

DOI: 10.32347/2522-4182.18.2026.33-42  
 UDC 624.012.45:624.04:624.072.2:693.554(091)

## DESIGN AND DETAILING OF REINFORCED CONCRETE ELEMENTS UNDER TORSION: NORMATIVE APPROACHES AND PRACTICAL FEATURES

*Leonid SKORUK*

Kyiv National University of Construction and Architecture,  
 31, Povitrianykh Syl Ave., Kyiv, Ukraine, 03037

skoruk.slm@gmail.com, <https://orcid.org/0000-0002-7362-1348>

**Abstract.** The article examines modern normative and practical approaches to the design and detailing of reinforced concrete elements under torsion in accordance with the requirements of DBN V.2.6-98:2009 and DSTU B V.2.6-156:2010, which are harmonized with European standards [1-7]. The physical nature of torsion as a complex three-dimensional stress-strain state is revealed, accompanied by the occurrence of principal tensile and compressive stresses oriented at an angle to the longitudinal axis of the element. The features of reinforced concrete behavior under torsional moments, the mechanism of spatial inclined crack formation, and the causes of reduction in load-bearing capacity of elements compared to bending are analyzed. It is shown that in most cases torsion acts in combination with bending and shear force, which significantly complicates the design and requires consideration of internal force interaction.

The paper presents a classification of torsion into primary (equilibrium) and secondary (compatibility) torsion, defines fundamental differences between them and features of consideration in engineering practice. Cases when torsion design is mandatory are considered, as well as situations where limitation to minimum reinforcement without detailed verification of load-bearing capacity is permitted.

The deformation model of the space truss and the concept of equivalent thin-walled closed cross-section, which form the basis of modern normative design methods [7-20], are detailed. The principle of determining shear stresses in the walls of the equivalent cross-section, the mechanism of concrete compression struts, and the role of transverse and longitudinal reinforcement in



resisting tensile forces are described. Limit state verification criteria are provided, particularly conditions for preventing crushing of concrete struts, as well as features of selecting the inclination angle of compressed members of the space truss.

The article analyzes the combined action of torsion, shear force and bending, presents conditions for superposition of internal forces and principles for total determination of required reinforcement area. Special attention is paid to detailing requirements for elements working under torsion, particularly the use of closed stirrups, uniform distribution of longitudinal reinforcement along the cross-section perimeter, and ensuring reliable anchorage of the reinforcement cage. Features of open thin-walled cross-sections are considered, for which warping and additional normal stresses must be accounted for.

The obtained results generalize modern normative approaches to the design of reinforced concrete elements under torsion and can be used in the design of beams, girders, frame and spatial structures where torsion is a determining or accompanying factor of the stress-strain state.

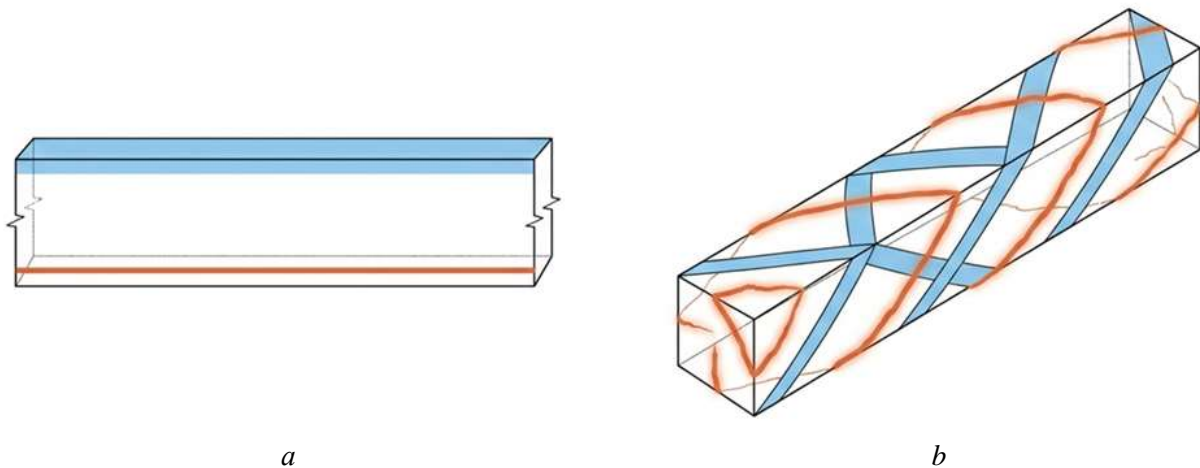
**Keywords:** torsional moment; spiral cracks; warping; shear stress.

© L. Scoruk, 2026

## PROBLEM STATEMENT

Torsion is a complex stress state in which principal tensile and compressive stresses occur in a reinforced concrete element, directed at an angle of  $45^\circ$  to its longitudinal axis [1-5].

Torsion transforms a linear element into a spatial system. Unlike bending, principal stresses "wrap" the element spirally (Fig. 1), requiring three-dimensional reinforcement [7-9].



