ISSN 2347-1921

Some properties on semi-symmetric metric T-connection on Sasakian Manifold

N.V.C.Shukla[*] and A.C.Pandey [**]

[*] Department of Mathematics and Astronomy, Lucknow University-281406, U.P., India.
Email: nvcshukla72@gmail.com.

[**] Department Of Mathematics, Brahmanand College, Kanpur-208004, U.P., India.
Email: acpbnd73@gmail.com

Abstract

In the present paper we have studied some properties of semi symmetric metric connection in almost contact metric manifold. In this paper we have studied some results related to quasi conformal curvature tensor, m-projective curvature tensor, con-harmonic curvature tensor, pseudo projective curvature tensor, T-connection and F-T connection.

2010 Mathematics Subject Classification: 53D15, 53C15, 53C25.

Keywords: Almost contact metric manifold; Semi symmetric metric metric T- connections; Curvature tensors; Sasakian manifold and F-T connection.

Council for Innovative Research
Peer Review Research Publishing System
Journal: Journal of Advances in Mathematics
Vol 9, No 2
editor@cirjam.org
www.cirjam.com, www.cirworld.com

1 Introduction

Friedmann and Schouten[1] introduced idea of semi symmetric linear connection on a differentiable manifold. Hayden [2] introduced the idea of semi symmetric linear connection on Riemannian manifold. K. Yano [3] studied semi-symmetric metric connection in a Riemannian manifold. Mishra and Pandey [9] studied semi symmetric metric connection in an almost contact manifold. A linear connection D in an n- dimensional(where n is odd) differentiable manifolds M is said to be semi-symmetric connection if its torsion tensor T of type (1, 2) is defined as

$$T(X,Y) = D_X Y - D_Y X - [X,Y]$$

$$= \eta(Y)X - \eta(X)Y. \tag{1.1}$$

for arbitrary vector fields X and Y and where η is 1-form. If T vanishes then the manifold M becomes torsion free. The connection D is a metric connection, if there is a Riemannian metric g in M such that $Dg = 0$, otherwise it is non metric. Various properties are studied by T.Imai [5], [6], Agashe and Chafle [12], [13] De and Sengupta [15], [16] and several others. Mishra and Pandey [9] defined semi-symmetric metric T-connection and studied some properties on the almost Grayan manifold. In this paper we study the semi-symmetric metric T-connection on a Sasakian manifold. Section 2 is devoted to preliminaries and some definitions. In section three we studied T- connections and find a relation between a generalised quasi Sasakian manifold and quasi Sasakian manifold. In section 4 some special cases of curvature tensor is studied. Finally we studied curvature properties with respect to the semi-symmetric metric F-T connection.

2 Preliminaries

An n-dimensional differentiable Manifold M of class C^{r+1} (where n is odd), is called an almost contact manifold if it admits an almost contact structure (F, ξ, η) consisting of a (1,1) tensor field F, a 1-form η and vector field ξ satisfying

$$F^2 X = -X + \eta(X)\xi, \tag{2.1}$$

$$F(\xi) = 0, \tag{2.2}$$

$$\eta o F = 0, \tag{2.3}$$

$$\eta(\xi) = 1, \tag{2.4}$$

for arbitrary vector field X. Let g be a compatible Riemannian metric with structure (F, ξ, η), that is

$$g(FX, FY) = g(X,Y) - \eta(X)\eta(Y), \tag{2.5}$$

for arbitrary vector fields X, Y in M, then (M, g) is said to be an almost contact metric manifold. If we put ξ for X in (2.5) and using (2.2), (2.3) and (2.4) we obtain

$$g(X,\xi) = \eta(X). \tag{2.6}$$

Also,

$$\Phi(X,Y) \overset{\text{def}}{=} g(FX,Y) \tag{2.7}$$

or

$$'F(X,Y) \overset{\text{def}}{=} g(FX,Y) \tag{2.8}$$

gives

$$\Phi(X,Y) + \Phi(Y,X) = 0. \tag{2.9}$$

An almost contact metric manifold M is said to be a Sasakian manifold [8] if it satisfies

$$(D_X F)Y = g(X,Y)\xi - \eta(Y)X, \tag{2.10}$$

for arbitrary vector fields X and Y on M. Here D denotes the Levi-Civita connection of the metric g. A normal contact metric manifold of dimension n greater than or equal to three is called a Sasakian manifold. Let R be the curvature tensor of type (1, 3) and S is the Ricci tensor of type $(0,2)$ with respect to the Levi-Civita connection D, then the following relations hold in a Sasakian manifold for any arbitrary vector fields X and Y.

