Table 1: Summary of Collected 689 RC deep beams database.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Ref.** | **#** | ***a/d*** | ***fc′* (MPa)** | ***ρl* (%)** | ***fy* (MPa)** | ***ρv* (%)** | ***fyv* (MPa)** | ***ρh* (%)** | ***fyh* (MPa)** | **vn =Vu/bwh(MPa)** |
| [1] | 48 | 1.15-2.44 | 13.8-47.6 | 0.93-3.45 | 321-370 | 0-1.22 | 0-331 | 0 | 0 | 0.96-4.69 |
| [2] | 14 | 1.56 | 17.2-25.0 | 2.72-4.25 | 483-483 | 0-0.52 | 0-483 | 0 | 0 | 2.46-4.67 |
| [3] | 25 | 0.35-1.18 | 18.6-24.6 | 0.52-1.74 | 287-287 | 0-2.45 | 0-303 | 0-2.45 | 0.0-303 | 3.78-5.67 |
| [4] | 51 | 0.77-2.01 | 16.1-22.7 | 1.93 | 431 | 0-1.25 | 0-437 | 0-0.91 | 0.0-437 | 2.41-5.07 |
| [5] | 6 | 0.41-1.53 | 34.9-52.0 | 0.16-1.16 | 330-493 | 0.21-0.36 | 211-454 | 0.27-0.51 | 211.0-454 | 1.8-7.5 |
| [6] | 24 | 0.97-1.01 | 13.9-26.4 | 1.07-1.52 | 420 | 0-0.35 | 0-420 | 0 | 0 | 1.98-7.6 |
| [7] | 25 | 0.27-1.69 | 44.0-86.3 | 1.23-2.58 | 499-505 | 0-1.43 | 0-375 | 0-3.17 | 0.0-447 | 3.36-21.09 |
| [8] | 1 | 1.32 | 83.0 | 2.42 | 440 | 0.66 | 590 | 0.37 | 590.0 | 9.09 |
| [9] | 29 | 1.75-2.5 | 63.6-89.4 | 1.66-3.69 | 433-452 | 0.1-0.22 | 569-632 | 0 | 0 | 2-6.55 |
| [10] | 30 | 1.5-2.5 | 52.0-73.0 | 3.77 | 414 | 0-1.81 | 0-414 | 0 | 0 | 1.8-8.97 |
| [11] | 11 | 0.56-1.14 | 30.8-49.1 | 2.6 | 520 | 0-0.12 | 0-414 | 0-0.12 | 0.0-414 | 3.11-12.14 |
| [12] | 9 | 2.00 | 32.0-91.0 | 2.02 | 410 | 0-0.5 | 0-370 | 0 | 0 | 2.42-3.79 |
| [13] | 47 | 0.5-2.0 | 23.7-73.6 | 1.29-1.56 | 415 | 0-0.37 | 0-415 | 0-0.94 | 0.0-415 | 1.55-10.24 |
| [14] | 12 | 1.10 | 24.8-32.4 | 1.15-1.28 | 469-540 | 0-0.45 | 0-455 | 0 | 0 | 2.78-3.81 |
| [15] | 8 | 0.84-0.85 | 30.7-42.5 | 2.6 | 530 | 0-0.41 | 0-250 | 0-0.89 | 0.0-511 | 4.64-10 |
| [16] | 11 | 0.91-1.67 | 30.5-85.2 | 1.38-3.65 | 364-500 | 0-1.43 | 0-448 | 0-0.22 | 0.0-577 | 2.81-9.35 |
| [17] | 5 | 2.50 | 120.1 | 1.59-6.7 | 431-472 | 0.43-1.75 | 407-458 | 0 | 0 | 1.32-8.46 |
| [18] | 49 | 0.76-2 | 15.0-41.5 | 0.95-4.76 | 483 | 0 | 0 | 0 | 0 | 1.18-3.64 |
| [19] | 22 | 0.95-2.01 | 11.3-47.2 | 0.57-3.83 | 483 | 0 | 0 | 0 | 0 | 1.05-7.27 |
| [20] | 4 | 1.85-2.41 | 14.9-27.6 | 1.86-2.89 | 328 | 0 | 0 | 0 | 0 | 1.15-1.34 |
| [21] | 7 | 1.51 | 22.4-27.0 | 0.75-3.05 | 267-724 | 0 | 0 | 0 | 0 | 2.38-3.36 |
| [22] | 6 | 1.35-1.38 | 17.9-26.1 | 1.59 | 483 | 0 | 0 | 0 | 0 | 2.71-3.77 |