**Fig. 1** The nature of spatial torsion: bending (a) and torsion (b).

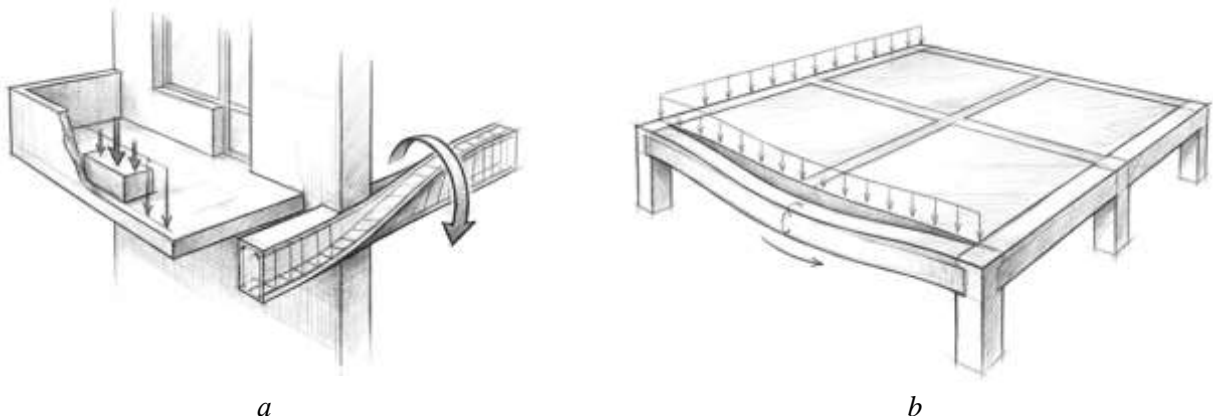
**Рис. 1** Природа просторового крутіння: згин (а) та крутіння (б).

Torsion rarely acts in pure form, but often accompanies bending. Typically torsion occurs in elements with asymmetric loading: in beams with one-sided cantilever slabs (e.g., balconies), edge frame girders, or in masts when wires break on one side.

The danger of torsion lies in the fact that the resistance of reinforced concrete to it is significantly less than to bending. Due to low tensile strength of concrete, dangerous spiral cracks form already at early loading stages. They encompass all four faces of the element,

and without proper reinforcement the structure can quickly fail along a spatial section.

According to current codes, torsion is divided into two categories: primary (equilibrium) and secondary (compatibility) torsion. Examples of such torsion are shown in Fig. 2.



**Fig. 2** Two types of torsion: Equilibrium torsion (a) and compatibility torsion (b).

**Рис. 2** Два види крутіння: крутіння рівноваги (а) та крутіння сумісності (б).

If the static equilibrium of the entire structure depends on the torsional capacity of elements (primary torsion), design is mandatory and requires complete verification for first and second limit states. Such structures include, for example, edge beams, spatial frames, or elements curved in plan (Fig. 2, a).

In statically indeterminate structures, torsion often arises only as a result of deformation compatibility of adjacent elements (secondary torsion). In such cases, structural stability does not depend on torsional resistance, therefore when checking the ultimate limit state it can generally be neglected (Fig. 2, b)

Despite the fact that for secondary torsion, strength verification can be neglected, to prevent excessive crack opening it is mandatory to provide minimum reinforcement in the form of closed stirrups and longitudinal bars.

Clear identification of the torsion type determines the necessity of detailed reinforcement design.

The design of reinforced concrete elements under torsional moments is performed based on the spatial failure model (spatial section model). The torsional resistance of the cross-section is determined based on the thin-walled closed cross-section model, in which equilibrium is ensured by a closed flow of shear stresses. Solid cross-sections are modeled as equivalent thin-walled hollow cross-sections.

Complex cross-sections, such as T-shaped or I-shaped, are divided into several simpler rectangular components for design. The total torsional resistance of such an element is taken as the sum of resistances of its individual parts, and the distribution of external torsional moment between them is carried out proportionally to their torsional stiffnesses in the uncracked stage. For hollow cross-sections, the actual wall thickness is the upper limit (Fig. 3-5).

Shear stress  $\tau_{t,i}$  in the wall of the equivalent cross-section from pure torsional moment  $T_{Ed}$  is determined from equilibrium conditions of the closed contour. Shear force  $V_{Ed,i}$  in each  $i$ -th wall is calculated as the product of shear stress  $\tau_{t,i}$ , reduced wall thickness  $t_{ef,i}$  and length of the wall side  $z_i$ .

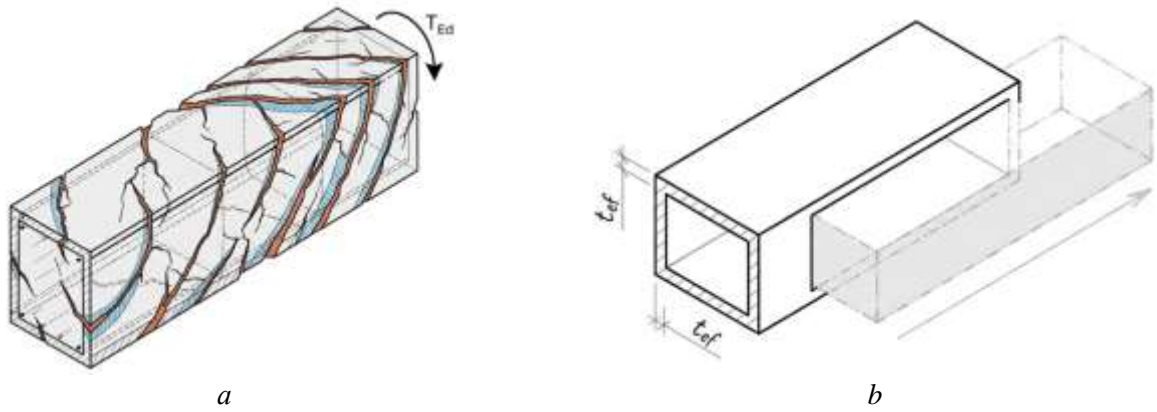
According to the deformation model (space truss analogy), after diagonal crack formation, torsional resistance is provided by a spatial lattice where concrete between cracks works as compression struts, and transverse and longitudinal reinforcement works as tension ties (Fig. 6). The length of side  $z_i$  is determined as the distance between intersection points of axes of adjacent walls.