ISSN 2347-1921

$$D_X \xi = -FX \quad (2.11)$$

$$R(X,Y)\xi = \eta(Y)X - \eta(X)Y \quad (2.12)$$

$$(D_X \eta)(Y) = g(X, FY) \quad (2.13)$$

$$R(\xi, X)Y = (D_X F)Y \quad (2.14)$$

$$S(FX, FY) = S(X,Y) - (n-1)\eta(X)\eta(Y) \quad (2.15)$$

$$S(X,\xi) = (n-1)\eta(X). \quad (2.16)$$

The projective curvature tensor having one-one correspondence between each coordinate neighbourhood of an n-dimensional Riemannian manifold and a domain of Euclidean space such that there is one-one correspondence between geodesics of Riemannian manifold with straight line in Euclidean space. The manifold M is projectively flat if and only its curvature becomes constant.

Definition 2.1 *Let M be an odd dimensional Riemannian manifold then the quasi conformal curvature tensor C [27] is given by*

$$C(X,Y)Z = aR(X,Y)Z + b[S(Y,Z)X - S(X,Z)Y$$
$$+ g(Y,Z)QX - g(X,Z)QY]$$
$$- \frac{r}{2n+1}[\frac{a}{2n} + b][g(Y,Z)X - g(X,Z)Y]. \quad (2.17)$$

where a and b are two scalars and r is the scalar curvature of the manifold.

Definition 2.2 *The M-projective curvature tensor* W^* *is defined as [4]*

$$W^*(X,Y)Z = R(X,Y)Z - \frac{1}{2(n-1)}[S(Y,Z)X - S(X,Z)Y$$
$$g(Y,Z)QX - g(X,Z)QY] \quad (2.18)$$

where R is Riemannian curvature tensor, S is Ricci tensor, Q is Ricci operator and g is metric tensor and X ,Y and Z are arbitrary vector fields. Also we have

$$W^*(X,Y,Z,U) = g(W^*(X,Y)Z,U) \quad (2.19)$$

Definition 2.3 *An almost contact manifold satisfying*

$$D_X{}'F(Y,Z) + D_Y{}'F(Z,X) + D_Z{}'F(X,Y) = 0 \quad (2.20)$$

for arbitrary vector fields X , Y , and Z , called quasi sasakian manifold [23].

Definition 2.4 *An almost contact manifold satisfying*

$$D_X{}'F(Y,Z) + D_Y{}'F(Z,X) + D_Z{}'F(X,Y) + \eta(X)[(D_Y\eta)(FZ)$$
$$-(D_Z\eta)(FY] + \eta(Y)[(D_Z\eta)(X) - (D_X\eta)(FZ)]$$
$$+\eta(Z)[(D_X\eta)(FY) - (D_Y\eta)(FX)] = 0. \quad (2.21)$$

for arbitrary vector fields X,Y and Z, called generalised quasi sasakian manifold [23].

Definition 2.5 *The almost contact metric manifold satisfying*

$$(D_X{}'F)(Y,Z) = \eta(Y)(D_X\eta)(FZ) - \eta(Z)(D_X\eta)(FY) \quad (2.22)$$

for arbitrary vector fields X,Y and Z, called generalised cosympletic manifold [23].

Definition 2.6 *The almost contact metric manifold satisfying*

$$(D_X{}'F)(Y,Z) + (D_Y{}'F)(Z,X) + (D_Z{}'F)(X,Y)$$

$$+\eta(X)[(D_Y\eta)(FZ)-(D_Z\eta)(FY)]$$
$$+\eta(Y)[(D_Z\eta)(FX)-(D_X\eta)(FZ)]$$
$$+\eta(Z)[(D_X\eta)(FY)-(D_Y\eta)(FX)]=0 \quad (2.23)$$

for arbitrary vector fields X,Y and Z, called generalised quasi sasakian manifold[23].

