifications.

$$\left(f_{yL}/0.90\right) \leq f_y \leq \left(f_{yU}/0.95\right) \tag{4.1}$$

where, f_{yL} , f_{yU} : lower limit value and upper limit value of yield point or 0.2% permanent deformation given in Table 3

f_y : measured value of yield point or 0.2% permanent deformation according to cut-out test piece

$$\left(f_{uL}/0.90\right) \leq f_u \tag{4.2}$$

where, f_{yL} : lower limit value of tensile strength given in Table 3

f_u : measured value of tensile strength according to cut-out test piece

(4) The purchaser, in the event there is a necessity in particular, may designate performance of Charpy impact tests. In such case, the Charpy impact tests shall be performed according to 7.2.5. The temperature of the test piece at this time shall be 0^{o}C, and it shall be confirmed that with regard to Charpy absorption energy the average value for 3 test pieces is not less than 47 J. In the event other specifications are required, they shall be agreed upon between the parties concerned with the delivery.

5. CONFIGURATION, DIMENSIONS, WEIGHT AND TOLERANCES

5 .1 Configuration

The configuration shall be according to the following.

(1) The large-diameter threaded reinforcing bar shall possess screw-shaped protrusions (hereinafter referred to as "1ugs") at the surface having a certain angle to the axial direction(2).

Note (2): A protrusion in the axial direction shall be referred to as a rib with protrusions other than ribs referred to as lugs.

(2) Lugs on a large-diameter threaded reinforcing bar shall be distributed at approximately constant intervals over the entire length, and shall have identical configurations and dimensions. However, in case of embossing with letters, numerals, etc., lugs may be omitted from those parts.

(3) Bases of lugs on large-diameter threaded reinforcing bars shall be of configurations for stress concentrations to be small.

5.2 Configurations, Dimensions, Weights, and Tolerances

Configurations, dimensions, weights, and tolerances thereof shall be according to the following.

(1) Dimensions, and allowable limits of lugs of large-diameter threaded reinforcing bars shall be according to Table 4.

Table 4-Dimensions, weights, and allowable limits of lugs.

Item			Designation	
			D57	D64
Nominal diameter (d)		mm	57.2	63.5
Nominal circumference (A)		cm	18.0	20.0
Nominal cross-sectional area (S)		cm^2	25.70	31.67
Unit weight		kg/m	20.2	24.9
Maximum value of average lug spacing		mm	40.0	44.4
Lug height	minimum	mm	2.9	3.2
	maximum	mm	5.8	6.4
Maximum value of sum of spacing between lugs		mm	45.0	50.0
Angle between lug and axial line			45^{o}min.	45^{o}min

Remark Methods of calculating nominal cross-sectional area, nominal circumference, lug spacing, and lug height shall be according to 5. of JIS G 3112 (Steel Bars for Concrete Reinforcement).

(2) Standard lengths of large-diameter threaded reinforcing bars shall be not less than 6 m and not more than 12 m, at 0.5 m pitch. However, the purchaser may specify a length other than the above upon discussion with the manufacturer.

(3) The tolerance on length of a large-diameter threaded reinforcing bar shall be +40 mm and -0 mm. However the purchaser may specify a tolerance other than the above upon discussion with the manufacturer.

(4) The tolerance on a large bend in a large-diameter threaded reinforcing bar shall be not more than 0.3% of the length.

(5) The tolerance on weight of a single large-diameter threaded reinforcing bar shall be ±4.0%. The methods of obtaining the sample and calculating tolerance shall be according to 7.3.

(6) The tolerance on the weight of a set of large-diameter threaded reinforcing bars shall be ±3.5%. However, this shall be applied in the event there is a specification by the purchaser. Further, the methods

of obtaining samples and calculating tolerance shall be according to 7.3.

6. APPEARANCE

Large-diameter threaded reinforcing bars shall not have defects injurious to use.

7 . TESTS

7 .1 Analytical Tests

Analytical tests shall be according to the following.

(1) General matters concerning analytical tests and method of obtaining samples for analyses shall be according to 3. of JIS G 0303 (General Rules for Inspection of Steel).

(2) The method of analysis shall be in accordance with one of the following:
JIS G 1211 (Methods for Determination of Carbon in Iron and Steel)
JIS G 1212 (Methods for Determination of Silicon in Iron and Steel)
JIS G 1213 (Methods for Determination of Manganese in Iron and Steel)
JIS G 1214 (Methods for Determination of Phosphorous in Iron and Steel)
JIS G 1215 (Methods for Determination of Sulfur in Iron and Steel)
JIS G 1217 (Methods for Determination of Chromium in Iron and Steel)
JIS G 1219 (Methods for Determination of Copper in Iron and Steel)
JIS G 1226 (Methods for Determination of Tin in Iron and Steel)
JIS G 1228 (Methods for Determination of Nitrogen in Iron and Steel)
JIS G 1253 (Method for Photoelectric Emission Spectrochemical Analysis of Iron and Steel)
JIS G 1256 (Method for Fluorescent X-ray Analysis of Iron and Steel)
JIS G 1257 (Atomic Absorption Spectrochemical Analysis of Iron and Steel)
JIS G 1258 (Method for Inductively Coupled Plasma Emission Spectrochemica1Analysis of Steel) JIS

7.2 Mechanical Tests

7.2.1 Tests in General

General matters concerning mechanical tests shall be according to 4. of JIS G 0303. In this case, the method of collecting samples shall be according to Class A and the number of samples according to the following.