The area  $A_k$ , used in equilibrium equations (Bredt-Batho formula) is the area enclosed precisely by the centerline of connected walls of the equivalent cross-section, and includes the area of the internal hollow region. Accurate determination of  $A_k$  is critical for correct shear stress calculation.

Under torsion, shear stresses concentrate at the periphery. The internal concrete core is ignored since shear stresses circulate only along the element perimeter (Fig. 3, b). For torsion design, a solid massive cross-section is modeled as a closed "thin-walled tube" (Fig. 4, 5). The effective wall thickness of this tube is calculated as  $t_{ef}=A/u$ , but cannot be less than twice the distance from the face to the longitudinal reinforcement axis. The physics of the "thin-walled tube" is universal. These DBN rules apply to T-shaped, I-shaped, or hollow elements. The torsion flow wraps around internal voids.

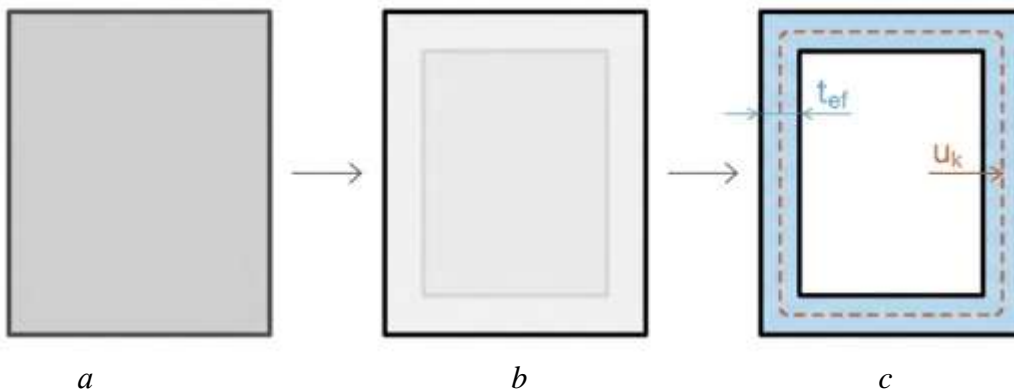
The thin-walled tube is designed by analogy with a space lattice truss. In this model, concrete forms compression struts (diagonals) at angle  $\theta$ , and closed stirrups and longitudinal bars work as tension members (ties and chords of the truss).

The inclination angle of concrete compression struts  $\theta$  is not fixed; it can be chosen within the range from  $21,8^\circ$  to  $45^\circ$  ( $1 \leq \cot \theta \leq 2,5$ ). Changing this angle allows optimization of costs: a smaller angle requires fewer stirrups but more longitudinal reinforcement, and vice versa.



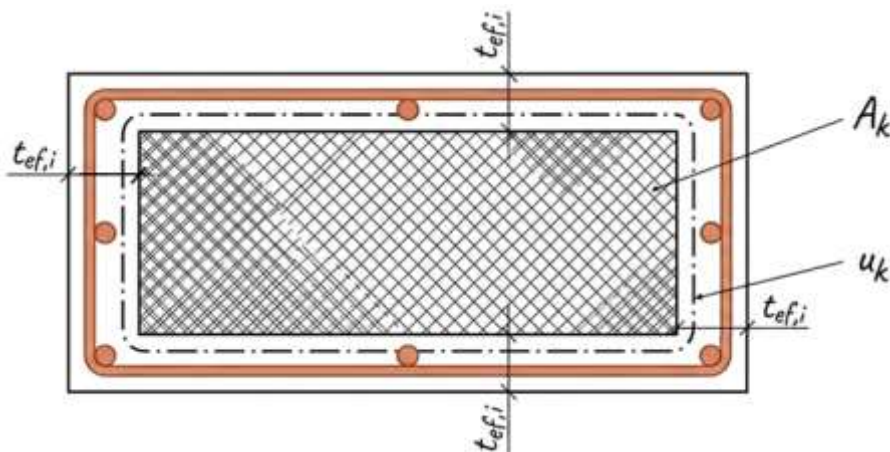
**Fig. 3** Spatial model of torsional failure (a) and cross-section abstraction for calculation – from solid section to thin-walled pipe (b).

**Рис. 3** Просторова модель руйнування від дії кручення (а) та абстракція перерізу для розрахунку – від суцільного перерізу до тонкостінної труби (б).