Definition 2.7 *The almost contact metric manifold satisfying*

$$(D_X{}'F)(Y,Z)+(D_X{}'F)(FY,Z)-\eta(Y)[(D_{FX}\eta)(FZ)]$$
$$+\eta(Z)[(D_{FX}\eta)(FY)-(D_X\eta)(Y)]=0 \quad (2.24)$$

for every vector fields X,Y and Z, called generalised almost contact normal metric manifold [23].

Definition 2.8 *The almost contact metric manifold satisfying*

$$(D_X{}'F)(Y,Z)=\eta(Y)(D_Z\eta)(FX)+\eta(Z)(D_{FX}\eta)(Y) \quad (2.25)$$

for arbitrary vector fields X,Y and Z, called normal quasi sasakian metric manifold.[23].

Definition 2.9 *The almost contact metric manifold satisfying*

$$(D_{FX}{}'F)(FY,Z)=(D_X{}'F)(Y,Z)-\eta(Y)(D_X\eta)(FZ) \quad (2.26)$$

for arbitrary vector fields X,Y and Z, called almost contact normal metric manifold[23].

3 T-connection

Let D be Riemannian connection then a linear connection $\tilde{\Delta}$ defined [9],[26] as

$$\tilde{\Delta}_X Y = D_X Y + \pi(Y)X - g(X,Y)\xi \quad (3.1)$$

for arbitrary vector fields X and Y and π is 1-form associated to vector field ξ, called semi symmetric metric connection if

$$\pi(Y)=g(Y,\xi) \quad (3.2)$$

The torsion tensor T of the connection ∇ and metric tensor is given by

$$T(X,Y)=\eta(Y)X-\eta(X)Y \quad (3.3)$$
$$\nabla_X g=0 \quad (3.4)$$

In addition if

$$\tilde{\Delta}_X\xi=0 \quad (3.5)$$
$$\tilde{\Delta}_X\eta(Y)=0 \quad (3.6)$$

holds for arbitrary fields X and Y then the connection $\tilde{\Delta}$ is called semi-symmetric metric T-connection. Putting $x=\xi$ in (3.1) and using equation (3.5) we get

$$\tilde{\Delta}_\xi Y = D_\xi Y + \pi(Y)X - g(X,\xi)\xi \quad (3.7)$$
$$D_X\xi + X - g(X,\xi)\xi = 0 \quad (3.8)$$
$$\eta(\xi)=1 \Leftrightarrow (D_X\eta)(Y)+g(FX,FY)=0 \quad (3.9)$$

Using (3.1) we get

$$(D_X\eta)(Y)=g(X,FY) \quad (3.10)$$

Replacing Y by ϕY in (3.10) we get

ISSN 2347-1921

$$(D_X\eta)[\phi Y] = -g[FX, F^2Y]$$

$$(D_X\eta)[\phi Y] = g(FX, Z) \quad (3.11)$$

Using (3.5) and(3.6) the equation (2.23) we get

$$D_X{}'F(Y,Z) + D_Y{}'F(Z,X) + D_Z{}'F(X,Y) + 2\eta(X)g(FY,Z)$$
$$+ 2\eta(Y)g(FZ,X) + 2\eta(Z)g(FX,Y) = 0. \quad (3.12)$$

If g is skew symmetric then (2.23) becomes

$$D_X{}'F(Y,Z) + D_Y{}'F(Z,X) + D_Z{}'F(X,Y) = 0 \quad (3.13)$$

Therefore we can state the following theorem

Theorem 3.1 *A generalised quasi sasakian manifold with semi symmetric metric T-connection becomes quasi sasakian manifold.*

4 Some special cases of curvature tensor

Taking inner product of (2.17) with X we have

$$\tilde{S}(Y,Z) = aS(Y,Z) + b[S(Y,Z)g(X,X) - S(e_i,Z)g(Y,e_i)$$
$$+ g(Y,Z)g(X,QX) - g(X,Y)g(X,QY)]$$
$$-\frac{r}{2n+1}[\frac{a}{2n}+b][g(Y,Z)g(X,X) - g(X,Z)g(Y,X)]$$
$$= [S(Y,Z)(a+b(n-1)) - g(Y,Z)S(X,X)] - g(X,Z)S(X,Y)$$
$$-\frac{r}{2n+1}[\frac{a}{2n}+b][g(Y,Z)(n-1)]. \quad (4.1)$$

because $g(X,QY) = S(X,Y)$. Hence we state the following theorem.