| [23] | 8 | 1.52-2.22 | 21.0-39.7 | 0.98-3.36 | 303-586 | 0 | 0 | 0 | 0 | 1.58-3.55 |
| [24] | 12 | 1.0-2.3 | 22.3-38.1 | 1.78-2.47 | 426-490 | 0 | 0 | 0 | 0 | 1.47-6.39 |
| [25] | 15 | 1.51 | 21.9-27.0 | 0.75-3.05 | 267-712 | 0 | 0 | 0 | 0 | 1.93-3.37 |
| [26] | 5 | 0.67-1.34 | 23.3-37.0 | 0.83-1.67 | 463 | 0 | 0 | 0 | 0 | 4.24-6.31 |
| [27] | 63 | 0.98-2.5 | 16.8-47.4 | 0.48-2.84 | 348-486 | 0 | 0 | 0 | 0 | 0.7-6.87 |
| [28] | 2 | 0.7-1.01 | 13.7-21.5 | 0.26-0.76 | 320 | 0 | 0 | 0 | 0 | 1.31-3.11 |
| [29] | 4 | 0.3-0.3 | 30.1-35.2 | 0.97 | 392-410 | 0 | 0 | 0 | 0 | 7.87-9.54 |
| [30] | 6 | 0.25-1.06 | 31.7-38.1 | 0.63-1.88 | 308-432 | 0 | 0 | 0 | 0 | 5.87-10.45 |
| [26] | 7 | 0.3-0.88 | 13.1-66.6 | 3-6 | 364-389 | 0 | 0 | 0 | 0 | 3.54-14.87 |
| [31] | 2 | 1.5 | 23.1-79.5 | 3.34 | 414 | 0 | 0 | 0 | 0 | 2.27-5.38 |
| [32] | 4 | 1.05-2.2 | 26.1-43.2 | 0.88-1.12 | 367-455 | 0 | 0 | 0 | 0 | 1.77-3.5 |
| [33] | 15 | 1.0-2.3 | 66.0-73.0 | 1.77-6.64 | 414 | 0 | 0 | 0 | 0 | 0.88-3.79 |
| [34] | 9 | 0.5-1.5 | 15.0-20.6 | 0.66-1.9 | 420 | 0 | 0 | 0 | 0 | 1.48-4.42 |
| [35] | 2 | 1-2.0 | 41.4-47.0 | 2.07-2.07 | 421 | 0 | 0 | 0 | 0 | 1.75-4.83 |
| [36] | 17 | 1.43-2.41 | 18.4-31.7 | 0.42-1.75 | 550 | 0 | 0 | 0 | 0 | 0.58-1.5 |
| [37] | 3 | 1.0 | 35.5-40.8 | 1.69-1.91 | 1004-1026 | 0 | 0 | 0 | 0 | 4.23-5.71 |
| [38] | 21 | 0.53-1.13 | 31.4-78.5 | 0.9-1.05 | 577-804 | 0 | 0 | 0 | 0 | 2.26-11.45 |
| [39] | 4 | 1.68-1.7 | 39.4-44.1 | 2.6 | 620 | 0 | 0 | 0 | 0 | 1.92-4.86 |
| [40] | 3 | 1.93 | 38.0-51.0 | 0.44-0.72 | 468-865 | 0 | 0 | 0 | 0 | 1.64-1.87 |
| [41] | 6 | 2.43-2.5 | 12.6-32.4 | 0.95-2.07 | 317-465 | 0 | 0 | 0 | 0 | 1.05-1.43 |
| [42] | 2 | 2.35 | 29.9-30.6 | 2.06-3.09 | 400 | 0 | 0 | 0 | 0 | 1.18-1.84 |
| [43] | 2 | 2.47 | 29.9 | 1.03 | 350 | 0 | 0 | 0 | 0 | 0.98-0.98 |
| [44] | 1 | 2.19 | 48.5 | 0.66 | 594 | 0 | 0 | 0 | 0 | 1.49-1.49 |
| [45] | 3 | 2.48 | 21.1-81.3 | 3.34 | 414 | 0 | 0 | 0 | 0 | 1.52-2.3 |
| [46] | 1 | 2.0 | 69.0 | 2.44 | 434 | 0 | 0 | 0 | 0 | 2.39-2.39 |
| [47] | 10 | 2.3 | 54.0-98.0 | 1.82-3.24 | 500 | 0 | 0 | 0 | 0 | 1.87-4.74 |
| [48] | 16 | 2.5 | 34.2-58.6 | 1.2-2 | 385-477 | 0 | 0 | 0 | 0 | 0.81-1.54 |
| [49] | 1 | 2.23 | 42.8 | 1.35 | 499 | 0 | 0 | 0 | 0 | 1.8-1.8 |
| [50] | 1 | 2.16 | 33.8 | 0.76 | 562 | 0 | 0 | 0 | 0 | 0.83-0.83 |