**Fig. 4** Equivalent thin-walled cross-section: solid cross-section (a), ignoring the core (b), equivalent tube (c).

**Рис. 4** Еквівалентний тонкостінний переріз: суцільний переріз (а), ігнорування ядра (б), еквівалентна труба (в).



**Fig. 5** Geometry of the equivalent cross-section:  $t_{ef,i}$  – effective wall thickness,  $A_k$  – area inside the centerline of the equivalent wall (shaded area),  $u_k$  – perimeter of the area  $A_k$ .

**Рис. 5** Геометрія еквівалентного перерізу:  $t_{ef,i}$  – ефективна товщина стінки,  $A_k$  – площа всередині осьової лінії еквівалентної стінки (заштрихована зона),  $u_k$  – периметр площі  $A_k$ .

If the acting torsional moment exceeds this value and the concrete strength condition is not satisfied, increasing the reinforcement amount will not help – it is necessary to increase the concrete cross-section dimensions or increase the concrete strength class.

In real structures, torsion almost always accompanies shear force action. Since these forces compete for the same concrete struts (Fig. 8, a), their shear stresses add on one face of the cross-section, creating a critical zone.

Under combined action of shear and torsion, the inclination angle of compression struts  $\theta$  must be taken equal for both types of design (Fig. 6, 7). The design reinforcement area (both transverse and longitudinal) is determined as the sum of reinforcement required to resist shear and reinforcement for torsion.

To prevent brittle concrete failure, the superposition condition (linear interaction) is mandatory (Fig. 8):

$$\frac{T_{Ed}}{T_{Rd,max}} + \frac{V_{Ed}}{V_{Rd,max}} \leq 1,0. \quad (1)$$

To resist tensile forces from torsion, joint action of both reinforcement types is necessary: closed transverse stirrups and longitudinal bars acting as a unified spatial cage. Torsional moment generates a uniform shear stress flow, therefore each stirrup leg works in tension.

$$\frac{A_{sw}}{s} = \frac{T_{Ed}}{2A_k f_{ywd} \cot\theta} \quad (2)$$

The calculated area is added to the stirrup area required for shear ( $V_{Ed}$ ).

Element bending creates zones of pure compression and pure tension. According to DBN/DSTU, tensile stresses from torsion are subtracted from compression stresses from bending in the upper zone (which reduces the need for longitudinal torsion reinforcement), but are added to tensile stresses from bending in the lower zone (which significantly increases the amount of bottom reinforcement).

In element flanges compressed from bending, the design amount of longitudinal

torsion reinforcement may be reduced proportionally to the existing compressive force in concrete. However, in tension flanges, torsion reinforcement must be added to longitudinal reinforcement. This area is distributed along the cross-section perimeter and added to reinforcement designed for bending ( $M_{Ed}$ ).

The total area of additional longitudinal reinforcement  $\Sigma A_{sl}$  designed for torsion must be uniformly distributed along the entire inner perimeter of stirrups, not concentrated only in the tension zone from bending (Fig. 9).

$$\Sigma A_{sl} = \frac{T_{Ed} u_k}{2A_k f_{yd}} \cot\theta \quad (3)$$

Even with accurate design, spatial element behavior under torsion will not be ensured without proper detailing. Transverse reinforcement working under torsion must be executed exclusively as closed stirrups reliably anchored in compressed and tensile zones.

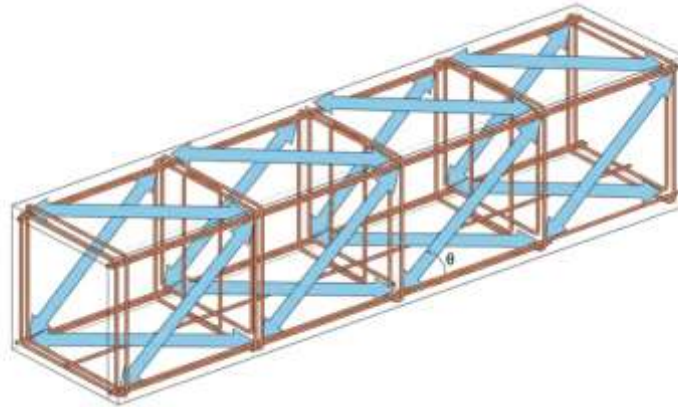
Longitudinal reinforcement must be located along the cross-section perimeter. For small cross-sections it may be concentrated at corners (at the ends of each wall length) to ensure formation of a spatial reinforcement cage.

Since torsion causes spiral cracks on all element faces, stirrups must have reliable lapping or welded hooks to avoid stirrup opening when the concrete cover spalls at cross-section corners (Fig. 9-11).

Torsion requires absolute closure of the contour. Ordinary open U-shaped stirrups used for bending do not work under torsion because warping (distortion) of the cross-section occurs.