Theorem 4.1 *Let M be a Sasakian manifold admitting a semi symmetric metric T-connection whose Ricci tensor vanishes with parameters $a=0$ and $b=0$ then the Ricci tensor for quasi conformal curvature tensor also vanishes.*

The m-projective curvature tensor field W^* is given by (2.18) and taking inner product with X, we get

$$\sum_{i=1}^{n} g(W(e_i,Y)Z,e_i) = \sum_{i=1}^{n} g(R(e_i,Y)Z,e_i)$$
$$-\frac{1}{2(n-1)}[S(Y,Z)\sum_{i=1}^{n} g(e_i,e_i) - \sum_{i=1}^{n} S(e_i,Z)g(Y,e_i)$$
$$+ g(Y,Z)g(Qe_i,e_i) - g(e_i,Z)g(QY,e_i)] \quad (4.2)$$

Therefore,

$$\tilde{S}(Y,Z) = S(Y,Z) - \frac{1}{2(n-1)}[S(Y,Z)(n-1) - S(Y,Z) + g(Y,Z)r - g(e_i,Z)S(Y,e_i)]$$

since $S(e_i,e_i) =$ Trace of Q = Scalar curvature where Q is Ricci operator and S is Ricci tensor. Hence

$$\tilde{S}(Y,Z) = S(Y,Z) - \frac{1}{2(n-1)}[S(Y,Z)(n-1) - S(Y,Z) + g(Y,Z)r - S(Y,Z)]$$

$$\tilde{S}(Y,Z)=\frac{1}{2(n-1)}[(n+1)S(Y,Z)+r.g(Y,Z)]$$

If scalar curvature r and Ricci tensor S(X,Y) both vanishes then

$$\tilde{S}(Y,Z)=0 \tag{4.3}$$

Hence we have the following theorem.

Theorem 4.2 *If the Ricci tensor S(X,Y) and scalar curvature r both vanishes then the Ricci tensor with respect to m-projective curvature tensor also vanishes.*

The conharmonic curvature tensor $\tilde{C}$ of Riemannian connection R is given by

$$\tilde{C}(X,Y,Z)=R(X,Y,Z)-\frac{1}{n-2}[S(Y,Z)X-S(X,Z)Y+g(Y,Z)QX-g(X,Z)QY] \tag{4.4}$$

for arbitrary vector fields X,Y and Z. where S is Ricci tensor and Q is Ricci operator. Contracting above equation with respect to X we get

$$\tilde{S}(Y,Z)=S(Y,Z)-\frac{1}{n-2}[S(Y,Z)\sum_{i=1}^{n}g(e_i,e_i)$$

$$-S(e_i,Z)g(Y,e_i)+g(Y,Z)g(Qe_i,e_j)$$

$$=S(Y,Z)-\frac{1}{n-2}[S(Y,Z)(n-1)-S(Z,Y)$$

$$+g(Y,Z)S(e_i,e_i)-g(e_i,Z)S(Y,e_i)]=S(Y,Z)$$

$$-\frac{1}{n-2}[S(Y,Z)(n-1)-S(Z,Y)+g(Y,Z)r-S(Z,Y)]$$

$$=\frac{1}{n-2}[S(Y,Z)+g(Y,Z)r] \tag{4.5}$$

where $\sum_{i=1}^{n}g(Qe_i,e_i)=$ scalar curvature r. Hence we have the following theorem.