(1) The numbers of tensile test pieces and flexural test pieces shall be one each for bars of identical diameters from the same melt as one group. However, when 100 t are exceeded, two samples each shall be obtained.

7.2.2 Tensile Test Pieces and Flexural Test Pieces

Tensile test pieces and flexural test pieces shall be according to the following.

(1) Tensile test pieces may be product as is or cut-out test pieces. In case of performing tests on product as is, the test piece shall be a No. 3 type test piece as specified in JIS Z 2201 (Tension Test Pieces for Metallic Materials), and the test piece shall be the product as is and not machine-finished. In case of testing with a cut-out test piece, the test piece shall be of circular cross section of diameter 35 mm with the center of the reinforcing bar as the center, and machine finishing shall be done for the length of the parallel part to be not less than 160 mm.

Gauge length shall be 4 times the nominal diameter in case of a No. 3 test piece of the product as is, and 140 mm in case of a cut-out test piece.

(2) Flexural test pieces shall be No.2 test pieces specified in JIS Z 2204 (Bend Test Pieces for Metallic Materials) and shall be the product as is and not machine-finished.

7.2.3 Methods of Tension Tests and Flexure Tests

Methods of tension tests and flexure tests shall be according to the following. However, the cross-sectional area used in case of a test piece of the product as is for obtaining yield point or 0.2% permanent deformation, tensile strength, and strain at yield plateau shall be the nominal cross section in Table 4. The cross-sectional area for a cut-out test piece in case of obtaining yield point or 0.2% permanent deformation, tensile strength, and strain at yield plateau shall be the value calculated from the measurements of diameter of machine finished test pieces.

(1) JIS Z 2241 (Method of Tension Test for Metallic Materials)
(2) JIS Z 2248 (Method of Bend Test for Metallic Materials)

7.2.4 Method of Testing Strain Value at Yield Plateau

The method of testing for strain value at the yield plateau shall be that of performing tension tests according to JIS Z 2241 (Method of Tension Test for Metallic Materials). The test piece and gauge length when measuring strain shall be identical to 7.2.2, and the load and elongation shall be measured using measuring jigs and measuring equipment. The cross-sectional area in case of obtaining stress shall be according to 7.2.3.

7.2.5 Chary Impact Test Method

A test piece for use in Charpy impact tests shall be sampled according to 4.2(1) of JIS G 0303 (General Rules for Inspection of Steel), performing fabrication of the No. 4 test piece specified in JIS Z 2202 (Impact Test Pieces for Metallic Materials) and with testing performed according to JIS Z 2242 (Method of Impact Test for Metallic Materials).

7.3 Measurements of Configuration, Dimensions, and Weight

The method of obtaining samples and methods of measuring configuration, dimensions and weights of large-diameter threaded reinforcing bars shall be according to 8.3 of JIS G 3112 (Steel Bars for Concrete Reinforcement).

8. INSPECTION

Inspections shall be according to the following.

(1) Chemical compositions, mechanical properties, configuration, dimensions, weights, and appearances shall meet the requirements of 3., 4., 5., and 6.

(2) Items not meeting requirements may be reinspected according to 4.4. of JIS G 0303 (General Rules for Inspection of Steel) to determine whether or not meeting requirements.

In the event of not meeting requirements on evaluation by tension tests using cut-out test pieces of yield point or 0.2% permanent deformation, tensile strength, elongation, and strain value of yield plateau, reinspection may be done by tension tests using test pieces of product as is to determine whether or not meeting requirements.

(3) In the event of the weight of a single large-diameter threaded reinforcing bar sampled at random not meeting the requirements of 5.2(5), two samples shall be obtained anew and measurements made, and the lot deemed acceptable if both meet requirements.

9. MARKING

Large-diameter threaded reinforcing bars shall be provided with the markings specified in 9.1 and 9.2.

9.1 Marking of Individual Bars

Marking by individual bars shall be according to the following.

(1) Marking to differentiate according to type shall be done according to Table 5. Marking shall be by rolled marks or by painting on different colors.

Table 5-Method of marking to differentiate between types.

Designation of type	Method of marking to differentiate between types	
	Rolled marking	Color marking
SD295-N	1 or	White(half section)
SD345-N	1 protrusion (*)	yellow(half section)
SD390-N	2 protrusions (**)	Green(half section)
SD490-N	3 protrusions (***)	Blue(half section)

(2) A large-diameter threaded reinforcing bar shall indicate the manufacturer's name or code by rolled markings. However, in case the name of the manufacturer is distinctly known by the configuration of the surface, the marking may be omitted.

9.2 Marking by Bundle

Marking by bundle shall be according to 10.2 of JIS G 3112 (Steel Bars for Concrete Reinforcement).

10. REPORT

The report shall be according to 8. of JIS G 0303 (General Rules for Inspection of Steel).