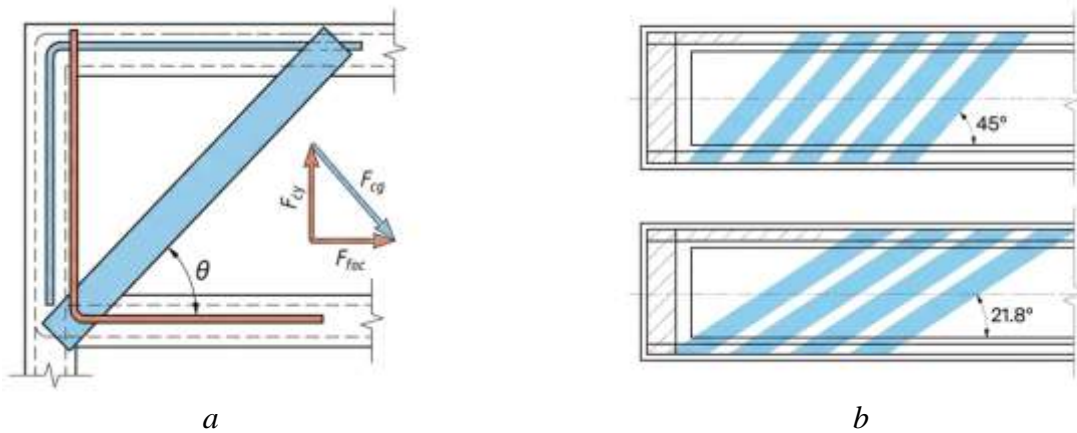
Stirrups must be closed with reliable anchorage by hooks at 135° angle into the concrete core (рис. 9, a). U-shaped stirrup forms are unacceptable.

Longitudinal bars act as chords of the space truss, restraining diagonal crack opening. They must be located strictly at the corners of closed stirrups to resist local bearing stresses from concrete struts (Fig. 9, b).



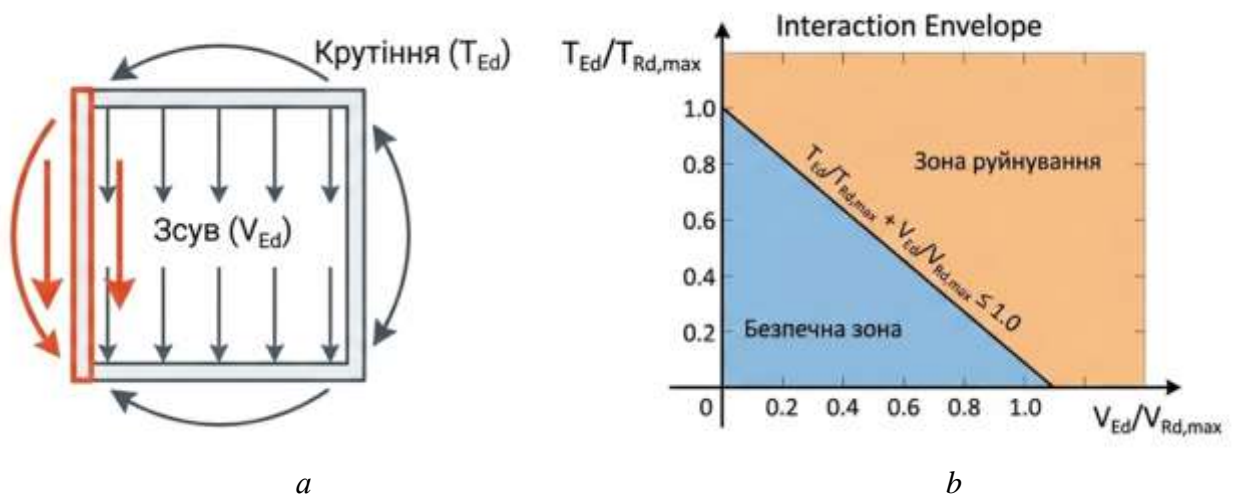
**Fig. 6** Spatial calculation model: changing the angle  $\theta$  determines the balance between the required concrete and reinforcement.

**Fig. 6** Просторова розрахункова модель: зміна кута  $\theta$  визначає баланс між необхідним бетоном та арматурою.



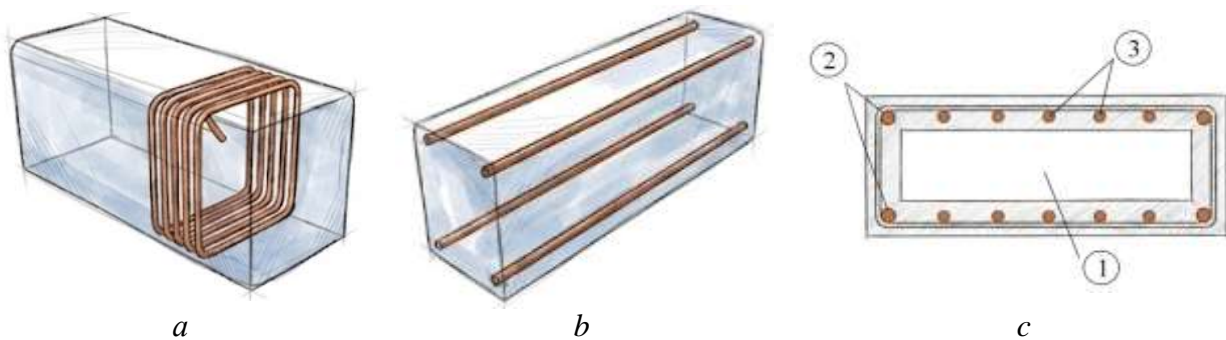
**Fig. 7** Kinematics of the truss (a) and the angle of compressed braces (b).