# is the number of tests for each reference

**References**

[1] A. P. Clark, “Diagonal Tension in Reinforced Concrete Beams,” *ACI J. Proc.*, vol. 48, no. 10, doi: 10.14359/11876.

[2] I. M. V. K. G. Moody R. C. Elstner, and E. Hognestad, “Shear Strength of Reinforced Concrete Beams Part 1 -Tests of Simple Beams,” *ACI J. Proc.*, vol. 51, no. 12, doi: 10.14359/11680.

[3] P. J. R. Fung-Kew Kong David F. Cole, “Web Reinforcement Effects on Deep Beams,” *ACI J. Proc.*, vol. 67, no. 12, doi: 10.14359/7336.

[4] K. N. S. and A. S. Vantsiotis, “Shear Strength of Deep Beams,” *ACI J. Proc.*, vol. 79, no. 3, doi: 10.14359/10899.

[5] N. K. Subedi, A. E. Vardy, and N. Kubotat, “Reinforced concrete deep beams some test results,” *Mag. Concr. Res.*, vol. 38, no. 137, pp. 206–219, 1986.

[6] J. W. and N. Lehwalter, “Size Effects in Short Beams Loaded in Shear,” *ACI Struct. J.*, vol. 91, no. 5, doi: 10.14359/4177.

[7] F.-K. K. Kang-Hai Tan Susanto Teng, and LingweiI Guan, “High-Strength Concrete Deep Beams With Effective Span and Shear Span Variations,” *ACI Struct. J.*, vol. 92, no. 4, doi: 10.14359/991.

[8] S. J. F. and R. I. Gilbert, “Experimental Studies on High-Strength Concrete Deep Beams,” *ACI Struct. J.*, vol. 95, no. 4, doi: 10.14359/554.

[9] P. Y. L. K. and B. V. Rangan, “Shear Strength of High-Performance Concrete Beams,” *ACI Struct. J.*, vol. 95, no. 6, doi: 10.14359/581.

[10] K.-S. L. Sung-Woo Shin Jung-Ill Moon, and S. K. Ghosh, “Shear Strength of Reinforced High-Strength Concrete Beams with Shear Span-to-Depth Ratios between 1.5 and 2.5,” *ACI Struct. J.*, vol. 96, no. 4, doi: 10.14359/691.

[11] K. H. T. and H. Y. Lu, “Shear Behavior of Large Reinforced Concrete Deep Beams and Code Comparisons,” *ACI Struct. J.*, vol. 96, no. 5, doi: 10.14359/738.