Theorem 4.3 *If M be an be an almost contact metric manifold admitting a semi symmetric metric T-connection whose Ricci tensor and scalar curvature r both vanishes then the Ricci tensor with respect to the semi symmetric metric T-connection also vanishes.*

5 Curvature properties of semi symmetric metric F-T connection

Definition 5.1 Let R be Riemannian connection on an almost contact manifold with 1-form η, vector field ξ and (1,1) tensor F satisfying[3]

$$D_XY=R_XY+\eta(Y)(X+FX)-g(X,Y)+'F(X,Y)+\eta(X)FY \tag{5.1}$$

The connection D be a metric (F,T) connection if

$$D_Xg=0 \tag{5.2}$$

$$D_XF=0 \tag{5.3}$$

$$D_X\eta=0 \tag{5.4}$$

and

$$D_X\xi=0 \tag{5.5}$$

where $'F(X,Y)=g(FX,Y)$ We have

$$(D_Z{}'F)(X,Y)=\nabla_Z[g(FX,Y)]$$

$$(D_Z{}'F)(X,Y)=(D_Z g)(FX,Y)+g[(D_Z F)X,Y]+g(FX,D_Y)$$

Using (5.2) and (5.3) we get

$$(D_Z{}'F)(X,Y)=g(FX,D_Z Y) \tag{5.6}$$

Therefore by (4.1) we get

$$(D_X{}'F)(Y,Z)+(D_Y{}'F)(Z,X)+(D_Z{}'F)(X,Y)=g(FX,D_Z Y)+g(FY,D_X Z)+g(FZ,D_X Y)$$

$$g(FX,D_Z Y)+g(FY,D_X Z)+g(FZ,D_X Y)=0 \tag{5.7}$$

for quasi Sasakian manifold. Thus we state the following theorem.

Theorem 5.1 *The quasi sasakian manifold with semi symmetric metric F-T connection satisfies*

$$g(FX,D_Z Y)+g(FY,D_X Z)+g(FZ,D_X Y)=0. \tag{5.8}$$

For F-T connection following condition holds

$$(D_Z{}'F)(X,Y)=g(FX,D_Z Y) \tag{5.9}$$

$$(D_X\eta)(Z)=g(FX,FZ) \tag{5.10}$$

$$(D_X\eta)(FZ)=g(FX,Z) \tag{5.11}$$

$$(D_{FX}\eta)(FZ)=g(FX,FZ) \tag{5.12}$$

$$(D_{FX}\eta)(Y)=g(F^2X,Y)$$

$$(D_{FX}\eta)(Y)=-g(X,Y)+\eta(X)\eta(Y) \tag{5.13}$$

By using (5.9), (5.10), (5.11) and (2.22) we get

$$g(FY,D_X Z)=\eta(Y)g(FX,Z)-\eta(Z)g(FX,Y) \tag{5.14}$$

Thus we can state the following theorem.

Theorem 5.2 *The generalised cosympletic manifold with semi symmetric metric F-T connection satisfies*

$$g(FY,D_X Z)=\eta(Y)g(FX,Z)-\eta(Z)g(FX,Y). \tag{5.15}$$

By using (5.9), (5.10), (5.11) and (2.23), we get

$$g(FY,D_X Z)+g(FZ,D_Y X)+g(FX,D_Z Y)+\eta(X)[g(FY,Z)-g(FZ,Y)]$$

$$+\eta(Y)[g(FZ,X)-g(FX,Z)]+\eta(Z)[g(FX,Y)-g(FY,Z)]=0 \tag{5.16}$$

Theorem 5.3 *Let* M *is generalised quasi sasakian manifold equipped with semi symmetric metric F-T connection satisfy*

$$g(FY,D_X Z)+g(FZ,D_Y X)+g(FX,D_Z Y+\eta(X)[g(FY,Z)-g(FZ,Y)]$$

$$+\eta(Y)[g(FZ,X)-g(FX,Z)]+\eta(Z)[g(FX,Y)-g(FY,Z)]=0. \tag{5.17}$$

By (2.24), (5.9), (5.10)and (5.12), we get

$$g(FY,D_{FX}Z)+g(F^2Y,D_X Z)-\eta(Y)[g(F^2X,Z)]-\eta(Z)[g(FX,FY))-g(FX,Y)] \tag{5.18}$$

Using definition of almost contact manifold we get

$$g(FY,D_{FX}Z)-g(Y,D_X Z)+\eta(Y)\eta(D_X Z)-\eta(Y)g(X,Z)$$

$$+\eta(X)+\eta(Y)+\eta(Z)+\eta(Z)g(FX,FY)-\eta(Z)g(FX,Y)=0 \tag{5.19}$$

Thus we state the following theorem.