**Рис. 7** Кінематика ферми (а) та кут стиснутих розкосів (б).



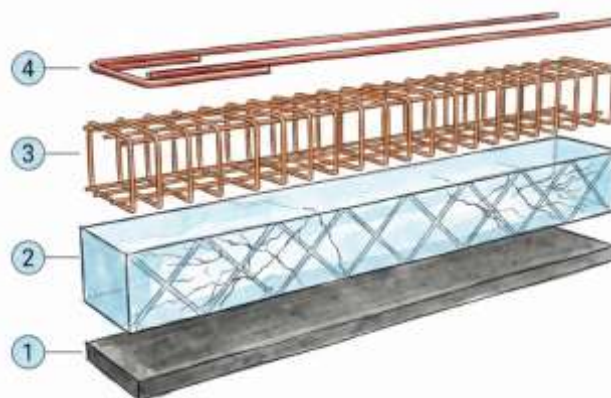
**Fig. 8** Shear and torsion interaction (a), interaction envelope (b).

**Рис. 8** Взаємодія зсуву та крутіння (а), оболонка взаємодії (б).



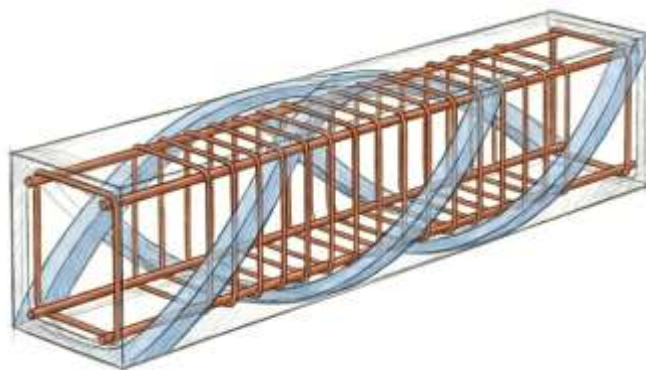
**Fig. 9** Design requirements: fixed clamps (a), longitudinal anchoring at corners (b), uniform spacing of longitudinal bars along the contour of the section (c), 1 – unreinforced central zone, 2 – mandatory rod in each corner, 3 – rod spacing along the contour of the clamps  $\leq 350$  mm.

**Fig. 9** Конструктивні вимоги: замкнені хомути (а), поздовжнє анкерування у кутах (б), рівномірний крок поздовжніх стержнів по контуру перерізу (в), 1 – неармована центральна зона, 2 – обов'язковий стрижень у кожному куті, 3 – крок стрижнів вздовж контуру хомутів  $\leq 350$  мм.



**Fig. 10** Anatomy of an element during torsion: 1 – concrete core, 2 – concrete compressed struts, 3 – transverse reinforcement (clamps), 4 – longitudinal reinforcement.

**Fig. 10** Анатомія елемента при крутінні: 1 – бетонне ядро, 2 – бетонні стиснуті підкоси, 3 – поперечна арматура (хомути), 4 – поздовжня арматура.



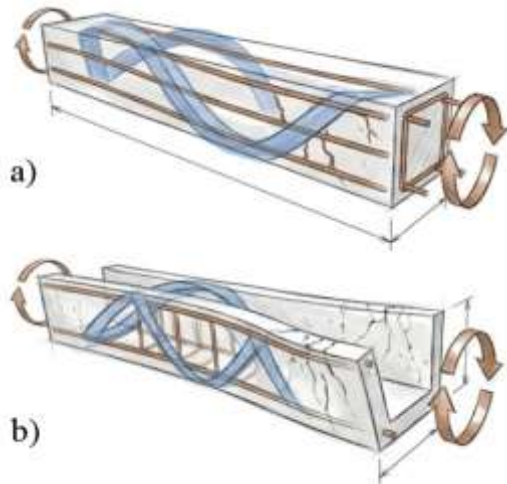
**Fig. 11** Engineering deconstruction of the work of a reinforced concrete cross-section in torsion.

**Fig. 11** Інженерна деконструкція роботи залізобетонного перерізу на крутіння.

Maximum longitudinal stirrup spacing is strictly limited by the smallest cross-section dimension, distance  $u_k/8$ , and cannot exceed 300 mm. The distance between longitudinal bars along the stirrup contour must not exceed 350 mm (Fig. 9, c).

Pull-out forces under torsion push reinforcement outward. Poor anchorage equals torsional section failure.

The universal deformation model and thin-walled closed cross-section model are based on the assumption of free torsion without significant cross-section warping from the plane. For closed thin-walled and solid cross-sections, warping under torsion can generally be neglected (Fig. 12).



**Fig. 12** Effect of deplaning: closed and solid sections (a), open thin-walled sections (b)  
**Fig. 12** Вплив депланації: закриті та суцільні перерізи (а), відкриті тонкостінні перерізи (б).

However, for open thin-walled elements (e.g., channels or I-beams without end stiffening ribs), warping causes significant additional normal stresses. In such cases, classical formulas are inaccurate.

For open thin-walled elements, codes require mandatory consideration of warping under torsion. Their design must be carried out based on more complex beam-lattice or "truss" models capable of accounting for combined action of bending and longitudinal normal force and shear caused by warping.

## CONCLUSIONS

The design and detailing of reinforced concrete elements under torsion is one of the most complex areas of design, since such a stress-strain state is accompanied by spatial behavior of concrete and reinforcement, formation of inclined spatial cracks, and significant interaction of torsion with bending and shear force. The conducted analysis of normative provisions of DBN V.2.6-98:2009 and DSTU B V.2.6-156:2010 showed that

modern methods are based on the deformation model of the space truss and the concept of equivalent thin-walled closed cross-section, which quite accurately describe element behavior after cracking.