[12] R. S. Pendyala and P. Mendis, “Experimental study on shear strength of high-strength concrete beams,” *Struct. J.*, vol. 97, no. 4, pp. 564–571, 2000.

[13] J.-K. O. and S.-W. Shin, “Shear Strength of Reinforced High-Strength Concrete Deep Beams,” *ACI Struct. J.*, vol. 98, no. 2, doi: 10.14359/10184.

[14] N. Zhang and K.-H. Tan, “Size effect in RC deep beams: Experimental investigation and STM verification,” *Eng. Struct.*, vol. 29, no. 12, pp. 3241–3254, 2007.

[15] K.-H. Tan, G.-H. Cheng, and N. Zhang, “Experiment to mitigate size effect on deep beams,” *Mag. Concr. Res.*, vol. 60, no. 10, pp. 709–723, 2008.

[16] K. S. Ismail, “Shear behaviour of reinforced concrete deep beams,” University of Sheffield, 2016.

[17] J. J. Roller and H. G. Russel, “Shear strength of high-strength concrete beams with web reinforcement,” *Struct. J.*, vol. 87, no. 2, pp. 191–198, 1990.

[18] K. G. Moody, I. M. Viest, R. C. Elstner, and E. Hognestad, “Shear strength of reinforced concrete beams part 2-tests of restrained beams without web reinforcement,” in *Journal Proceedings*, 1955, vol. 51, no. 1, pp. 417–434.

[19] J. M. and I. M. Viest, “Shear Strength of Reinforced Concrete Frame Members Without Web Reinforcement,” *ACI J. Proc.*, vol. 53, no. 3, doi: 10.14359/11558.

[20] T. S. Chang and C. E. Kesler, “Static and fatigue strength in shear of beams with tensile reinforcement,” in *Journal Proceedings*, 1958, vol. 54, no. 6, pp. 1033–1057.

[21] D. Watstein and R. G. Mathey, “Strains in beams having diagonal cracks,” in *Journal Proceedings*, 1958, vol. 55, no. 12, pp. 717–728.

[22] J. J. Rodriguez, A. C. Bianchini, I. M. Viest, and C. E. Kesler, “Shear strength of two-span continous reinforced concrete beams,” in *Journal Proceedings*, 1959, vol. 55, no. 4, pp. 1089–1130.

[23] R. D. De Cossio and C. P. Siess, “Behavior and strength in shear of beams and frames without web reinforcement,” in *Journal Proceedings*, 1960, vol. 56, no. 2, pp. 695–736.

[24] F. Leonhardt and R. Walther, “The Stuttgart shear tests,” *Cem. \& Concr. Assoc. Libr.*, vol. 11, no. 28, pp. 49–54, 1961.

[25] R. G. M. and D. Watstein, “Shear Strength of Beams Without Web Reinforcement Containing Deformed Bars of Different Yield Strengths,” *ACI J. Proc.*, vol. 60, no. 2, doi: 10.14359/7851.

[26] Q. Q. Liang, B. Uy, M. A. Bradford, and H. R. Ronagh, “Strength Analysis of Steel–Concrete Composite Beams in Combined Bending and Shear,” *J. Struct. Eng.*, vol. 131, no. 10, pp. 1593–1600, 2005, doi: 10.1061/(asce)0733-9445(2005)131:10(1593).

[27] G. Kani, “How safe are our large reinforced concrete beams?,” in *Journal Proceedings*, 1967, vol. 64, no. 3, pp. 128–141.

[28] V. Ramakrishnan and Y. Ananthanarayana, “Ultimate strength of deep beams in shear,” in *Journal Proceedings*, 1968, vol. 65, no. 2, pp. 87–98.

[29] R. F. Manuel, B. W. Slight, and G. T. Suter, “Deep beam behavior affected by length and shear span variations,” *Am Concr. Inst J. \& Proc.*, vol. 68, no. 12, 1971.

[30] R. F. Manuel, “Failure of deep beams,” *Spec. Publ.*, vol. 42, pp. 425–440, 1974.