Theorem 5.4 *The generalised almost contact normal metric manifold with semi symmetric metric F-T connection satisfy*

$$g(FY, D_{FX}Z) - g(Y, D_X Z) + \eta(Y)\eta(D_X Z) - \eta(Y)g(X, Z)$$
$$+\eta(X) + \eta(Y) + \eta(Z) + \eta(Z)g(FX, FY) - \eta(Z)g(FX, Y) = 0. \quad (5.20)$$

Now by using (5.9),(5.11),(5.12) and (2.25) gives

$$g(FY, D_X Z) = \eta(Y)[g(FZ, X)] + \eta(Z)[-g(X, Y) + \eta(X)\eta(Y)] \quad (5.21)$$

$$g(FY, D_X Z) = \eta(Y)[g(FZ, X) - \eta(Z)g(X, Y) + \eta(X)\eta(Y)\eta(Z)] \quad (5.22)$$

Hence we can state the above result in the form of following theorem.

Theorem 5.5 *A normal quasi Sasakian manifold with semi symmetric metric F-T connection satisfies*

$$g(FY, D_X Z) = \eta(Y)[g(FZ, X) - \eta(Z)g(X, Y) + \eta(X)\eta(Y)\eta(Z)]. \quad (5.23)$$

Now by use of (5.9), (5.11), (5.12) and (2.26), which gives

$$g(F^2Y, D_{FX}Z) = g(FY, D_X Y) - \eta(Y)g(FX, Z) \quad (5.24)$$

$$g(-Y + \eta(Y)\xi, D_{FX}Z) = g(FY, D_X Y) - \eta(Y)g(FX, Z) \quad (5.25)$$

$$-g(Y, D_{FX}Z) + \eta(Y)g(\xi, D_{FX}Z) = g(FY, D_X Y) - \eta(Y)g(FX, Z) \quad (5.26)$$

Therefore,

$$g(Y, D_{FX}Z) + g(FY, D_X Y) - \eta(Y)g(FX, Z) - \eta(Y)g(\xi, D_{FX}Z) = 0 \quad (5.27)$$

Hence we can state the above result in the form of following theorem.

Theorem 5.6 *The almost contact normal metric manifold with F-T connection satisfy*

$$g(Y, D_{FX}Z) + g(FY, D_X Y) - \eta(Y)g(FX, Z) - \eta(Y)g(\xi, D_{FX}Z) = 0. \quad (5.28)$$

By (5.9), (5.10) and (2.20) gives

$$g(FY, D_X Z) + g(FZ, D_Y X) + g(FX, D_Z Y) = 0 \quad (5.29)$$

Hence we can have following theorem.

Theorem 5.7 *The quasi sasakian manifold with semi symmetric metric F-T connection satisfy*

$$g(FY, D_X Z) + g(FZ, D_Y X) + g(FX, D_Z Y) = 0. \quad (5.30)$$

References

[1] Friedmann A. and Schouten J. A., Ü ber die Geometric der halbsymmetrischen Ü bertragung, Math., Zeitschr., 21 (1924), pp 211–223.

[2] Hayden H. A., Subspace of a space with torsion, Proceedings of London Mathematical Society II Series 34 (1932), pp 27-50.

[3] Yano K., On semi-symmetric metric connections, Rev. Roumaine Math. Pure Appl., 15 (1970), pp 1579–1586.

[4] Pokhariyal G.P. and Mishra R.S.,curvature tensor and their relativistic significance II, Yokohama Mathematical J. 19(1971), pp 97–103.

[5] Imai T., Notes on semi-symmetric metric connections, Tensor N. S., 24 (1972), pp 293–296.