It is established that the key stage of design is correct determination of the torsion character — primary (equilibrium) or secondary (compatibility). This determines the necessity of complete load-bearing capacity calculation and the scope of detailing measures. For primary torsion, complete verification for limit states is mandatory, while for secondary torsion in many cases it is permissible to limit to minimum reinforcement aimed at limiting crack formation and ensuring spatial element rigidity.

The study showed that the limit state under torsion is determined not only by reinforcement strength, but primarily by the load-bearing capacity of concrete compression struts. The condition of preventing concrete crushing is determining, and exceeding the limit torsional moment cannot be compensated by simply increasing the reinforcement amount. In such cases, increasing the concrete class or increasing cross-section geometric dimensions is necessary. This confirms that the efficiency of element behavior under torsion is largely determined by spatial geometry and cross-section rigidity.

Special attention must be paid to the combined action of torsion, shear force and bending, since all these factors use a common mechanism of force transfer through concrete struts and the reinforcement system. In this case, design must be performed according to the internal force interaction condition, and the inclination angle of concrete struts must be taken uniform for combined element behavior. Design practice shows that ignoring the combined action of internal forces often becomes the cause of local damage and brittle structural failure.

The work also confirmed the decisive importance of proper reinforcement detailing. Spatial element behavior under torsion is possible only with the use of closed stirrups, uniform distribution of longitudinal reinforcement along the perimeter, and ensuring reliable anchorage of all reinforcement cage elements. Open stirrups or insufficient corner zone reinforcement do not

allow formation of an effective space truss and lead to intensive development of spiral cracks.

Thus, detailing requirements in torsion design have no less important significance than analytical verifications themselves.

It should be noted separately that classical normative models are effective mainly for closed or solid cross-sections where warping can be neglected. For open thin-walled elements, it is necessary to use more complex spatial models capable of accounting for additional normal stresses from cross-section warping. This indicates the importance of correct selection of the design model depending on structure type and its working conditions.

Therefore, the modern approach to designing reinforced concrete elements under torsion is based on combining physically justified deformation models, normative requirements, and detailing principles for ensuring spatial behavior. Comprehensive consideration of torsion, shear and bending allows increasing reliability and durability of structures, avoiding brittle failure forms, and ensuring safe operation of spatial and frame systems under real working conditions.

#### ETHICAL DECLARATIONS

The authors have no relevant financial or non-financial interests to report.

#### REFERENCES

1. **Model Code 2010** – First complete draft, Volume 1. *Fib Bulletin* (55), 318 s. DOI: [doi.org/10.35789/fib.BULL.0055](https://doi.org/10.35789/fib.BULL.0055)
2. **Model Code 2010** – First complete draft, Volume 2. *Fib Bulletin* (56), 312 s. DOI: [doi.org/10.35789/fib.BULL.0056](https://doi.org/10.35789/fib.BULL.0056)
3. **fib Model Code for Concrete Structures 2010**. *International Federation for Structural Concrete (fib)*, p. 402. DOI: [10.1002/9783433604090](https://doi.org/10.1002/9783433604090)
4. **Mosley, W. H., Bungey, J. H., & Hulse, R.** (2012). Reinforced concrete design to Eurocode 2. *CRC Press*. p. 448
5. **Toniolo, G., & di Prisco, M.** (2017). Reinforced concrete design to Eurocode 2. *Springer*. p.836
6. **Bond, A. J.** (2018). How to design concrete structures using Eurocode 2. *MPA The Concrete Centre*. p. 114.
7. **Bernardo, L. F. A., & Lopes, S. M. R.** (2008) Behaviour of concrete beams under torsion: NSC plain and hollow beams. *Materials and Structures*, 41, 1143–1167. DOI: [10.1617/s11527-007-9315-0](https://doi.org/10.1617/s11527-007-9315-0)
8. **Bernardo, L.** (2019) Modeling the Full Behavior of Reinforced Concrete Flanged Beams under Torsion. *Applied Sciences*, 9(13), 2730. <https://doi.org/10.3390/app9132730>
9. **Bernardo, L. F. A., Taborda, C., & Andrade, J.** (2018) Generalized Softened Variable Angle Truss Model for PC Beams under Torsion. *International Journal of Concrete Structures and Materials* 12(1), Article 62. DOI: [10.1186/s40069-018-0285-0](https://doi.org/10.1186/s40069-018-0285-0)
10. **Deifalla, A., & Ghobarah, A.** (2014) Behavior and analysis of inverted T-shaped RC beams under shear and torsion. *Engineering Structures*, 68, 57–70. <https://doi.org/10.1016/j.engstruct.2014.02.011>
11. **Bernardo, L. F. A., & Lopes, S. M. R.** (2011) Theoretical behavior of HSC sections under torsion. *Engineering Structures*, 33, 3702–3714 <https://doi.org/10.1016/j.engstruct.2011.08.007>
12. **Ju, H., Lee, D., Kim, J. R., & Kim, K. S.** (2020) Maximum torsional reinforcement ratio of reinforced concrete beams. *Structures*, 23, 481–493. <https://doi.org/10.1016/j.istruc.2019.09.007>
13. **Ibrahim, M. S., Gebreyouhannes, E., Muhdin, A., & Gebre, A.** (2020). Effect of concrete cover on the pure torsional behavior of reinforced concrete beams. *Engineering Structures*, 216, 110790. <https://doi.org/10.1016/j.engstruct.2020.110790>
14. **Salama, A. E., Kasseem, M. E., & Mahmoud, A. A.** (2018) Torsional behavior of T- shaped reinforced concrete beams with large web openings. *Journal of Building Engineering*, 18, 84–94. <https://doi.org/10.1016/j.jobee.2018.02.004>
15. **Fang, I.-K., Lin, T.-J., & Chang, J. J.-L.** (2012) Behavior of reinforced concrete beams subjected to combined bending, shear and torsion. *Journal of the Chinese Institute of Civil and Hydraulic Engineering*, 24(2), 135–145.
16. **Ilkhani, M. H., Naderpour, H., & Kheyroddin, A.** (2019) A proposed novel approach for torsional strength prediction of RC beams. *Journal of Building Engineering*, 25, 100810. <https://doi.org/10.1016/j.jobee.2019.100810>
17. **Rahal, K. N.** (2013) Torsional strength of normal and high strength reinforced concrete beams. *Engineering Structures*, 56, 2206–2216. <https://doi.org/10.1016/j.engstruct.2013.09.005>