[31] A. G. Mphonde and G. C. Frantz, “Shear tests of high-and low-strength concrete beams without stirrups,” in *Journal Proceedings*, 1984, vol. 81, no. 4, pp. 350–357.

[32] J. G. M. David M. Rogowsky and See Y. Ong, “Tests of Reinforced Concrete Deep Beams,” *ACI J. Proc.*, vol. 83, no. 4, doi: 10.14359/10558.

[33] S. H. Ahmad and D. M. Lue, “Flexure-shear interaction of reinforced high strength concrete beams,” *Struct. J.*, vol. 84, no. 4, pp. 330–341, 1987.

[34] N. Lehwalter, “Bearing capacity of concrete compression struts in truss-systems, exemplified by the case of short beams,” 1988.

[35] Y. Xie, S. H. Ahmad, T. Yu, S. Hino, and W. Chung, “Shear ductility of reinforced concrete beams of normal and high-strength concrete,” *Struct. J.*, vol. 91, no. 2, pp. 140–149, 1994.

[36] P. Adebar, “One-way shear strength of large footings,” *Can. J. Civ. Eng.*, vol. 27, no. 3, pp. 553–562, 2000, doi: 10.1139/l00-008.

[37] T. LERTSRISAKULRAT, “Concept of Concrete Compressive Fracture Energy in RC Deep Beams without Transverse Reinforcement,” コンクリート工学年次論文集, vol. 23, no. 3, pp. 97–102, 2001.

[38] K.-H. Yang, H.-S. Chung, E.-T. Lee, and H.-C. Eun, “Shear characteristics of high-strength concrete deep beams without shear reinforcements,” *Eng. Struct.*, vol. 25, no. 10, pp. 1343–1352, 2003.

[39] K. H. Tan, G. H. Cheng, and H. K. Cheong, “Size effect in shear strength of large beams—Behaviour and finite element modelling,” *Mag. Concr. Res.*, vol. 57, no. 8, pp. 497–509, 2005.

[40] H. Seliem, A. Hosny, H. Dwairi, and S. Rizkalla, “Shear behavior of concrete beams reinforced with MMFX steel without web reinforcement,” *NC State Univ. Final Report, Proj. No. IS-06-08*, 2006.

[41] J. E. Bower and I. M. Viest, “Shear strength of restrained concrete beams without web reinforcement,” in *Journal Proceedings*, 1960, vol. 57, no. 7, pp. 73–98.

[42] W. J. Krefeld and C. W. Thurston, “Studies of the shear and diagonal tension strength of simply supported reinforced concrete beams,” in *Journal Proceedings*, 1966, vol. 63, no. 4, pp. 451–476.

[43] H. P. J. Taylor, “Shear stresses in reinforced concrete beams without shear reinforcement,” 1968.

[44] F. J. Heger and T. J. McGrath, “Design method for reinforced concrete pipe and box sections,” 1982.

[45] A. G. Mphonde and G. C. Frantz, “Shear tests of high-and low-strength concrete beams with stirrups,” *Spec. Publ.*, vol. 87, pp. 179–196, 1985.

[46] A. H. Elzanaty, A. H. Nilson, and F. O. Slate, “Shear capacity of reinforced concrete beams using high-strength concrete,” in *Journal Proceedings*, 1986, vol. 83, no. 2, pp. 290–296.

[47] E. Thorenfeldt and G. Drangsholt, “Shear capacity of reinforced high-strength concrete beams,” *Spec. Publ.*, vol. 121, pp. 129–154, 1990.

[48] W. M. Ghannoum, “Size effect on shear strength of reinforced concrete beams,” 1998.

[49] M. Guadagnini, “Shear behaviour and design of FRP RC beams,” 2002.

[50] A. Uzel, B. Podgorniak, E. C. Bentz, and M. P. Collins, “Design of Large Footings for One-Way Shear.,” *ACI Struct. J.*, vol. 108, no. 2, 2011.