[6] Imai T., Hypersurfaces of a Riemannian manifold with semi-symmetric metric connection, Tensor N. S., 24 (1972), pp 300–306.

[7] Kenmotsu K.,, A class of almost contact Riemannian manifolds, Tohoku Math. J., 24 (1972), pp 93-103.

[8] Blair D.E.,, Contact manifolds in Riemannian Ggeometry, Lecture Notes in Mathematics, 509, Springer-Verlag Berlin, 1976.

[9] Mishra R.S. and Pandey S.N., Semi symmetric connection in an almost contact manifold, Indian J. Pure and Appl. Math., 9 no. 6(1978) pp 570-580.

[10] Mishra R. S., Structures on differentiable manifold and their applications, Chandrama Prakashan, Allahabad, India,1984.

[11] Mishra R.S., Almost contact metric manifolds, Tensor Soc. of India, Lucknow, 1991.

[12] Agashe N. S. and Chafle M. R., A semi-symmetric non-metric connection in a Riemannian manifold, Indian J. Pure Appl. Math., 23 (1992), pp 399–409.

[13] Agashe N. S. and Chafle M. R., On submanifolds of a Riemannian manifold with semi-symmetric non-metric

connection, Tensor N. S., 55, no. 2 (1994), pp 120–130.
[14] Prasad B., On a semi-symmetric non-metric connection in an SP-Sasakian manifold, Instanbul $\ddot{U}$ niv. Fen Fak. Mat. Der., 53, (1994), pp 77–80.
[15] De U. C. and Kamilya D., Hypersurfaces of a Riemannian manifold with semi-symmetric non-metric connection, J. Indian Inst. Sci., 75, (1995), pp 707–710.
[16] De U. C. and Sengupta J., On a type of semi-symmetric non-metric connection, Bull. Cal. Math. Soc., 92, no. 5 (2000), pp 375–384.
[17] Sengupta J., De U. C. and Binh T. Q., On a type of semi-symmetric non-metric connection on a Riemannian manifold, Indian J. Pure Appl. Math., 31, no. (1-2) (2000), pp 1659–1670.
[18] Chaubey S. K., On a semi-symmetric non-metric connection, Prog. of Math., (41 ; 42), (2007), pp 11-20.
[19] ChaturvediB. B. and Pandey P. N., Semi-symmetric non-metric connection on a K$\ddot{a}$hler manifold, Diff. Geom. Dynam. Syst., 10, (2008), pp 86–90.
[20] Dubey A. K., Chaubey S. K. and Ojha R. H., On semi-symmetric non-metric connection, International Mathematical Forum, 5, no. 15 (2010), pp 731–737.
[21] Kumar A.and Chaubey S. K., A semi-symmetric non-metric connection in a generalised cosymplectic manifold, Int. Journal of Math. Analysis, 4, no. 17 (2010), pp 809–817.
[22] Jaiswal J. P. and Ojha R. H., Some properties of K- contact Riemannian manifolds admitting a semi-symmetric non-metric connection, Filomat 24:4, (2010), pp 9–16.
[23] Chaubey S.K. and Kumar Ashok, Semi symmetric metric T-connection in an almost contact metric manifold, Int. Math. Forum, 5, (2010), no.23, pp 1121-1129.
[24] Chaubey S. K. and R. H. Ojha, On a semi-symmetric non-metric connection, Filomat, 26, 2, (2012), pp 63-69.
[25] Chaubey S.K. and Pandey A.C., Some properties of a semi symmetric connection on a Sasakian manifold,Int. J. Contemp. Math. Sci., Vol8, (2013), no.16, pp 789-799.
[26] Chaubey S.K. and Ojha R.H., On the m-projective curvature tensor of a Kenmotsu manifold, Diff. Geom. Dynamical system, Vol. 12,(2010), pp 52–60.
[27] De U.C. and Avijit Sarkar, On the quasi conformal curvature tensor of a (k, μ)contact metric manifold,math reports14(64),(2012), pp 115–129.
[28] Shukla N.V.C., and Saha Riddhi Jung, On a semi-symmetric non-metric connection in P-sasakian manifolds, Bull. Cal. Math. Soc., 106,(1),(2014), pp 73-82.