18. Kim, H.-G., Jo, M.-S., Kim, D.-H., Park, J.-H., & Kim, K.-H. (2026) Delay in torsional failure of under-reinforced concrete beams subjected to combined shear, non-uniform bending, and torsion. *Journal of Building Engineering*, 125, 116168  
<https://doi.org/10.1016/j.jobe.2026.116168>
19. Tulonen, J., & Laaksonen, A. (2019) Variable compression panel thickness for concrete members under bending and torsion: Experimental study. *Engineering Structures*, 279, 115606.  
<https://doi.org/10.1016/j.engstruct.2023.115606>
20. Fang, I.-Kuang, & Shiau, J.-K. (2004) Torsional Behavior of Normal- and High-Strength Concrete Beams. *ACI Structural Journal*, 101, 304–313 DOI: 10.14359/13090

## РОЗРАХУНОК ТА КОНСТРУЮВАННЯ ЗАЛІЗОБЕТОННИХ ЕЛЕМЕНТІВ НА КРУТІННЯ: НОРМАТИВНІ ПІДХОДИ ТА ПРАКТИЧНІ ОСОБЛИВОСТІ

Леонід СКОРУК

**Анотація.** У статті розглянуто сучасні нормативні та практичні підходи до розрахунку і конструювання залізобетонних елементів на крутіння відповідно до вимог ДБН В.2.6-98:2009 та ДСТУ Б В.2.6-156:2010. Висвітлено фізичну природу крутіння як складного просторового напружено-деформованого стану, що супроводжується виникненням головних розтягувальних і стискальних напружень, орієнтованих під кутом до поздовжньої осі елемента. Проаналізовано особливості роботи залізобетону при дії крутних моментів, механізм утворення просторових похилих тріщин та причини зниження несучої здатності елементів у порівнянні з роботою на згин. Показано, що крутіння у більшості випадків діє сумісно із згином та поперечною силою, що суттєво ускладнює розрахунок і вимагає врахування взаємодії внутрішніх зусиль.

**Received:** March 1, 2026.

**Revised:** April 3, 2026.

**Accepted:** May 28, 2026.

У роботі наведено класифікацію крутіння на первинне (рівноважне) та вторинне (від сумісності деформацій), визначено принципи відмінності між ними та особливості врахування в інженерній практиці. Розглянуто випадки, коли розрахунок на крутіння є обов'язковим, а також ситуації, у яких допускається обмеження конструктивним армуванням без детальної перевірки несучої здатності.

Детально висвітлено деформаційну модель просторової ферми та концепцію еквівалентного тонкостінного замкненого перерізу, які лежать в основі сучасних нормативних методик розрахунку. Описано принцип визначення дотичних напружень у стінках еквівалентного перерізу, механізм роботи бетонних стиснутих розкосів та роль поперечної і поздовжньої арматури у сприйнятті розтягувальних зусиль. Наведено критерії перевірки граничних станів, зокрема умови недопущення роздавлювання бетонних розкосів, а також особливості вибору кута нахилу стиснутих елементів просторової ферми.

У статті проаналізовано сумісну дію крутіння, поперечної сили та згину, наведено умови суперпозиції внутрішніх зусиль і принципи сумарного визначення необхідної площі арматури. Окрему увагу приділено конструктивним вимогам до армування елементів, що працюють на крутіння, зокрема застосуванню замкнених хомутив, рівномірному розміщенню поздовжньої арматури по периметру перерізу та забезпеченню надійного анкерування арматурного каркаса. Розглянуто особливості роботи відкритих тонкостінних перерізів, для яких необхідно враховувати депланацію та додаткові нормальні напруження.

Отримані результати узагальнюють сучасні нормативні підходи до розрахунку залізобетонних елементів на крутіння та можуть бути використані при проектуванні балок, ригелів, рамних і просторових конструкцій, у яких крутіння є визначальним або супутнім фактором напружено-деформованого стану.

**Ключові слова:** крутний момент, спіральні тріщини, депланація.